OMEP

OFICINA PARA EL MEJORAMIENTO DE LAS ESCUELAS PÚBLICAS DE PUERTO RICO

19 de julio de 2022

NÚMERO DE SUBASTA: CI-2022-06-05-4271
PROYECTO DE REPARACIONES GENERALES

48306 - MILDRED ARROYO CARDOZA
BARRIO MIRADERO CARR.P.R. 308 KM. 5.1 SECTOR PUERTO REAL, CABO ROJO, P.R. 00623
+
47357 - SEVERO E. COLBERG RAMÍREZ
CARR. 102 KM 19.4, AVE. PEDRO ALBIZU CAMPOS, CABO ROJO, P.R. 00623

ADDENDUM #1

Estimados Licitadores:

A tenor con orden ejecutiva 2021 – 021 y el Artículo 7.2.5 del Reglamento Uniforme de Compras y Subastas de Bienes, Obras y Servicios No Profesionales de la Administración de Servicios Generales del Gobierno de Puerto Rico se aclara lo siguiente para el proceso de adquisición referido.

1. En la **INVITACION A SOMETER PROPUESTAS**, se elimina el requerimiento de someter cualificaciones ambientales con la propuesta según Articulo XI.iv.

2. Se enmienda el **EXHIBIT J - Condiciones Especiales Suplementarias**, Articulo II.C.1 – Instalaciones Temporeras, y se añade la siguiente oracion:
   - *"El contratista seleccionado deberá someter para aprobación de OMEP/DEPRE las siguientes cualificaciones ambientales antes de comenzar cualquier trabajo de mitigación y disposición de asbestos/plomo:*
     a. *Certificación de Plomo de la EPA - Lead EPA RRP (Renovation, Reparation and Paint).*
     b. *Evidencia de certificación en Manejo de Plomo 2 horas (Two hours course of Asbestos Awareness).*
     c. *Evidencia de certificación Manejo de seguridad en manejo de hongo- (Two hours course of safety Mold Awareness).*
     d. *Certificación de 30 horas OSHA (General o construcción) del supervisor designado por el contratista. Plan de seguridad específico al alcance de trabajo del proyecto.*

3. Se incluyen como parte de este ADDENDUM #1 los **Key Plans**.

4. Se enmienda el EXHIBIT K – Reference Technical Specifications y se reemplaza en su totalidad por un nuevo **EXHIBIT K – DRAWINGS AND REFERENCE TECHNICAL SPECIFICATIONS** incluido y anejado a este ADDENDUM #1.

Los demás pronunciados de los pliegos de subasta permanecen inalterados.

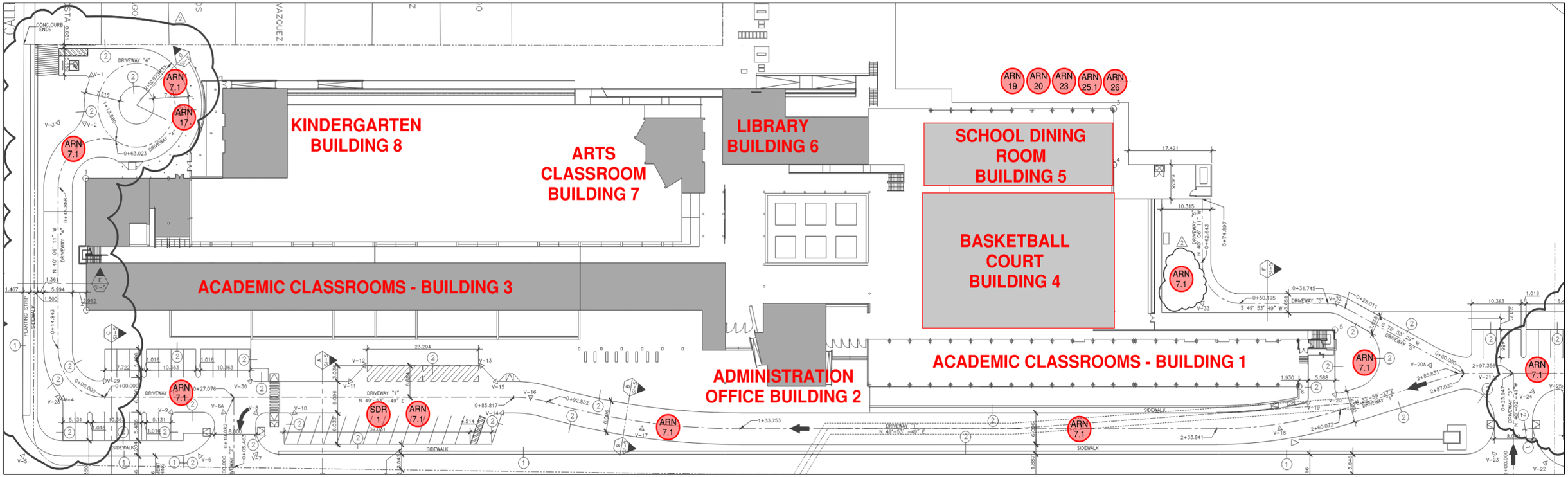
Este Addendum se hace formar parte de todos los documentos relacionados al proceso de adquisición y a las órdenes emitidas bajo el mismo. Todo contratista deberá indicar haber recibido este Addendum en el Exhibit B – Declaración del Contratista.

Exhibit K

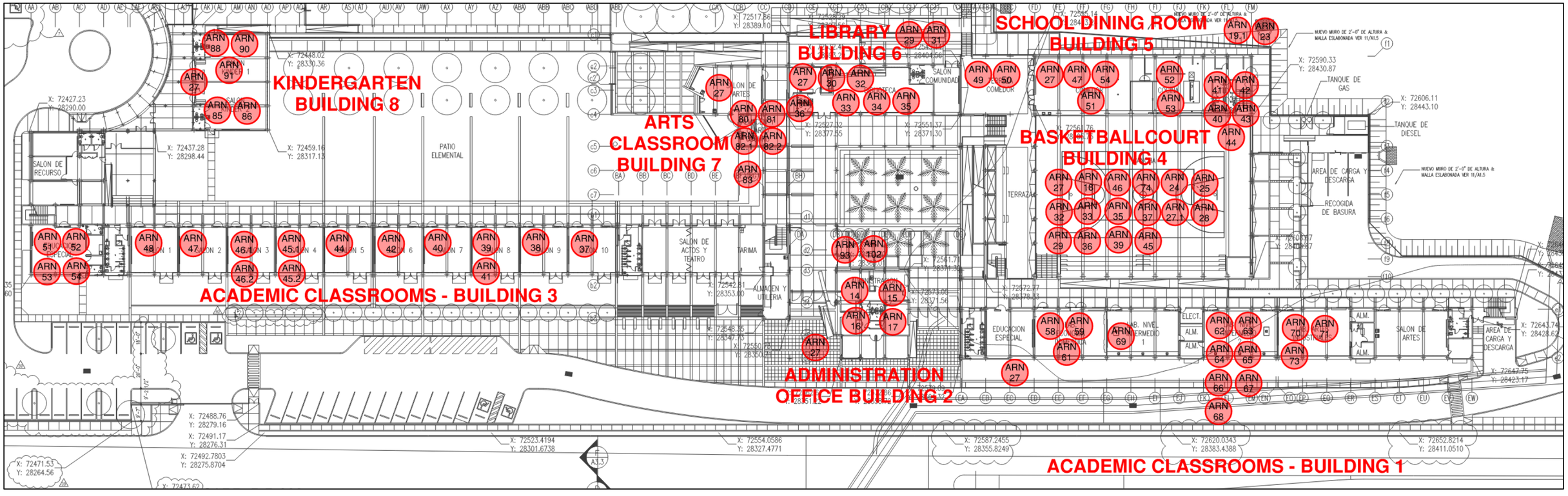
Key Plans
Typical Recommended Repairs
Reference Technical Specifications

KEY PLANS

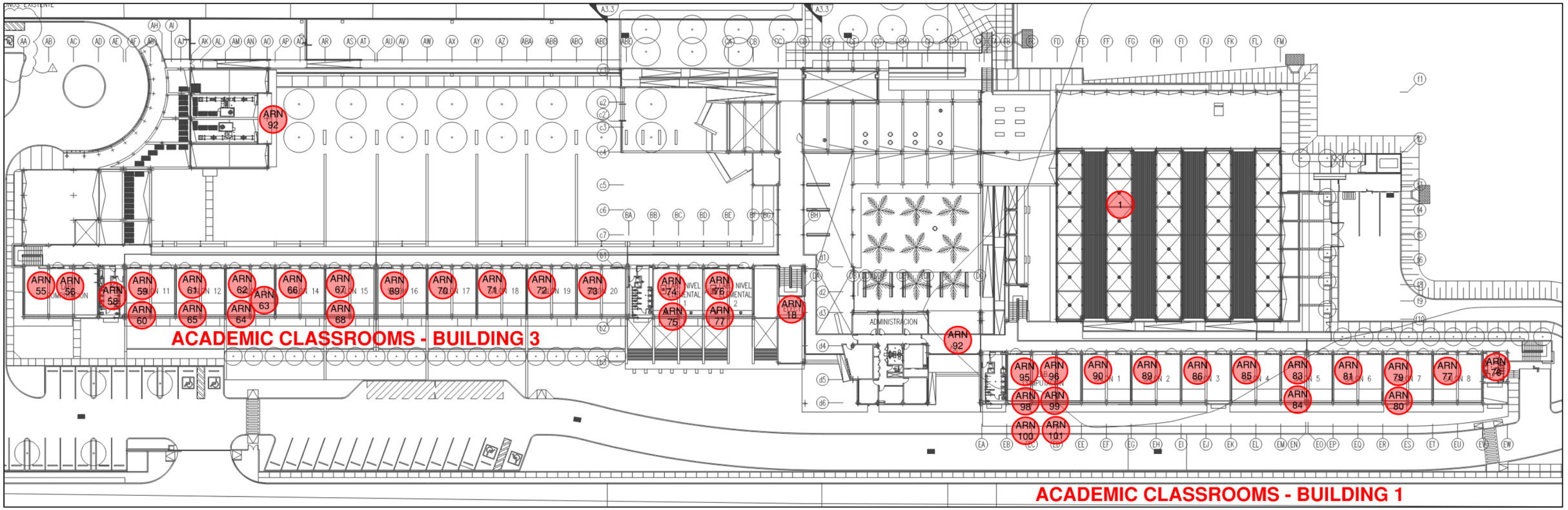
Mildred Arroyo Cardoza



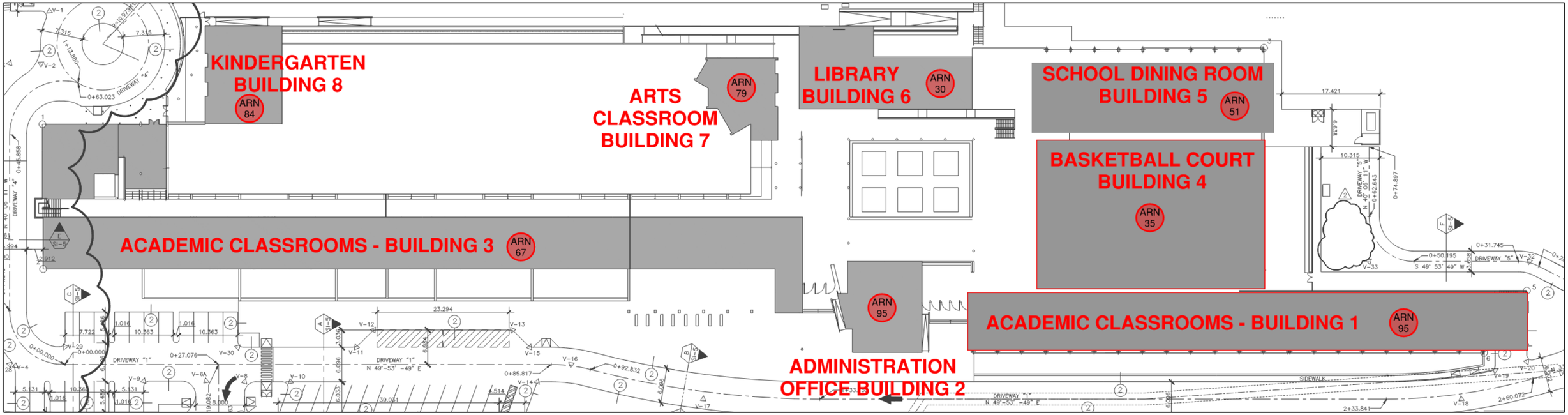
KEY PLAN – 43806 MILDRED ARROYO CARDOZA, CABO ROJO [SITE PLAN]



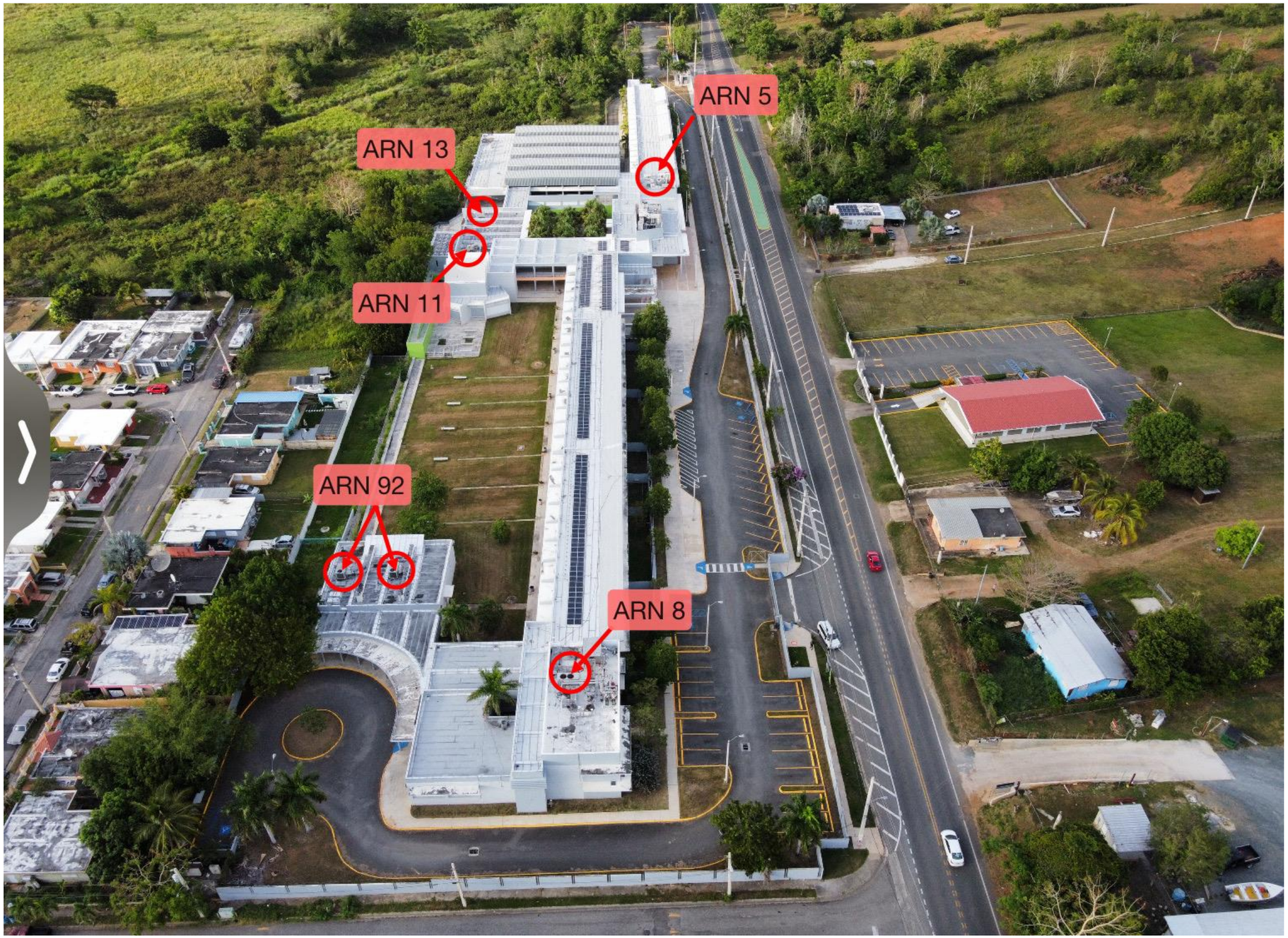
KEY PLAN – 43806 MILDRED ARROYO CARDOZA, CABO ROJO [FIRST FLOOR PLAN]



KEY PLAN – 43806 MILDRED ARROYO CARDOZA, CABO ROJO [SECOND FLOOR PLAN]



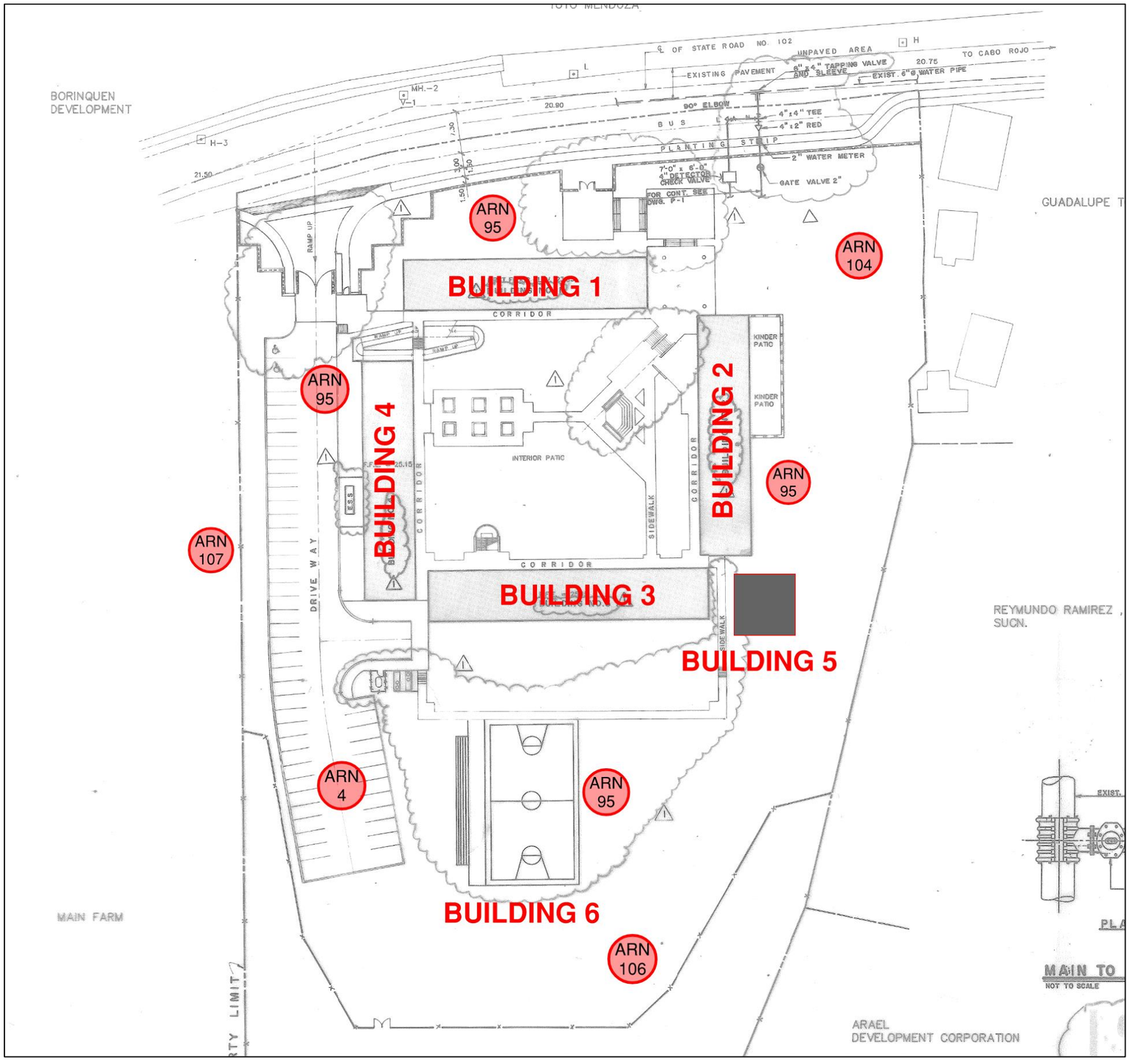
KEY PLAN – 43806 MILDRED ARROYO CARDOZA, CABO ROJO [ROOF PLAN]



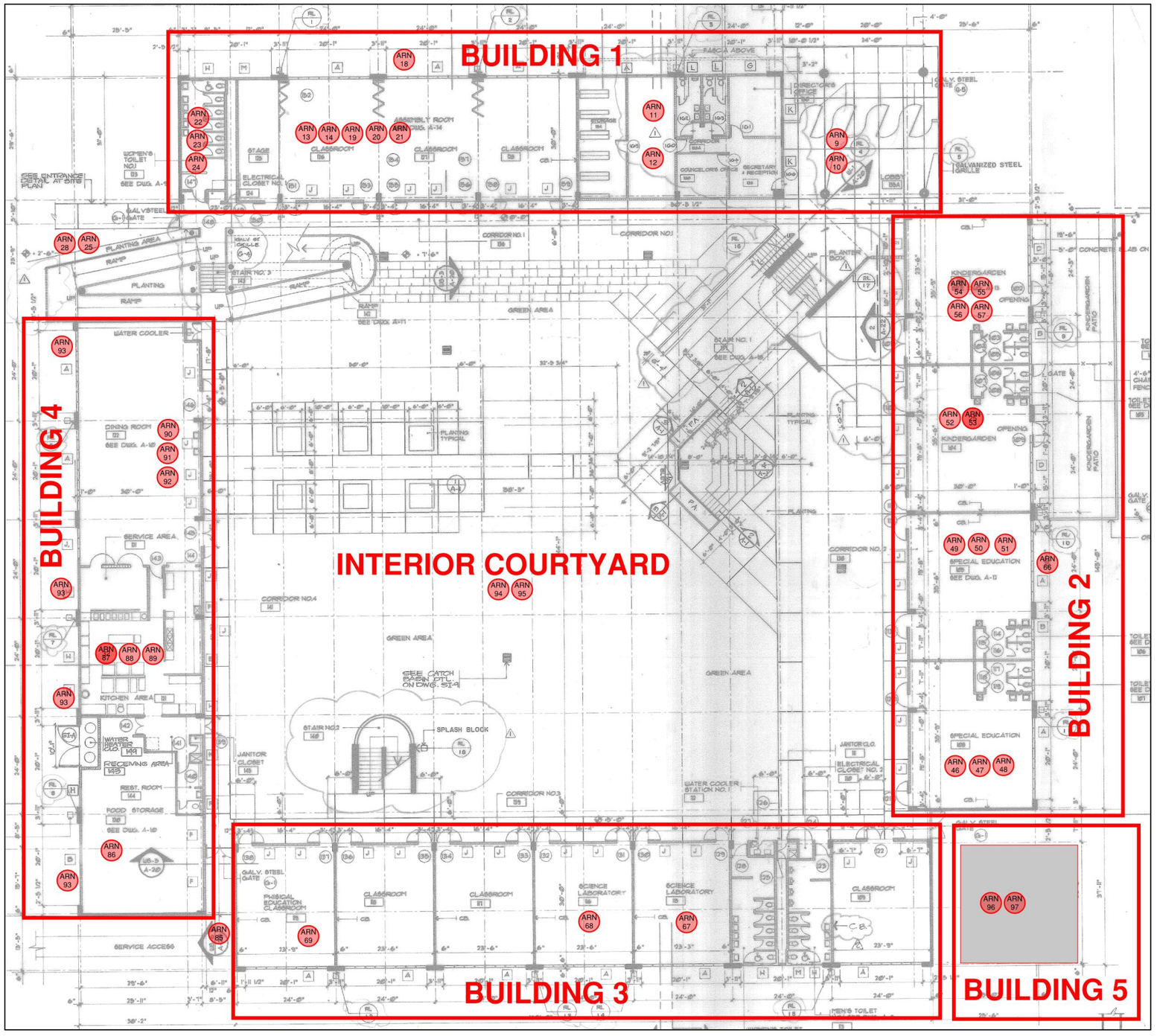
KEY PLAN – 43806 MILDRED ARROYO CARDOZA, CABO ROJO [MECHANICAL EQUIPMENT]

KEY PLANS

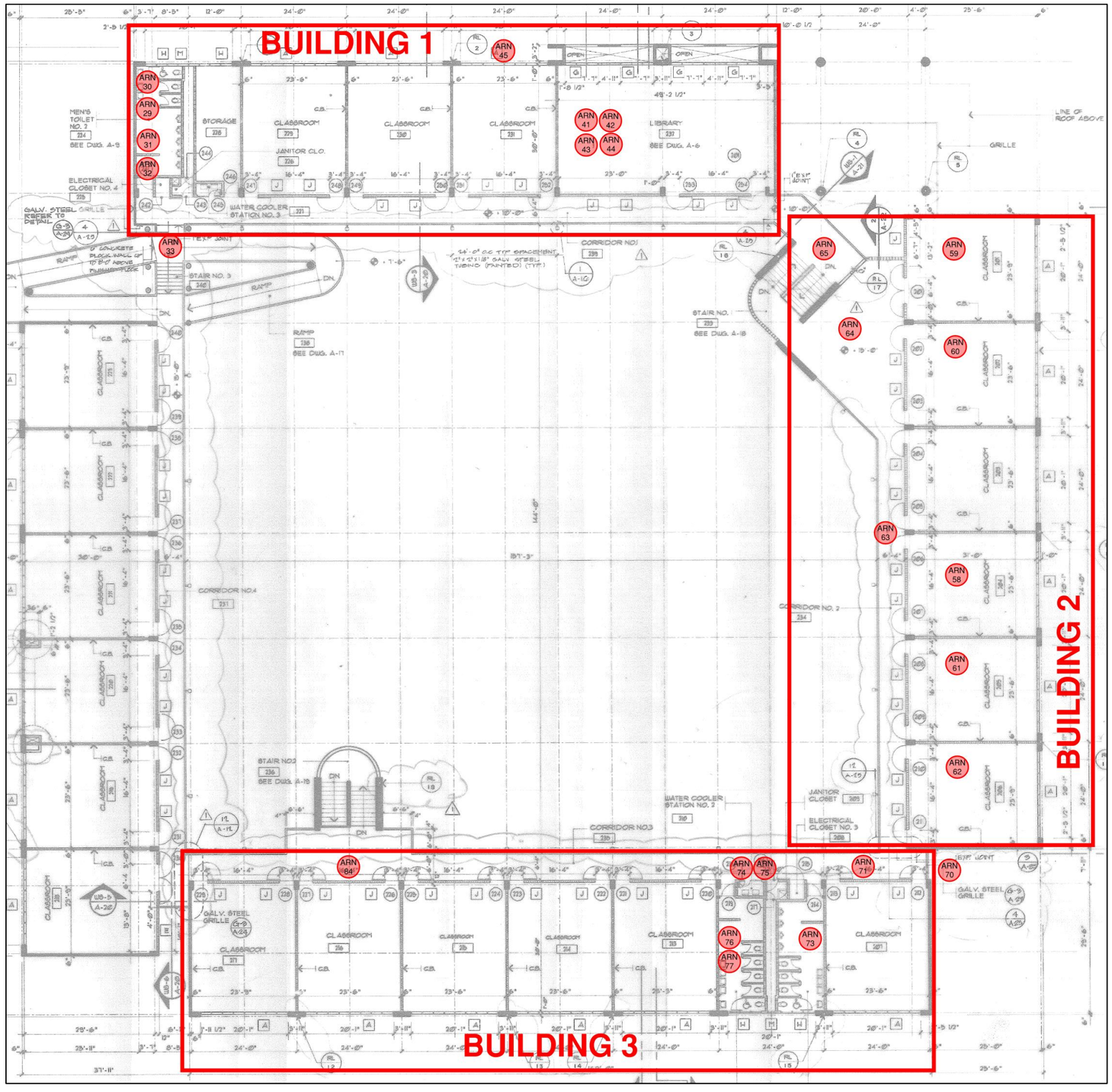
Severo E. Colberg Ramírez



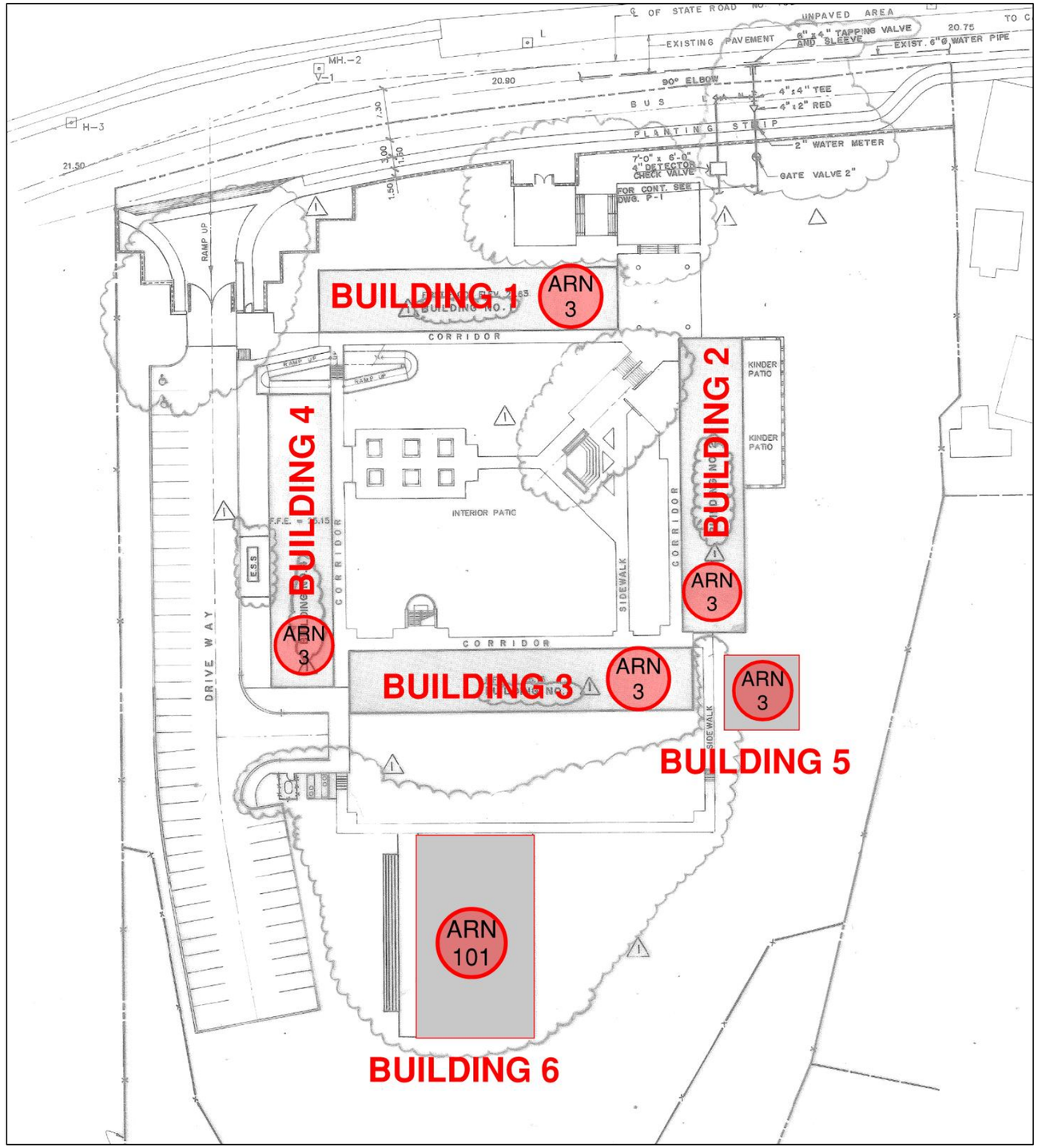
KEY PLAN – 47357 ESCUELA SEVERO COLBERG, CABO ROJO [SITE PLAN]



KEY PLAN – 47357 ESCUELA SEVERO COLBERG, CABO ROJO [FIRST FLOOR PLAN]



KEY PLAN – 47357 ESCUELA SEVERO COLBERG, CABO ROJO [SECOND FLOOR PLAN]



KEY PLAN – 47357 ESCUELA SEVERO COLBERG, CABO ROJO [ROOF PLAN]



KEY PLAN – 47357 ESCUELA SEVERO COLBERG, CABO ROJO [BASKETBALL COURT]

TYPICAL RECOMMENDED REPAIRS

TYPICAL RECOMMENDED REPAIRS

At the locations where cracks are showing on the surface remove the plaster and review the concrete/masonry element below to determine if the below crack repairs are warranted. The products referenced in this narrative are for reference only. Contractor may base their proposal on products from other manufacturers that are similar or equal in performance.

I. Concrete Spalls

Two products produced by Sika Corporation can be used to repair the concrete spalls. The products to be used at the contractor's choice are Sika Quick VOH or Sikatop 123 plus. We recommend the Sika Quick VOH unless the product sets too quickly for construction. Below is comparison of the two materials.

- Sika Quick VOH sets much quicker than Sikatop 123 Plus which may cause construction issues if the material hardens too fast.
- Sika Quick VOH is cheaper than Sikatop 123 plus.
- Sika Quick VOH can be installed in 3" lifts versus 1.5" lifts using Sikatop 123 plus.
- Sikatop 123 plus has a 6,000 psi strength versus Sika Quick VOH having 5,500 psi. The 5,500 psi strength is acceptable.
- Sika Quick VOH is a single component material which just needs water added. Sikatop 123 Plus is a 2-component material.

Reference **Appendix A** for detailed installation instructions for the patching materials and the product data sheets. Key details indicated in the instructions include:

- Area should be clean and sound
- Remove contaminations and bond inhibiting materials
- Sawcut around perimeter of repair area to achieve a minimum of 3/8" shoulder and eliminate feathered edges.
- Remove corrosion from rebar by blast cleaning or by mechanical means.
- Saturate the concrete surface but do not leave standing water. This reduces the drying out of the patching material when applied to the concrete.
- Apply the repair mortar in a thin coat pressing to the concrete surface filling all voids including behind reinforcing bars. This serves as the bonding agent.
- Apply the repair mortar not exceeding the maximum lift thickness of 3" for Sika Quick VOH or 1.5" for Sikatop 123 plus. Repeat lifts as required until the repair is completed.
- Cure patch per ACI recommendations directly after finishing using wet burlap and a fine mist of water.

II. Concrete Cracks

Concrete (not masonry) cracks are to be repaired using a combination of products produced by Sika Corporation. The products are Sikadur 31 Hi-Mod Gel which encapsulates the crack and Sikadur 35 Hi-Mod LV which repairs the cracks. Reference **Appendix B Part 3-Execution** for the crack repair procedure and the product data sheets. Key details indicated in the instructions include:

- Set the porting devices into the cracks. The devises are to be installed at an interval which will allow the complete length and depth of the crack to be filled with Sikadur 35.
  - The contractor may use drilled porting devices followed by encasing the crack in Sikadur 31.
  - The contractor may use surface mounted porting devices. Surface mounted porting devises are to be held in place using Sikadur 31.
- Inject Sikadur 35 into the porting devises to completely fill the length and depth of the cracks.

- After the Sikadur 35 has cured the Sikadur 31 product and porting devises are to be removed and the area cleaned.

III. Masonry Cracks

The concrete repair materials are not approved for masonry repairs. The cracks in the masonry are to be repaired by repointing the masonry joints and cracks with Type S masonry mortar. The mortar is to be pressed into the cracks to fill the face shells solid.

Construction

SikaTop 123 Plus

Also to be used for
SikaQuick VOH

Application Instructions

For Reference Only.
Contractor required to submit products that are approved-similar or equal.



Sika Corporation

Construction

SikaTop 223 Plus

- Two-component, polymer-modified, portland cement based.
- Fast-setting, non-sag mortar.
- High performance repair mortar for vertical and overhead surfaces.
- Offers the additional benefit of FerroGard 901- A penetrating corrosion inhibitor.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.



Sika Corporation

Construction

SikaTop 123 Plus

- Where to use:
  - On grade, above, and below grade on concrete and mortar.
  - On vertical and overhead surfaces.
  - As a structural repair material for:
    - Parking structures
    - Industrial plants
    - Water/waste water treatment facilities
    - Roads, walkways, bridges, tunnels, dams, ramps, etc.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Construction

SikaTop 123 Plus

- Packaging:
  - “A” Comp: 1 gal Jug of Dispersion.
  - “B” Comp: 44 lb Multi-wall bag.
- Coverage:
  - .39 cu. ft / unit.
  - 674 cu. inches per unit.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation

Construction

Surface Preparation

- Cementitious Substrates:
  - Should be clean and sound.
  - Remove contaminations and bond inhibiting materials from repaired area.
  - Obtain exposed/fractured aggregate surface ~1/16 to 1/8 inch profile (ICRI CSP 5 & above).
  - Substrate must be saturated surface dry (SSD) with no standing water.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Construction

Surface Preparation

- Cementitious Substrates:
  - Surface should be cleaned and roughened to create a profile.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

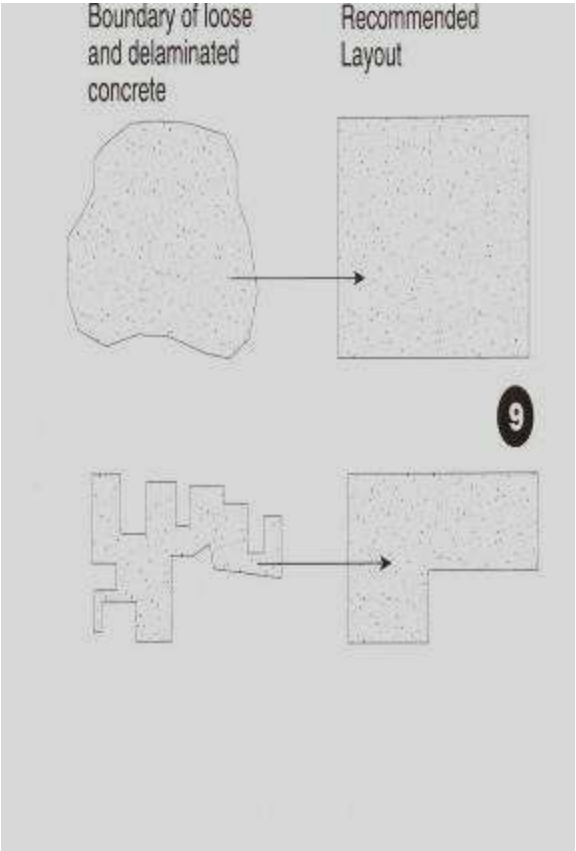
Sika®

Sika Corporation

Construction

Surface Preparation

- Saw cut around perimeter of repair area to achieve a minimum 3/8” shoulder.
- Eliminates feathered edges giving a clean repair transition



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

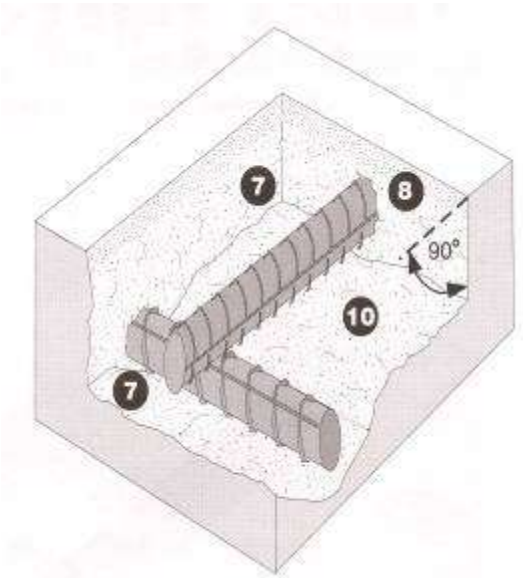
Sika®

Sika Corporation

Construction

Surface Preparation

- Steel:
  - Remove all corrosion and contaminants from exposed steel.
  - Surface should be cleaned thoroughly by blast cleaning or mechanical means.
  - Exposed steel should be cleaned to white steel.
  - If half of the diameter is exposed, chip behind bar, ½" minimum for mortar only.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

Steel Preparation

- Steel should be cleaned to a bright metal finish.





For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

Tools Required

- ½” Drill Motor.
- Low speed drill 400-600 rpm.
- Large mixing paddle
- Margin trowel



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

Mixing

- Pour “A” Component into clean pail.
- Leave approximately 1” of “A” Component in jug.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

Mixing

- Add “B” Component to pail with “A” already inside, while mixing continuously.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Construction

Mixing

1. Dispersion ¾ -1 gallon of dispersion/Bag.
2. Start with adding liquid to the mixing container.
3. Slowly add powder.
4. Once all the powder is added mix for **3 minutes**.
5. Do not add any more than the recommended liquid.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

Mixing

1. While mixing for 3 minutes stop to scrape down the sides to insure all material is fully mixed.
2. Add additional “A”Comp. liquid for desired consistency.
3. Most cases you will have liquid left.



4. Thorough mixing and proper proportioning is necessary.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation

Construction

ST 123+ Application

- Apply the mortar to the patch area while the Armatec 110 EpoCem is still wet.



- If Armatec is not used as a bonding agent, SSD the surface and scrub coat the repair mortar into the substrate filling all pores and voids.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

ST 123+ Application

- Apply SikaTop repair mortar to patch.
- Press mortar behind rebar and make sure the material is consolidated and compacted fully.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika®

Sika Corporation

Construction

ST 123+ Application

- Complete filling patch area.
- Work mortar from the center of the patch to the outside.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.



Sika Corporation

Construction

Min / Max application thickness

- Neat
  - Min 1/8 inch
  - Max 1.5 inch

- SikaTop 123 Plus cannot be extended with aggregate.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Construction

SikaTop 123 Finish

- After filling patch section, allow mortar to set to desired stiffness.
- Then finish with steel, wood, or sponge float to attain look required.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Construction

Sikatop 123+ Finish

- To assist in the finishing of the SikaTop use SikaFilm.
  - SikaFilm is a finishing aid that also retards moisture evaporation.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Construction

SikaTop 123+ Finish

- You can use a steel trowel to attain a smooth surface.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.



Sika®

Sika Corporation

Construction

Sponge Float Finish

- You can use Sponge float to attain a textured surface.







For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation

Construction

SikaTop Curing

- Cure as per ACI recommendations. Curing is required.
- Moist cure with wet burlap and polyethylene, a fine mist of water.
- Moist curing should commence immediately after finishing.
- Protect newly applied material from direct sun light, wind, rain and frost.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation

Construction

SikaTop 123 Plus

Sika Technical Data Sheets can be obtained via:

www.sikaconstruction.com

Refer to data sheets for specific information on each Sika product.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation



SIKAQUICK® VOH

FAST SETTING, ONE COMPONENT, CEMENTITIOUS VERTICAL AND OVERHEAD REPAIR MORTAR

- Application up to 3" on vertical surfaces in one layer
- Overhead thickness up to 2"
- Fiber reinforced and polymer modified containing corrosion inhibitor
- Low dust version available

Available in
Bag
44 lbs.



For Reference Only.
Contractor required to submit products that are approved-similar or equal.

BUILDING TRUST

SIKAQUICK® VOH

VERTICAL AND OVERHEAD REPAIR MORTAR

APPLICATIONS

- Fast repairs to overhead and vertical concrete and mortar surfaces on grade, above and below grade.
- Repair material for building facades, parking structures, industrial plants, bridges, etc.
- Fast setting repair material for new construction defects

TYPICAL DATA

- Shelf Life: One year in original, unopened bags
- Storage Conditions: Store dry at 40°-95°F (4°-35°C)
- Product Conditioning: Condition material to 65°-75°F before using.
- Color: Concrete gray
- Mixing Ratio: 6 - 6.5 pints/unit
- Density (Wet mix): ~ 125 lbs. / cu. ft.
- Application Time: Approximately 20 minutes.
- Finishing Time: 20-30 minutes
- Lift Height: Max: 3" Min: 1/8"
- Time Between Lifts: After final set

BENEFITS

- Minimal time required between lifts.
- Fast finishing time
- Available as low dust version
- Time/labor-saving material; application up to 3 inches on vertical surfaces in one layer
- Easy to use; just add water
- High bond strength ensures excellent adhesion
- High early and ultimate strength
- Increased freeze/thaw durability and resistance to deicing salts
- Suitable for exterior and interior applications
- Not a vapor barrier
- Overhead thickness up to 2"
- Fiber reinforced and polymer modified
- Contains corrosion inhibitor

LITERATURE

- Product Data Sheet
- Material Safety Data Sheet

*Always refer to Current Product Data Sheet and MSDS for detailed performance specifications prior to use.



Mix to uniform consistency, no longer than 3 minutes



Moist cure and protect from elements immediately after finishing.



Scrub material into substrate, filling any pores and voids.



Finish with trowel, float, or sponge, depending on desired surface texture.

Note: Advice on specific applications is available from the Technical Service Department of Sika Construction Products Division.

FOR MORE INFORMATION:

Contact Sika: Phone 800.933.SIKA(7452) Website: usa.sika.com

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 201-933-8800
Fax: 201-933-6225

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

BUILDING TRUST

© Sika Corporation/Refurbishment/06.1303.2/11/2018

SIKAQUICK® VOH

VERTICAL AND OVERHEAD REPAIR MORTAR

APPLICATIONS

- Fast repairs to overhead and vertical concrete and mortar surfaces on grade, above and below grade.
- Repair material for building facades, parking structures, industrial plants, bridges, etc.
- Fast setting repair material for new construction defects

TYPICAL DATA

- Shelf Life: One year in original, unopened bags
- Storage Conditions: Store dry at 40°-95°F (4°-35°C)
- Product Conditioning: Condition material to 65°-75°F before using.
- Color: Concrete gray
- Mixing Ratio: 6 - 6.5 pints/unit
- Density (Wet mix): ~ 125 lbs. / cu. ft.
- Application Time: Approximately 20 minutes.
- Finishing Time: 20-30 minutes
- Lift Height: Max: 3" Min: 1/8"
- Time Between Lifts: After final set

BENEFITS

- Minimal time required between lifts.
- Fast finishing time
- Available as low dust version
- Overhead thickness up to 2"
- Easy to use; just add water
- High bond strength ensures excellent adhesion
- High early and ultimate strength
- Increased freeze/thaw durability and resistance to deicing salts
- Suitable for exterior and interior applications
- Time/labor-saving material; application up to 3 inches on vertical surfaces in one layer
- Fiber reinforced and polymer modified
- Contains corrosion inhibitor

LITERATURE

- Product Data Sheet
- Safety Data Sheet
- CSI Specification

*Always refer to Current PDS and SDS for detailed performance specifications prior to use.



Mix to uniform consistency, no longer than 3 minutes



Moist cure and protect from elements immediately after finishing.



Scrub material into substrate, filling any pores and voids.



Finish with trowel, float, or sponge, depending on desired surface texture.

Note: Advice on specific applications is available from the Technical Service Department of Sika Construction Products Division.

FOR MORE INFORMATION:

Contact Sika: Phone 800.933.SIKA(7452) Website: usa.sika.com

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 201-933-8800
Fax: 201-933-6225

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

BUILDING TRUST

© Sika Corporation/Refurbishment/06.1303.2/11/2018

BUILDING TRUST

PRODUCT DATA SHEET

SikaTop®-123 Plus

Two-component, polymer-modified, cementitious, non-sag mortar plus Sika FerroGard® 901 penetrating corrosion inhibitor

PRODUCT DESCRIPTION

SikaTop®-123 Plus is a two-component, polymer-modified, Portland cement-based, fast-setting, non-sag mortar. It is a high performance repair mortar for vertical and overhead surfaces and offers the additional benefit of Sika FerroGard® 901, a penetrating corrosion inhibitor included in its formulation.

USES

- On grade, above and below grade on concrete and mortar.
- On vertical and overhead surfaces.
- As a structural repair material for parking structures, industrial plants, walkways, bridges, tunnels, dams and ramps.
- Approved for repairs over cathodic protection systems

CHARACTERISTICS / ADVANTAGES

- Extremely low shrinkage proven by four industry standard test methods.
- High compressive and flexural strengths.
- Increased freeze/thaw durability and resistance to deicing salts.
- Increased density - improved carbon dioxide resistance (carbonation) without adversely affecting water vapor transmission (not a vapor barrier).
- Enhanced with Sika FerroGard® 901, a penetrating corrosion inhibitor - reduces corrosion even in the adjacent concrete.
- Compatible with coefficient of thermal expansion of concrete - Passes ASTM C 884.

APPROVALS / STANDARDS

- USDA certifiable for incidental food contact
- ANSI/NSF Standard 61 potable water approved compliant.
- Tested per ICRI Guidline NO. 320.3R for inorganic repair material data sheet protocol

PRODUCT INFORMATION

Packaging	Component A	1 gal (3.68 L) jug - 4/carton
	Component B	44 lb. (20 kg) bag
Appearance / Color	Gray powder	
Shelf Life	12 months from date of production if stored properly in original, unopened and undamaged sealed packaging	
Storage Conditions	Store dry at 40–95 °F (4–35 °C).	

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Protect Component ‘B’ from moisture. If damp, discard material
Protect Component ‘A’ from freezing. If frozen, discard.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

TECHNICAL INFORMATION

Compressive Strength	1 day		3,000 psi (20.7 MPa)	(ASTM C-109) 73 °F (23 °C) 50 % R.H.
	7 days		4,000 psi (27.6 MPa)	
	28 days		6,000 psi (41.4 MPa)	
Modulus of Elasticity in Compression	2.94 x 10^6 psi			(ASTM C-469)
Flexural Strength	28 days		1,500 psi (10.3 MPa)	(ASTM C-293) 73 °F (23 °C) 50 % R.H.
Splitting tensile strength	28 days		900 psi (6.2 MPa)	(ASTM C-496) 73 °F (23 °C) 50 % R.H.
Tensile Adhesion Strength	28 days		2,000 psi (13.8 MPa)	(ASTM C-882 modified)
	* Mortar scrubbed into substrate at 73 °F (23 °C) and 50 % R.H.			
Pull-Out Resistance	28 days		500 psi (3.4 MPa) Substrate failure	(ASTM C-1583)
Shrinkage	28 days	1x1x11-1/4'' specimen	0.05 %	(ASTM C-157, mod. ICRI 320.3R)
	28 days	3x3x11-1/4'' specimen	0.038 %	
Ring test			> 70 days	(ASTM C-1581)
	Average Max Strain		- 36 µstrain	
	Average Stress Strain		4.92 psi/day	
	Potential for Cracking		Low	
Baenziger block	90 days		No cracking	
Freeze-Thaw Stability	300 cycles		98 %	(ASTM C-666)
Rapid Chloride Permeability	28 days		< 500 C	(ASTM C-1202 AASHTO T-277)

APPLICATION INFORMATION

Fresh mortar density	132 lb/ft^3 (2.2 kg/l)	(ASTM C-138)
Coverage	0.39 ft^3 (0.01 m^3) per bag (Coverage figures do not include allowance for surface profile and porosity or material waste)	
Layer Thickness	**Min.**	**Max.**
	1/8 " (3 mm)	1.5" (38 mm)
Product Temperature	65–75 °F (18–24 °C)	
Ambient Air Temperature	> 45 °F (7 °C)	
Substrate Temperature	> 45 °F (7 °C)	
Set Time	15 - 40 min.	(ASTM C-266)
Final set time	< 60 min.	(ASTM C-266)

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Finishing time	20–60 minutes Note: All times start after adding Component 'B' to Component 'A' and are highly affected by temperature, relative humidity, substrate temperature, wind, sun and other job site conditions.

BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

**For Reference Only.
Contractor required to submit products that are approved-similar or equal.**

DIRECTIVE 2004/42/CE - LIMITATION OF EMISSIONS OF VOC

0 g/l (EPA method 24)

LIMITATIONS

- Do not use solvent-based curing compound.
- Size, shape and depth of repair must be carefully considered and consistent with practices recommended by ACI or ICRI.
- For additional information on substrate preparation, refer to ICRI Guideline No. 310.2R.
- If aggressive means of substrate preparation is employed, substrate strength should be tested in accordance with ACI 503 Appendix A prior to the repair application.
- As with all cement based materials, avoid contact with aluminum to prevent adverse chemical reaction and possible product failure. Insulate potential areas of contact by coating aluminum bars, rails, posts etc. with an appropriate epoxy such as Sikadur® 32, Hi-Mod.

APPLICATION INSTRUCTIONS

SURFACE PREPARATION

Surface preparation

- Surface must be clean and sound. Remove all deteriorated concrete, dirt, oil, grease, and other bond-inhibiting materials from the area to be repaired.
- Be sure repair area is not less than 1/8" (3 mm) in depth.
- Preparation work should be done by high pressure water blast, scabbler or other appropriate mechanical means to obtain an exposed aggregate surface profile of ±1/16" (1.6 mm) (CSP-5).
- To ensure optimum repair results, the effectiveness of decontamination and preparation should be assessed by a pull-off test.
- Saw cutting of edges is preferred and a dovetail is recommended.
- Substrate should be Saturated Surface Dry (SSD) with clean water prior to application. No standing water should remain during application.

Priming

- Reinforcing steel: Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. Where corrosion has occurred due to the presence of chlorides, the steel should be high pressure washed with clean water after mechanical cleaning. For priming of reinforcing steel use Sika® Armatec® 110 EpoCem (consult PDS).

- Concrete Substrate:
  - Prime the prepared substrate with a brush or sprayed

applied coat of Sika® Armatec® 110 EpoCem (consult PDS).
- Alternately, a scrub coat of SikaTop®-123 Plus can be applied prior to placement of the mortar. The repair mortar has to be applied into the wet scrub coat before it dries.

MIXING

- Pour Component 'A' into mixing container.
- Add Component 'B' while mixing continuously.
- Mix mechanically with a low-speed drill (400–600 rpm) and mixing paddle or mortar mixer.
- Mix to a uniform consistency, maximum 3 minutes.
- Manual mixing can be tolerated only for less than a full unit. Thorough mixing and proper proportioning of the two components is necessary.

**For Reference Only.
Contractor required to submit products that are approved-similar or equal.**

APPLICATION

- SikaTop®-123 Plus must be scrubbed into the substrate, filling all pores and voids.
- Force material against edge of repair, working toward center.
- After filling repair, consolidate, then screed.
- Material may be applied in multiple lifts.

Multiple lifts

- Where multiple lifts are required score top surface of each lift to produce a roughened surface for next lift.
- Allow preceding lift to reach initial set, 30 minutes minimum, before applying fresh material.
- Substrate should be Saturated Surface Dry (SSD) with clean water prior to application. No standing water should remain during application.
- Scrub fresh mortar into preceding lift.
- Allow mortar or concrete to set to desired stiffness, then finish with wood or sponge float for a smooth surface.

CURING TREATMENT

- As per ACI recommendations for Portland cement concrete, curing is required.
- Moist cure with wet burlap and polyethylene, a fine mist of water or a water based* compatible curing compound (ASTM C-309).
- Curing compounds adversely affect the adhesion of following lifts of mortar, leveling mortar or protective coatings.
- Moist curing should commence immediately after finishing.
- Protect freshly applied mortar from direct sunlight, wind, rain and frost.

* Pretesting of curing compound is recommended.

OTHER RESTRICTIONS

See Legal Disclaimer.

LEGAL DISCLAIMER

- **KEEP CONTAINER TIGHTLY CLOSED**
- **KEEP OUT OF REACH OF CHILDREN**
- **NOT FOR INTERNAL CONSUMPTION**
- **FOR INDUSTRIAL USE ONLY**
- **FOR PROFESSIONAL USE ONLY**

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates ("SIKA"), the user must always

read and follow the warnings and instructions on the product's most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA's Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within the product's shelf life. User determines suitability of product for intended use and assumes all risks. User's and/or buyer's sole remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs. **NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.**

Sale of SIKA products are subject to the Terms and Conditions of Sale which are available at https://usa.sika.com/en/group/SikaCorp/termsandconditions.html or by calling 1-800-933-7452.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: +1-800-933-7452
Fax: +1-201-933-6225
usa.sika.com

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537

Appendix B - Concrete Crack Repairs

Spec Component: SC-001-03/10
Sikadur 35, Hi-Mod LV
Sikadur 31, Hi-Mod Gel

DIVISION 3 -CONCRETE
Section 03930 Concrete Rehabilitation
Epoxy-Injected Crack Repair

Part 1 - General

1.01 Summary

A. This specification describes the pressure injection of cracks with an epoxy resin adhesive.

1.02 Quality Assurance

A. Manufacturing qualifications: The manufacturer of the specified product shall be ISO 9001/9002 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. Contractor qualifications: Contractor shall be qualified in the field of concrete repair and protection with a successful track record of 5 years or more. Contractor shall maintain qualified personnel who have received product training by a manufacturer's representative.

C. Install materials in accordance with all safety and weather conditions required by the manufacturer, or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult Material Safety Data Sheets for complete handling recommendations.

1.03 Delivery, Storage, and Handling

A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Store all materials off the ground and protect from rain, freezing or excessive heat until ready for use.

C. Condition the specified product as recommended by the manufacturer.

1.04 Job Conditions

A. Environmental Conditions: Do not apply material if it is raining or snowing or if such conditions appear to be imminent. Minimum application temperature 40ºF (5ºC) and rising.

B. Protection: Precautions should be taken to avoid damage to any surface near the work zone due to mixing and handling of the specified product.

1.05 Submittals

A. Submit two copies of manufacturer's literature, to include: Product Data Sheets, and appropriate Material Safety Data Sheets (MSDS).

1.06 Warranty

A. Provide a written warranty from the manufacturer against defects of materials for a period of one (1) year, beginning with date of substantial completion of the project.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Part 2 - Products

2.01 Manufacturers

A. **Sikadur 35 Hi-Mod LV**, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302 is considered to conform to the requirements of this specification.

B. **Sikadur 31 Hi-Mod Gel**, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302 is considered to conform to the requirements of this specification

2.02 Materials

A. Epoxy resin adhesive for pressure injection of cracks shall be **Sikadur 35 Hi-Mod LV:**

1. Component "A" shall be a modified epoxy resin of the diglycidiether bisphenol A Type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidiether bisphenol A Type containing suitable viscosity control agents, pigments, and accelerators.
3. The ratio of component A: componet B shall be 2:1 by volume
4. The material shall not contain asbestos.

B. Epoxy resin adhesive for sealing of cracks & porting devices shall be **Sikadur 31 Hi-Mod Gel.:**

1. Component "A" shall be a modified epoxy resin of the diglycidiether bisphenol A Type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidiether bisphenol A type containing suitable viscosity control agents, pigments, and accelerators.
5. The ratio of Component A: Componet B shall be 1:1 by volume
6. The material shall not contain asbestos.

C. Porting devices as required for either manual or automated application. Porting devices for automated application shall be supplied from maufacturer of the pressure injection equipment.

2.03 Performance Criteria

A. Properties of the mixed epoxy resin adhesive used for the pressure injection grouting::

1. Pot Life: min. 25 minutes (60 gram mass) @ 73° F
2. Tack-FreeTime:

90°F	(32°C)	1.5 to 2 hours
75°F	(24°C)	3 to 3.5 hours
40°F	(5°C)	14-16 hours

3. Viscosity: Approx. 375 cps.
4. Color: Clear, Amber

B. Properties of the cured epoxy resin adhesive used for pressure injection of grout:

1. Compressive Strength (ASTM D-695) .min.
   a 3 day: 10,000 psi (69.9 MPa)
   b. 7 day: 11,000 psi (75.8 MPa)
   c. 28 day: 13,000 psi (89.6 MPa)
   Compressive Modulus, Psi : min.
   a. 7 day 320,000 psi (2,200 Mpa)
2. Shear Strength (ASTM D-732)
   a. 14 day: 5,100 psi (35 MPa)
3. Flexural Strength (ASTM D-790) min.
   a. 14 day: 14,000 psi (97 MPa

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Tangent Modulus of Elasticity in Bending min.

b. 14 day: 370,000 psi (2,600 Mpa)

4. Bond Strength (ASTM C-882)

14 days (moist cure) min.

a. Hardened Concrete to Hardened Concrete: 2,900 psi (15 Mpa)

5. Water Absorption (ASTM D-570) max.

a. 24 hour 0.90%

6. Tensile properties (ASTM D-638) min.

a. 7 day Tensile Strength 8,900 psi (61 Mpa)

Elongation at Break 5.4%

b. 14 day Modulus of Elasticity 4.1×10^5 psi (2,800 Mpa)

C. Properties of the mixed epoxy resin adhesive used for sealing of cracks & porting devices::

1. Pot Life: min. 60 minutes (500 gram mass) @ 73° F
2. Tack-FreeTime: @73°F(23°C) 1.5 – 2.5 hours @ 30 mils thick
   Consistency: Non-Sag paste
3. Color: Concrete Gray

D. Properties of the cured epoxy resin adhesive used for sealing of cracks & porting devices:

1. Compressive Strength (ASTM D-695) .min. @ 73F
   a 1 day: 13,000 psi (89.6 MPa)
   b. 3 day: 14,000 psi (96.5 MPa)
   c. 28 day: 16,000 psi (110.3 MPa)
   Compressive Modulus, Psi : min.
   a. 7 day 795,000 psi (5,485 Mpa)
2. Shear Strength (ASTM D-732)
   a. 14 day: 4,600 psi (31.7 MPa)
3. Flexural Strength (ASTM D-790) min.
   a. 14 day: 6,100 psi (42 MPa)
   Tangent Modulus of Elasticity in Bending .min.
   b. 14 day: 1.67×10^6 psi (11,520 MPa)
4. Bond Strength (ASTM C-882)

   14 day (moist cure) min.

   a. Hardened Concrete to Hardened Concrete 2,900 psi (20 Mpa)

5. Water Absorption (ASTM D-570) max.

   a. 24 hour 0.79%

6. Tensile properties (ASTM D-638) min.

   a. 7 day Tensile Strength 3,300 psi (22.7 Mpa)

   Elongation at Break 0.9%

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Note: Tests above were performed with material & curing conditions at 73F & 45-55% relative humidity.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Part 3 - Execution

3.01 Mixing and Application

A. Mixing the epoxy resin adhesive for sealing the cracks & porting devices: Premix each component. Proportion equal parts by volume of Component "A" and Component "B" into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its potlife (60 minutes @ 73F).

B. Mixing of the epoxy resin adhesive used for the pressure injection grouting:

1. Manual: Proportion two parts by volume of Component "A" to one part Component "B" into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its potlife (20-30 minutes 73F).

C. Placement procedure:

1. The epoxy resin adhesive for sealing the cracks & porting device: Set the porting devices as required by the epuipment manufacturer. Spacing of the porting devices shall be accomplished as required to achieve the travel of the epoxy resin for the pressure injection grouting between ports and fill the cracks to the maximum. On structures open on both sides, provide porting devices on opposite sides at staggered elevations. Apply the mixed epoxy resin adhesive for sealing over cracks and around each porting device to provide an adequate seal to prevent the escape of the epoxy resin adhesive for the injection grouting. Where required by the Engineer, apply the epoxy resin adhesive for sealing in such a manner that minimal defacing or discoloration of the substrate shall result.

2. The epoxy resin adhesive for the pressure injection grouting:

Manual: Load the mixed epoxy resin adhesive for grouting into a disposable caulking cartridge or bulk-loading caulking gun. Inject the prepared cracks with a consant pressure in order to achieve maximum filling & penetration without the inclusion of air pockets or voids in the epoxy resin adhesive. Begin the pressure injection at the widest part of the crack being injected and continue until there is the appearance of epoxy resin adhesive at an adjacent port, thus indicating travel. When travel is indicated, to discontinue or continue the pressure injection from that port should be made by the contractor based on his experience, with the approval of the Engineer. Continue procedure until pressure injectable cracks has been filled.

Automated: Dispense the epoxy resin adhesive for grouting under constant pressure in accordance with prcedures recommended by the equipment manufacturerer as required to achieve maximum filling and penetration of the prepared cracks without the inclusion of air pockets or voids in the epoxy resin adhesive. The pressure injection of single or multiple ports, by use of a manifold system, is possible. This decision should be made by the contractor, with the approval of the Engineer. Continue the approved procedure until all pressure injectable cracks have been filled.

D. If penetration of any cracks is impossible, consult the Engineer before discontinuing the injection procedure. If modification of the proposed procedure is required to fill the cracks, submit said modification in writing to the Engineer for acceptance prior to proceeding.

E. Adhere to all limitations and cautions for the epoxy resin adhesive in the manufacturers current printed literature.

3.02 Cleaning

A. After the epoxy resin adhesive for grouting has cured, the epoxy resin adhesive for sealing cracks and porting devices shall be removed as required by the Engineer. Clean the substrate in a manner to produce a finish appearance acceptable to the Owner.

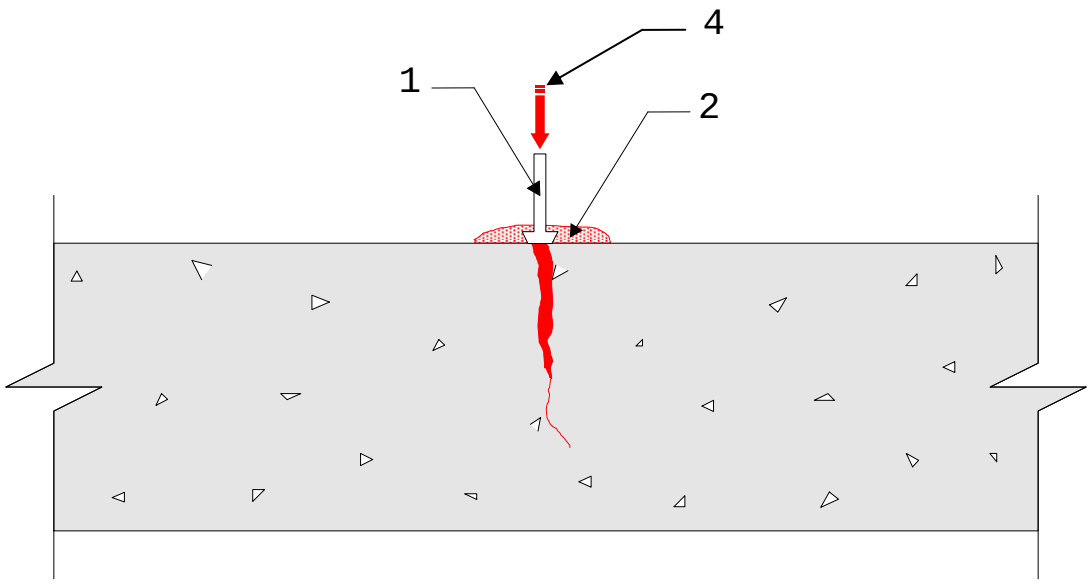
B. The uncured epoxy resin adhesive can be cleaned from tools with approved solvent. The cured epoxy resin adhesive can only be removed mechanically.

C. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

SC001 Sikadur 35, Hi-Mod LV Crack Filler

Sikadur 31, Hi-Mod Gel Cap Seal

For Reference Only. Contractor required to submit products that are approved-similar or equal.



1.Set porting devices over cracks.

2. Place mixed Sikadur 31, Hi-Mod Gel epoxy resin adhesive over cracks and around each injection port a minimum of 1" wide by a ¼" thick.

3. Allow sufficient time for epoxy resin adhesive cap seal to set before injecting.

4. When the cap seal has cured, inject Sikadur 35, Hi-Mod LV with steady pressure.

5. Use automated injection equipment or manual method.

The preceding specifications are provided by Sika Corporation as a guide for informational purposes only and are not intended to replace sound engineering practice and judgment and should not be relied upon for that purpose. **SIKA CORPORATION MAKES NO WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS OR THE CONTENTS OF THESE GUIDE SPECIFICATIONS**. Sika Corporation assumes no liability with respect to the provision or use of these guide specifications, nor shall any legal relationship be created by, or arise from, the provision of such specifications **SIKA SHALL NOT BE RESPONSIBLE UNDER ANY LEGAL THEORY TO ANY THIRD PARTY FOR ANY DIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND ARISING FROM THE USE OF THESE GUIDE SPECIFICATIONS.** The specifier, architect, engineer or design professional or contractor for a particular project bears the sole responsibility for the preparation and approval of the specifications and determining their suitability for a particular project or application.

Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's most current Technical Data Sheet, product label and Material Safety Data Sheet which are available at www.sikaconstruction.com or by calling (201) 933-7452. Nothing contained in any Sika materials relieves the user of the obligation to read and follow the warnings and instructions for each Sika product as set forth in the current Technical Data Sheet, product label and Material Safety Data Sheet prior to product use.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

BUILDING TRUST

PRODUCT DATA SHEET

Sikadur®-31 Hi-Mod Gel LPL

High-modulus, high-strength, structural, extended pot life, epoxy paste adhesive

PRODUCT DESCRIPTION

Sikadur®-31 Hi-Mod Gel LPL is a 2-component, 100 % solids, moisture-insensitive, high-modulus, high-strength, structural epoxy paste adhesive. It conforms to the current ASTM C-881, Types I and IV, Grade-3, Class-C and AASHTO M-235 specifications.

USES

Sikadur®-31 Hi-Mod Gel LPL may only be used by experienced professionals.

- Structural bonding of concrete, masonry, metals, wood, etc. to a maximum glue line of 1/8 in. (3mm)
- Seals cracks and around injection ports prior to pressure-injection grouting
- Interior, vertical, and overhead repair of concrete as an epoxy mortar binder
- As a pick-proof sealant around windows, doors, lock-ups etc. inside correctional facilities

CHARACTERISTICS / ADVANTAGES

- Extended pot life
- Moisture-tolerant before, during, and after cure
- High-modulus, high-strength, structural paste adhesive
- Excellent adhesion to concrete, masonry, metals, wood, and most structural materials
- Paste consistency ideal for vertical and overhead applications
- Fast-setting and strength-producing adhesive
- Convenient easy mix ratio A:B = 2:1 by volume

**For Reference Only.
Contractor required to submit products that are approved-similar or equal.**

PRODUCT INFORMATION

Packaging	3 gal. (11 L) units
Color	Concrete gray
Shelf Life	24 months in original, unopened containers
Storage Conditions	Store dry at 40–95 °F (4–35 °C). Condition material to 65–75 °F (18–24 °C) before using.
Consistency	Non-sag paste

TECHNICAL INFORMATION

Compressive Strength	36 hours	6,400 psi (41.4 MPa)	(ASTM D-695) 73 °F (23 °C) 50 % R.H.
	2 day	7,000 psi (41.4 MPa)	
	3 day	9,000 psi (48.3 MPa)	
Slant Shear Strength	**Bond Strength**	**Hardened Concrete to Hardened Concrete**	(ASTM C-882) 73 °F (23 °C) 50 % R.H.
	2 days	2,000 psi (20.7 MPa)	
	14 day (moist cure)	2,300 psi (20.0 MPa)	
Heat Deflection Temperature	124 °F (51 °C) (7 days [fiber stress loading = 264 psi (1.8 MPa)]		(ASTM D-648)

APPLICATION INFORMATION

Mixing Ratio	Component 'A' : Component 'B' = 2:1 by volume
Coverage	1 gal. yields 231 cu. in. of epoxy paste adhesive and grout. 1 gal. mixed with 1 gal. by loose volume of oven-dried aggregate yields approximately 346 cu. in. of epoxy mortar.
Pot Life	Approximately 120 minutes at 73 °F (23 °C) (gal., L volume) Approximately 60 minutes at at 90 °F (32 °C) (gal., L volume)
Cure Time	**Tack-Free Time:** 6–8 hours

APPLICATION INSTRUCTIONS

SUBSTRATE PREPARATION

Surface must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, disintegrated materials and any other contaminants.

Preparation Work: Concrete - Sandblast or use other approved mechanical methods.
Steel - Blast clean or use other equivalent mechanical means to achieve a white metal finish.

MIXING

Pre-mix each component. Proportion 1 part Component 'B' to 2 parts Component 'A' by volume into a clean pail. Mix thoroughly for 3 minutes with Sika paddle on low-speed (400–600 rpm) drill until uniform in color. Mix only that quantity that can be used within its pot life.

To prepare an epoxy mortar: Slowly add up to 1 part by loose volume of an oven-dried aggregate to 1 part of the mixed Sikadur®-31 Hi-Mod Gel LPL and mix until uniform in consistency.

APPLICATION METHOD / TOOLS

As a structural adhesive - Apply the neat mixed Sikadur®-31 Hi-Mod Gel LPL, to the mating or nonmating prepared substrates. Work into the substrate for positive adhesion. Secure the bonded unit firmly into place until the adhesion has cured. Glue line should not exceed 1/8 in. (3 mm).

To seal cracks for injection grouting - Place the neat mixed material over the cracks to be pressure injected and around each injection port. Allow sufficient time to set before pressure injecting.

For interior vertical and overhead patching - Place the prepared mortar in void, working the material into the prepared substrate, filling the cavity. Strike off level. Lifts should not exceed 1 in. (25 mm).

As a pick-proof sealant - Use automated or manual method. Apply an appropriate size bead of material around the area being sealed. Seal with neat Sikadur®-31 Hi-Mod Gel LPL.

LIMITATIONS

- Minimum substrate and ambient temperature 40 °F (4 °C).
- Do not thin. Addition of solvents will prevent proper cure.
- Use oven-dried aggregate only.
- Maximum epoxy mortar thickness is 1 in. (25 mm) per lift.
- Epoxy mortar is for interior use only. Material is a vapor barrier after cure.
- Minimum age of concrete must be 21–28 days, depending upon curing and drying conditions, for mortar applications.
- Porous substrates must be tested for moisture-vapor transmission prior to mortar applications.
- Not for sealing cracks under hydrostatic pressure at the

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

time of application.
- Not an aesthetic product. Color may alter due to variations in lighting and/or UV exposure.

BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

OTHER RESTRICTIONS

See Legal Disclaimer.

**For Reference Only.
Contractor required to submit products that are approved-similar or equal.**

ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

LEGAL DISCLAIMER

- **KEEP CONTAINER TIGHTLY CLOSED**
- **KEEP OUT OF REACH OF CHILDREN**
- **NOT FOR INTERNAL CONSUMPTION**
- **FOR INDUSTRIAL USE ONLY**
- **FOR PROFESSIONAL USE ONLY**

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates (“SIKA”), the user must always read and follow the warnings and instructions on the product’s most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA’s Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within the product’s shelf life. User determines suitability of product for intended use and assumes all risks. User’s and/or buyer’s sole remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs. **NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.**

Sale of SIKA products are subject to the Terms and Conditions of Sale which are available at https://usa.sika.com/en/group/SikaCorp/termsandconditions.html or by calling 1-800-933-7452.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: +1-800-933-7452
Fax: +1-201-933-6225
usa.sika.com

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537

BUILDING TRUST

PRODUCT DATA SHEET

Sikadur®-35 Hi-Mod LV

High modulus, low viscosity, high strength epoxy grouting/sealing/binder adhesive

PRODUCT DESCRIPTION

Sikadur®-35 Hi-Mod LV is a 2-component, 100 % solids, moisture-tolerant, low-viscosity, high-strength, multipurpose, epoxy resin adhesive. It conforms to the current ASTM C-881, Types I, II, and IV, Grade-1, Class C* and AASHTO M-235 specifications.
*except for gel time

USES

Sikadur®-35 Hi-Mod LV may only be used by experienced professionals.

- Pressure-injection of cracks in structural concrete, masonry, wood, etc.
- Gravity-feed of cracks in horizontal concrete and masonry.
- Epoxy resin binder for epoxy mortar patching and overlay of interior, horizontal surfaces.
- Seal interior slabs and exterior above-grade slabs from water, chlorides, and mild chemical attack; also improves wearability.

CHARACTERISTICS / ADVANTAGES

- Super low viscosity.
- Convenient easy mix ratio A:B = 2:1 by volume.
- Unique, high-strength, structural adhesive for “can’t dry” surfaces.
- Deep penetrating and tenacious bonding of cracks in structural concrete.
- High-early-strength developing adhesive.
- Excellent chemical resistance in flooring systems.

**For Reference Only.
Contractor required to submit products that are approved-similar or equal.**

PRODUCT INFORMATION

Packaging	3 gal. (11 L) units; 1 gal. (3.8 L) units; 12 fl. oz. (355 ml) units, 12/case
Color	Clear, amber
Shelf Life	2 years in original, unopened containers.
Storage Conditions	Store dry at 40–95 °F (4–35 °C). Condition material to 65–75 °F (18–24 °C) before using.
Viscosity	Approx. 375 cps.

TECHNICAL INFORMATION

Compressive Strength

Neat

	40 °F (4 °C)	73 °F (23 °C)	90 °F (32 °C)
4 hours	-	-	-
8 hours	-	180 psi (1.2 MPa)	3,200 psi (22.1 MPa)
16 hours	-	4,500 psi (31.1 MPa)	6,300 psi (43.5 MPa)
1 day	-	6,000 psi (41.4 MPa)	9,100 psi (62.8 MPa)
3 days	4,000 psi (27.6 MPa)	10,700 psi (73.8 MPa)	10,500 psi (72.5 MPa)
7 days	6,800 psi (46.9 MPa)	11,000 psi (75.9 MPa)	10,500 psi (72.5 MPa)
14 days	10,300 psi (71.1 MPa)	12,000 psi (82.8 MPa)	10,500 psi (72.5 MPa)
28 days	12,400 psi (85.6 MPa)	13,000 psi (89.7 MPa)	10,500 psi (72.5 MPa)

(ASTM D-695)
50 % R.H.

For Reference Only. Contractor required to submit products that are approved-similar or equal.

Epoxy Mortar (1: 5)

	40 °F (4 °C)	73 °F (23 °C)	90 °F (32 °C)
4 hours	-	-	800 psi (5.5 MPa)
8 hours	-	-	4,100 psi (28.3 MPa)
16 hours	-	400 psi (2.8 MPa)	5,700 psi (39.3 MPa)
1 day	120 psi (0.8 MPa)	5,000 psi (34.5 MPa)	6,900 psi (47.6 MPa)
3 days	6,200 psi (42.8 MPa)	6,800 psi (46.9 MPa)	7,000 psi (48.3 MPa)
7 days	6,300 psi (43.5 MPa)	7,900 psi (54.5 MPa)	8,800 psi (60.7 MPa)
14 days	6,800 psi (46.9 MPa)	8,500 psi (58.7 MPa)	8,800 psi (60.7 MPa)
28 days	7,000 psi (48.3 MPa)	8,600 psi (59.3 MPa)	8,800 psi (60.7 MPa)

(ASTM D-695)
50 % R.H.

Modulus of Elasticity in Compression

	Neat	Mortar
7 days	3.2 x 10^5 psi (2,200 MPa)	-
28 days	-	8.1 x 10^5 psi (5,600 MPa)

(ASTM D-695)
73 °F (23 °C)
50 % R.H.

Flexural Strength

	Neat	Mortar
14 day	14,000 psi (96,6 MPa)	2,200 psi (15,2 MPa)

(ASTM D-790)
73 °F (23 °C)
50 % R.H.

Modulus of Elasticity in Flexure

	Neat	Mortar
14 days	3.7 x 10^5 psi (2,600 MPa)	9.5 X 10^5 (6,500 MPa)

(ASTM D-790)
73 °F (23 °C)
50 % R.H.

Tensile Strength		**Neat**	**Mortar**	(ASTM D-638) 73 °F (23 °C) 50 % R.H.
	7 days	8,900 psi (61.4 MPa)	840 psi (5.8 MPa)	
Tensile Modulus of Elasticity		**Neat**	**Mortar**	(ASTM D-638) 73 °F (23 °C) 50 % R.H.
	14 days	4.1 X 10^5 psi (2800 MPa)	7.6 X 10^5 psi (5200 MPa)	
Elongation at Break		**Neat**	**Mortar**	(ASTM D-638) 73 °F (23 °C) 50 % R.H.
	7 day	5.4 %	0.3 %	
Tensile Adhesion Strength	2 days	(moist cure)	4,000 psi (27.6 MPa)	(ASTM C-882): Hardened concrete to hardened concrete 73 °F (23 °C) 50 % R.H.
	14 days	(moist cure)	2,900 psi (20.0 MPa)	
	2 days	(dry cure)	2,800 psi (19.3 MPa)	
Shear Strength		**Neat**	**Mortar**	(ASTM D-732) 73 °F (23 °C) 50 % R.H.
	14 days	5,100 psi (35,2 MPa)	2,300 psi (15.9 MPa)	
Heat deflection temperature		**Neat**	**Mortar**	(ASTM D-648) [fiber stress loading = 264 psi (1.8 MPa)]
	7 day	124 °F (51 °C)	129 °F (54 °C)	
Water Absorption	7 days	0.27 %		(ASTM D-570) 73 °F (23 °C) 50 % R.H.

APPLICATION INFORMATION

Mixing Ratio	Component "A": Component "B" = 2:1 by volume.			
Coverage	1 gal. yields 231 in^3 of adhesive and grout. 1 gal. of adhesive, when mixed with 5 gal. by loose volume of oven-dried aggregate, yields approximately 808.5 in^3 of epoxy mortar.			
Pot Life	Approx. 25 minutes (mass of 60 grams)			
Cure Time	**Tack-Free Time**	**40 °F (4 °C)**	**73 °F (23 °C)**	**95 °F (35 °C)**
	(3-5 mils) Neat	14–16 hours	3–3.5 hours	1.5–2 hours

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

LIMITATIONS

- Minimum substrate and ambient temperature 40ºF (4ºC).
- Do not thin with solvents. Consult Technical Service at 800-933-7452.
- Use oven-dried aggregate only.
- Maximum epoxy mortar thickness is 1.5 in. (38 mm) per lift.
- Epoxy mortar is for interior use only.
- Do not seal exterior slabs on grade.
- Minimum age of concrete must be 21–28 days, depending on curing and drying conditions, for mortar and to seal slabs.
- Porous substrates must be tested for moisture-vapor transmission prior to application.
- Not for injection of cracks under hydrostatic pressure at the time of application.
- Do not inject cracks greater than 1/4 in. (6 mm) Consult Technical Service.
- Not an aesthetic product. Color may alter due to variations in lighting and/or UV exposure.

ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

APPLICATION INSTRUCTIONS

SUBSTRATE PREPARATION

Surface must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles and disintegrated materials.
Concrete - Blast clean, shot blast or use other approved mechanical means to provide an open roughened texture.
Steel - Should be cleaned and prepared thoroughly by blast cleaning.

MIXING

Proportion 1 part Component 'B' to 2 parts Component 'A' by volume into a clean pail. Mix thoroughly for 3 minutes with Sika Paddle on low-speed (400–600 rpm) drill until uniformly blended. Mix only that quantity that can be used within its pot life. To prepare an epoxy mortar, slowly add 4–5 parts by loose volume of an ovendried aggregate to 1 part of the mixed Sikadur®-35 Hi-Mod LV and mix until uniform in consistency.

APPLICATION METHOD / TOOLS

To gravity feed cracks - Blow vee-notched crack clean with oil-free compressed air. Pour neat Sikadur®-35 Hi-Mod LV into vee-notched crack. Continue placement until completely filled. Seal underside of slab prior to filling if cracks reflect through.
To pressure-inject cracks - Use automated injection equipment or manual method. Set appropriate injection ports based on system used. Seal ports and crack with Sikadur® 31, Hi-Mod Gel or Sikadur® 33. When the epoxy adhesive seal has cured, inject Sikadur®-35 Hi-Mod LV with steady pressure. Consult Technical Service for additional information.
To seal slabs - Spread neat Sikadur®-35 Hi-Mod LV over slab. Allow penetration. Remove excess to prevent surface film. Seal interior slabs and above-grade exterior slabs only.
For an epoxy mortar - Prime prepared surface with neat Sikadur®-35 Hi-Mod LV. Place prepared epoxy mortar before primer becomes tack-free. Place the epoxy mortar using trowels. Compact and level with vibrating screed or trowels. Finish with finishing trowel. Sikadur®-35 Hi-Mod LV mortar is for interior use only.

OTHER RESTRICTIONS

LEGAL DISCLAIMER

- **KEEP CONTAINER TIGHTLY CLOSED**
- **KEEP OUT OF REACH OF CHILDREN**
- **NOT FOR INTERNAL CONSUMPTION**
- **FOR INDUSTRIAL USE ONLY**
- **FOR PROFESSIONAL USE ONLY**

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates ("SIKA"), the user must always read and follow the warnings and instructions on the product's most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA's Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within the product's shelf life. User determines suitability of product for intended use and assumes all risks. User's and/or buyer's sole

**For Reference Only.
Contractor required to submit products that are approved-similar or equal.**

remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs. **NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.**

Sale of SIKA products are subject to the Terms and Conditions of Sale which are available at https://usa.sika.com/en/group/SikaCorp/termsandconditions.html or by calling 1-800-933-7452.

For Reference Only.
Contractor required to submit products that are approved-similar or equal.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: +1-800-933-7452
Fax: +1-201-933-6225
usa.sika.com

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537

REFERENCE TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS INDEX

SECTION	DESCRIPTION	PAGES
Division 1 -	**General Requirements**	
01300	Administrative Requirements	06
01330	Submittals Procedure	05
01400	Quality Requirements	05
014219	Reference Standards	10
01500	Temporary Facilities and Controls	06
01600	Products Requirements	03
01700	Execution Requirements	04
Division 2 -	**Site Work**	
02 41 00	Selective Demolition	04
02700	Chain Link Fences	04
02763	Painted Pavement Markings	08
Division 3 -	**Concrete**	
03200	Concrete Reinforcement	03
03300	Cast-In-Place Concrete	11
03310	Concrete Works	25
035216	Lightweight Cellular Insulating Concrete	07
03732	Concrete Repair	04
03930	Concrete Rehabilitation Epoxy-Injected Crack Repair	05
Division 4 -	**NO ITEMS ON THIS DIVISION**	
Division 5 -	**Metals**	
05120	Structural Steel	14
05520	Handrails and Railings	02
05700	Ornamental Metals	03
05810	Expansion Joint Cover Assemblies	08
Division 6 -	**NO ITEMS ON THIS DIVISION**	

TECHNICAL SPECIFICATIONS INDEX

SECTION	DESCRIPTION	PAGES
Division 7 -	**Thermal and Moisture Protection**	
075200	Modified Bituminous Membrane Roofing	05
075400	Thermoplastic Membrane Roofing	05
	Thermoplastic PVC Feltback EnergyStar Single Ply Membrane Adhered to LWIC	10
076200	Sheet Metal Flashing and Trim	08
07900	Joint Sealers and Water Repellent Coating	07
07951	Sealants and Calking	09
Division 8 -	**Openings**	
08 11 00	Metal Doors and Frames	06
08 14 16	Flush Wood Doors	16
08520	Aluminum Jalousies Windows	09
08 71 00	Door Hardware	16
08800	Glazing	09
Division 9 -	**Finishes**	
09180	Cement Plaster	05
09 29 00	Gypsum Wallboard	03
09 65 33	Resilient Tile Flooring	04
09900	Painting	14
Division 10 -	**Specialties**	
10111	Whiteboards	01
10161	Laminated Plastic Toilet Partitions and Urinal Screens	02
10522	Extinguishers and Cabinets	03
10800	Toilets and Bath Accessories	08
Division 11 Thru 14	**NO ITEMS ON THESE DIVISIONS**	
Division 15 -	**Mechanical**	
15000	General Specifications for HVAC System Cleaning	10
15010	Basic Mechanical Requirements	06

TECHNICAL SPECIFICATIONS INDEX

SECTION	DESCRIPTION	PAGES
Division 15 -	**Mechanical (Cont.')**	
15050	Basic Mechanical Materials and Methods	14
15060	Hangers and Supports	11
15081	Duct Insulation	12
15083	Pipe Insulation	19
15110	Valves	22
15121	Pipe Expansion Fittings and Loops	08
15180	Heating and Cooling Piping	12
15400	Plumbing	12
15420	Drainage and Vent Piping	09
15720	Air Handling Units	07
15781	Packaged Rooftop Cooling Units	08
15801	General Specifications for A/C Works	14
15815	Metal Ducts	13
15820	Duct Accessories	11
15839	Ductwork	03
15855	Diffusers, Registers and Grilles	04
15990	Testing, Adjusting and Balancing	25
Division 16 -	**Electrical**	
16000	Electrical Work – General	06
16011	Panelboards	02
16020	Conduit Work	02
16030	Boxes	02
16040	Lighting Fixtures	10
16041	Wiring Devices	03
16050	Conductors	02
16060	Grounding and Bonding	04
16075	Electrical Identification	05
16095	Minor Electrical Demolition	05
16485	Lighting Contactors	01
16500	Time Switches	02
16540	Fire Alarm System	09
16600	Emergency Generator	15

CLARIFYING NOTE: All sections of technical specifications have been provided as PBA reference to stipulates a minimum quality standard for materials, products, and construction/installation procedures. Codes and regulations indicated on such sections should be outdated. Therefore, any prospective bidder must consider, as part of his proposal, all latest federal, state, and local laws, codes, and regulations, applicable for each item of work included on this Contract.

SECTION 01300

ADMINISTRATIVE REQUIREMENTS

1 GENERAL

1.1 SECTION INCLUDES

A. Coordination and project conditions.

B. Preconstruction meeting.

C. Site mobilization meeting.

D. Progress meetings.

E. Pre-installation meetings.

F. Cutting and patching.

G. Special procedures.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas except as otherwise indicated, conceal pipes, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.

E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

F. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.3 PRECONSTRUCTION MEETING

A. Owner and Owner's Representatives will schedule meeting after Notice of Award.

B. Attendance Required: Owner and Owner's Representatives, Representatives of Governmental or other regulatory Agencies, Architect/Engineer and his Consultants, Contractor and Sub-Contractors as Pertinent to Agenda.

C. Agenda:
1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of Subcontractors, list of products, schedule of values, and progress schedule.
5. Designation of personnel representing parties in Contract, and Architect/Engineer.
6. Procedures and processing of field decisions, submittals, and substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Scheduling.

D. Record minutes and distribute copies within 4 days after meeting to participants.

1.4 SITE MOBILIZATION MEETING

A. Owner and Owner's Representatives will schedule meeting at Project site prior to Contractor occupancy.

B. Attendance Required: Owner and Owner's Representatives, Representatives of Governmental or other regulatory Agencies, Architect/Engineer and his Consultants, Contractor and major Subcontractors.

C. Agenda:
1. Use of premises by Owner and Contractor.
2. Owner's requirements and occupancy.
3. Construction facilities and controls provided by Owner.
4. Temporary utilities provided by Owner.
5. Survey and building layout.
6. Security and housekeeping procedures.
7. Schedules.
8. Application for payment procedures.
9. Procedures for testing.

10. Procedures for maintaining record documents.
11. Requirements for start-up of equipment.
12. Inspection and acceptance of equipment put into service during construction period.

D. Record minutes and distribute copies within 4 days after meeting to participants.

1.5 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Owner and Owner's Representatives will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Attendance Required: Owner and Owner's Representatives, Job Superintendent, Major Subcontractor and Suppliers, Representatives of Government or other regulatory Agencies, Architect/Engineer As appropriate to agenda topics for each meeting.

D. Agenda:
1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems impeding planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. Other business relating to Work.

E. Record minutes and distribute copies within 4 days after meeting to participants.

1.6 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Owner and Owner's Representatives, Architect/Engineer four days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

E. Record minutes and distribute copies within 4 days after meeting to participants.

2 PRODUCTS

Not Used.

3 EXECUTION

3.1 CUTTING AND PATCHING

A. Employ skilled and experienced installer to perform cutting and patching.

B. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:
   1. Fit the several parts together, to integrate with other Work.
   2. Uncover Work to install or correct ill-timed Work.
   3. Remove and replace defective and non-conforming Work.
   4. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

C. Execute work by methods to avoid damage to other Work, and to provide proper surfaces to receive patching and finishing.

D. Cut masonry and concrete materials using masonry saw or core drill.

E. Restore Work with new products in accordance with requirements of Contract Documents.

F. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

G. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

H. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

I. Identify hazardous substances or conditions exposed during the Work to Owner and Owner's Representatives, Architect/Engineers for decision or remedy.

3.2 SPECIAL PROCEDURES

A. Materials: As specified in product sections; match existing with new products for patching and extending work.

B. Employ skilled and experienced installer to perform alteration work.

C. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.

D. Remove unsuitable material not marked for salvage, including rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.

E. Remove debris and abandoned items from area and from concealed spaces.

F. Prepare surface and remove surface finishes to permit installation of new work and finishes.

G. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.

H. Remove, cut, and patch Work in manner to minimize damage and to permit restoring products and finishes to original or specified condition.

I. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.

J. Where new Work abuts or aligns with existing, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

K. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and submit recommendation to Architect/Engineer for review.

L. Where change of plane of 1/4 inch (6mm) or more occurs, request instructions from Architect/Engineer.

M. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.

N. Finish surfaces as specified in individual product sections.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

1 GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Construction progress schedules.

C. Proposed products list.

D. Product data.

E. Shop drawings.

F. Samples.

G. Test reports.

H. Certificates.

I. Manufacturer's instructions.

J. Construction photographs.

1.2 SUBMITTAL PROCEDURES

A. Transmit each submittal with Architect/Engineer accepted form.

B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.

C. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.

D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.

E. Schedule submittals to expedite Project, and deliver to Architect/Engineer at [business address. Coordinate submission of related items.

F. For each submittal for review, allow 15 days excluding delivery time to and from Contractor.

G. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.

H. Allow space on submittals for Contractor and Architect/Engineer review stamps.

I. When revised for resubmission, identify changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

K. Submittals not requested will not be recognized or processed.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial schedules within 15 days after date established in Notice to Proceed.

B. Submit revised Progress Schedules with each Application for Payment.

C. Submit computer generated horizontal bar chart with separate line for each major portion of Work, identifying first work day of each week.

D. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.

E. Indicate estimated percentage of completion for each item of Work at each submission.

F. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties.

G. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

H. Submit submittal dates for shop drawings, product data, and samples, including and dates reviewed submittals will be required from Architect/Engineer. Indicate decision dates for selection of finishes.

I. Indicate delivery dates for products identified under Allowances.

J. Revisions To Schedules:
   1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.

2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
3. Prepare narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including effect of changes on schedules of separate contractors.

1.4 PROPOSED PRODUCTS LIST

A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.5 PRODUCT DATA

A. Product Data: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Submit number of copies Contractor requires, plus two copies Architect/Engineer will retain.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01700.

1.6 SHOP DRAWINGS

A. Shop Drawings: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01700.

1.7 SAMPLES

A. Samples: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Samples For Selection as Specified in Product Sections:
   1. Submit to Architect/Engineer for aesthetic, color, or finish selection.
   2. Submit samples of finishes from full range of manufacturers' standard colors, textures, and patterns for Architect/Engineer selection.

C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

D. Include identification on each sample, with full Project information.

E. Submit number of samples specified in individual specification sections; Architect/Engineer will retain one sample.

1.8 CERTIFICATES

A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Architect/Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect/Engineer.

1.9 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, to Architect/Engineer in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.10 CONSTRUCTION PHOTOGRAPHS

A. Submit photographs with Application for Payment.

B. Photographs: two prints; color glossy 8 x 10 inch (200 x 250mm) size; with left edge binding margin for three hole punch.

C. Take two site photographs from differing directions and two interior photographs of building indicating relative progress of the Work, 7 days maximum prior to submitting.

D. Identify each print on back. Identify name of Project, contract number, orientation of view, date and time of view, name and address of photographer, and photographer's numbered identification of exposure.

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

F. 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.

2 PRODUCTS

Not Used.

3 EXECUTION

Not Used.

END OF SECTION

SECTION 01400 QUALITY REQUIREMENTS

GENERAL

1.1 SECTION INCLUDES

1. Quality control and control of installation.
2. Tolerances
3. References.
4. Mock-up requirements.
5. Testing and inspection services.
6. Examination.
7. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

1. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
2. Comply with manufacturers' instructions, including each step in sequence.
3. When manufacturers' instructions conflict with Contract Documents, request clarification from Owner’s Representatives before proceeding.
4. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
5. Perform Work by persons qualified to produce required and specified quality.
6. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.3 TOLERANCES

1. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

2. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Owner's Representatives before proceeding.

3. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

1. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

2. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

3. Obtain copies of standards where required by product specification sections.

4. When specified reference standards conflict with Contract Documents, request clarification from Owner's Representatives before proceeding.

5. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Architect/Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 MOCK-UP REQUIREMENTS

1. Tests will be performed under provisions identified in this section and identified in respective product specification sections.

2. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

3. Accepted mock-ups shall be comparison standard for remaining Work.

4. Where mock-up has been accepted Architect and Owner's Representatives and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so Owner's Representatives.

1.6 TESTING AND INSPECTION SERVICES

1. Contractor will employ and pay for services of an independent testing agency or laboratory acceptable to Owner's Representative to perform specified testing.

1. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time specialist and responsible officer.
2. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.

2. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner's Representatives.
   1. Laboratory: Authorized to operate in Puerto Rico.
   2. Laboratory Staff: Maintain full time registered Engineer on staff to review services.
   3. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

3. Testing, inspections and source quality control may occur on or off project site.

4. Testing and employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

5. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on Owner's Representatives.

6. Agency Responsibilities:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Owner/s Representatives, in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Owner's Representatives, of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Owner's Representatives.
   7. Attend preconstruction meetings and progress meetings.

7. Agency Reports: After each test, promptly submit five copies of report to Owner's Representatives, Architect/Engineer and to Contractor. When requested Owner's Representatives, provide interpretation of test results. Include the following:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.

4. Date and time of sampling or inspection.
5. Identification of product and specifications section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

8. Limits On Testing Authority:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency or laboratory may not approve or accept any portion of the Work.
   3. Agency or laboratory may not assume duties of Contractor.
   4. Agency or laboratory has no authority to stop the Work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

1. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

2. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

3. Examine and verify specific conditions described in individual specification sections.

4. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

1. Clean substrate surfaces prior to applying next material or substance.

2. Seal cracks or openings of substrate prior to applying next material or substance.

3. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

SECTION 014219
REFERENCE STANDARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements relating to referenced standards.

1.02 QUALITY ASSURANCE

A. For products or workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with the reference standard of date of issue specified in the individual specification sections, except where a specific date is established by applicable code.

C. Should specified reference standards conflict with Contract Documents, request clarification from the Architect before proceeding.

D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Architect shall be altered by Contract Documents by mention or inference otherwise in any reference document.

PART 2 CONSTRUCTION INDUSTRY ORGANIZATION DOCUMENTS

1.03 3GPP SPECIFICATION - THE 3GPP SPECIFICATIONS (IOT OR MOBILE BROADBAND STANDARD): 5G, GSM (GPRS, EDGE, EDGE+), W-CDMA (HSPA, HSPA+), LTE (LTE-ADVANCED, LTE-ADVANCED PRO), AND UMTS;CURRENT EDITION.

1.04 AA -- ALUMINUM ASSOCIATION, INC.

1.05 AABC -- ASSOCIATED AIR BALANCE COUNCIL

1.06 AAMA -- AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION

1.07 AASHTO -- AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

1.08 AATCC -- AMERICAN ASSOCIATION OF TEXTILE CHEMISTS & COLORISTS

1.09 ABMA -- AMERICAN BEARING MANUFACTURERS ASSOCIATION, INC.

1.10 ACA -- AMERICAN COATINGS ASSOCIATION

1.11 ACG -- AABC COMMISSIONING GROUP

1.12 ACGIH -- AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

1.13 ACI -- AMERICAN CONCRETE INSTITUTE INTERNATIONAL

1.14 ACMA -- AMERICAN COMPOSITES MANUFACTURERS ASSOCIATION

1.15 ADC -- AIR DIFFUSION COUNCIL

1.16 AFPA -- AMERICAN FOREST AND PAPER ASSOCIATION

1.17 AGA -- AMERICAN GALVANIZERS ASSOCIATION, INC.

1.18 AGC -- ASSOCIATED GENERAL CONTRACTORS OF AMERICA

1.19 AGMA -- AMERICAN GEAR MANUFACTURERS ASSOCIATION

1.20 AHA -- AMERICAN HARDBOARD ASSOCIATION

1.21 AHRI -- AIR-CONDITIONING, HEATING, AND REFRIGERATION INSTITUTE

1.22 AI -- THE ASPHALT INSTITUTE

1.23 AIA -- THE AMERICAN INSTITUTE OF ARCHITECTS

1.24 AISC -- AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.

1.25 AISI -- AMERICAN IRON AND STEEL INSTITUTE

1.26 AIST -- ASSOCIATION FOR IRON AND STEEL TECHNOLOGY

1.27 AITC -- AMERICAN INSTITUTE OF TIMBER CONSTRUCTION

1.28 ALI -- AMERICAN LADDER INSTITUTE

1.29 ALSC -- AMERICAN LUMBER STANDARDS COMMITTEE

1.30 AMCA -- AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

1.31 ANSI -- AMERICAN NATIONAL STANDARDS INSTITUTE

A. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015 (Reaffirmed 2020).

1.32 APA -- APA - THE ENGINEERED WOOD ASSOCIATION

1.33 APHA -- AMERICAN PUBLIC HEALTH ASSOCIATION

1.34 API -- AMERICAN PETROLEUM INSTITUTE

1.35 ARI -- AIR-CONDITIONING AND REFRIGERATION INSTITUTE (SEE AHRI)

1.36 ARRA -- ASPHALT RECYCLING AND RECLAIMING ASSOCIATION

1.37 ASA -- ACOUSTICAL SOCIETY OF AMERICA

1.38 ASCA -- ARCHITECTURAL SPRAY COATERS ASSOCIATION

1.39 ASCE -- AMERICAN SOCIETY OF CIVIL ENGINEERS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASCE 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures 2016.

1.40 ASHRAE -- AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASHRAE (REFR) - ASHRAE Handbook - Refrigeration Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASHRAE (HVACS) - ASHRAE Handbook - HVAC Systems and Equipment Most Recent Edition Cited by Referring Code or Reference Standard.

E. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.41 ASME -- THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

1.42 ASPE -- AMERICAN SOCIETY OF PLUMBING ENGINEERS

1.43 ASSE -- AMERICAN SOCIETY OF SANITARY ENGINEERING

1.44 ASTM A SERIES -- ASTM INTERNATIONAL

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

1.45 ASTM B SERIES -- ASTM INTERNATIONAL

1.46 ASTM C SERIES -- ASTM INTERNATIONAL

A. ASTM C1036 - Standard Specification for Flat Glass 2021.

B. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.

1.47 ASTM D SERIES -- ASTM INTERNATIONAL

A. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.

1.48 ASTM E SERIES -- ASTM INTERNATIONAL

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.

1.49 ASTM F SERIES -- ASTM INTERNATIONAL

1.50 ASTM G SERIES -- ASTM INTERNATIONAL

1.51 AWC -- AMERICAN WOOD COUNCIL

A. AWC (WFCM) - Wood Frame Construction Manual for One- and Two-Family Dwellings 2018.

1.52 AWI -- ARCHITECTURAL WOODWORK INSTITUTE

1.53 AWI/AWMAC/WI -- JOINT PUBLICATION OF ARCHITECTURAL WOODWORK INSTITUTE/ARCHITECTURAL WOODWORK MANUFACTURERS ASSOCIATION OF CANADA/WOODWORK INSTITUTE

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).

1.54 AWPA -- AMERICAN WOOD-PRESERVERS' ASSOCIATION

1.55 AWPB -- AMERICAN WOOD PRESERVERS BUREAU

1.56 AWS -- AMERICAN WELDING SOCIETY

1.57 AWWA -- AMERICAN WATER WORKS ASSOCIATION

1.58 BHMA -- BUILDERS HARDWARE MANUFACTURERS ASSOCIATION

1.59 BIA -- BRICK INDUSTRY ASSOCIATION

1.60 BICSI -- BUILDING INDUSTRY CONSULTING SERVICE INTERNATIONAL

1.61 BIFMA -- BUSINESS AND INSTITUTIONAL FURNITURE MANUFACTURERS ASSOCIATION

1.62 BOMA -- BUILDING OWNERS AND MANAGERS ASSOCIATION

1.63 C2C -- CRADLE TO CRADLE PRODUCTS INNOVATION INSTITUTE

1.64 CAGI -- COMPRESSED AIR AND GAS INSTITUTE

1.65 CAL -- STATE OF CALIFORNIA

1.66 CARB -- CALIFORNIA AIR RESOURCES BOARD

1.67 CFSEI - COLD-FORMED STEEL ENGINEERS INSTITUTE

1.68 CGA -- COMPRESSED GAS ASSOCIATION

1.69 CHPS -- COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS

1.70 CISCA -- CEILINGS & INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION

1.71 CISPI -- CAST IRON SOIL PIPE INSTITUTE

1.72 CLFMI -- CHAIN LINK FENCE MANUFACTURERS INSTITUTE

1.73 CONSENSUSDOCS -- CONSENSUSDOCS, LLC

1.74 CRI -- CARPET AND RUG INSTITUTE

1.75 CRRC -- COOL ROOF RATING COUNCIL

1.76 CRSI -- CONCRETE REINFORCING STEEL INSTITUTE

1.77 CSA -- CSA GROUP (FORMERLY CSA INTERNATIONAL)

1.78 CSI/CSC -- CONSTRUCTION SPECIFICATIONS INSTITUTE/CONSTRUCTION SPECIFICATIONS CANADA

1.79 CTA -- CONSUMER TECHNOLOGY ASSOCIATION (FORMERLY CONSUMER ELECTRONICS ASSOCIATION)

1.80 CTI -- CERAMIC TILE INSTITUTE

1.81 CTI -- COOLING TECHNOLOGY INSTITUTE

1.82 DASMA -- DOOR & ACCESS SYSTEMS MANUFACTURERS' ASSOCIATION, INTERNATIONAL

1.83 DBIA -- THE DESIGN BUILD INSTITUTE OF AMERICA, INC.

1.84 DHI -- DOOR AND HARDWARE INSTITUTE

1.85 DIPRA - DUCTILE IRON PIPE RESEARCH ASSOCIATION

1.86 DOCSIS -- DATA-OVER-CABLE SERVICE INTERFACE SPECIFICATIONS

1.87 EIA -- ELECTRONIC INDUSTRIES ALLIANCE

1.88 EIA -- ENVIRONMENTAL INDUSTRY ASSOCIATION

1.89 EIMA -- EXTERIOR INSULATION MANUFACTURERS ASSOCIATION

A. ANSI/EIMA 99-A - Standard for Exterior Insulation and Finish Systems (EIFS) and EIFS with Drainage 2017.

1.90 EJCDC -- ENGINEERS' JOINT CONTRACT DOCUMENTS COMMITTEE

1.91 EJMA -- EXPANSION JOINT MANUFACTURERS ASSOCIATION

1.92 ETG -- ETHERCAT TECHNOLOGY GROUP

1.93 FIELDCOMM GROUP (FFTS) - FOUNDATION FIELDBUS TECHNICAL SPECIFICATIONS;2014.

1.94 FLA -- STATE OF FLORIDA

A. FLA (PAD) - Florida Building Code Online - Product Approval Directory Current Edition.

1.95 FM -- FACTORY MUTUAL GLOBAL

1.96 GA -- GYPSUM ASSOCIATION

1.97 GANA -- GLASS ASSOCIATION OF NORTH AMERICA

1.98 GEI -- GREENGUARD ENVIRONMENTAL INSTITUTE

1.99 GREEN GLOBES -- GREEN BUILDING INITIATIVE

1.100 GREENSEAL -- GREENSEAL, INC.

1.101 GRI -- GEOSYNTHETIC RESEARCH INSTITUTE

1.102 HI -- HYDRAULIC INSTITUTE

1.103 HPDC -- HEALTH PRODUCT DECLARATION COLLABORATIVE

1.104 HPVA -- HARDWOOD PLYWOOD VENEER ASSOCIATION

1.105 HPW -- H.P. WHITE LABORATORY, INC.

1.106 IAAF -- INTERNATIONAL AMATEUR ATHLETIC FEDERATION

1.107 IAPMO -- INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS

1.108 IAS -- INTERNATIONAL ACCREDITATION SERVICE

1.109 ICC -- INTERNATIONAL CODE COUNCIL, INC.

A. ICC (IBC)-2018 - International Building Code 2018.

B. ICC (IEBC) - International Existing Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ICC (IECC) - International Energy Conservation Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ICC (IFC) - International Fire Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. ICC (IFGC) - International Fuel Gas Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. ICC (IMC) - International Mechanical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. ICC (IPMC) - International Property Maintenance Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ICC (IPSDC) - International Private Sewage Disposal Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. ICC (IRC) - International Residential Code for One- and Two-Family Dwellings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. ICC (ISPSC) - International Swimming Pool and Spa Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.110 ICC-ES -- ICC EVALUATION SERVICE, INC.

1.111 ICEA -- INSULATED CABLE ENGINEERS ASSOCIATION

1.112 ICRI -- INTERNATIONAL CONCRETE REPAIR INSTITUTE

1.113 IEC -- INTERNATIONAL ELECTROTECHNICAL COMMISSION

1.114 IEEE -- INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

1.115 IES/IESNA -- ILLUMINATING ENGINEERING SOCIETY

1.116 IETF -- INTERNET ENGINEERING TASK FORCE

1.117 IGMA -- INSULATING GLASS MANUFACTURERS ALLIANCE

1.118 ILI -- INDIANA LIMESTONE INSTITUTE OF AMERICA, INC.

1.119 IMIAWC -- INTERNATIONAL MASONRY INDUSTRY ALL-WEATHER COUNCIL

1.120 ISA -- INSTRUMENT SOCIETY OF AMERICA

1.121 ISDI -- INSULATED STEEL DOOR INSTITUTE

1.122 ISFA - INTERNATIONAL SURFACE FABRICATORS ASSOCIATION

1.123 ISS -- IRON AND STEEL SOCIETY

1.124 ISSFA - INTERNATIONAL SOLID SURFACE FABRICATORS ASSOCIATION

1.125 ISO -- INTERNATIONAL STANDARDS ORGANIZATION

1.126 ITS -- INTERTEK TESTING SERVICES NA, INC.

1.127 ITU-T -- INTERNATIONAL TELECOMMUNICATIONS UNION -TELECOMMUNICATION STANDARDIZATION SECTOR

1.128 IWBI -- INTERNATIONAL WELL BUILDING INSTITUTE

1.129 LPI -- LIGHTNING PROTECTION INSTITUTE

1.130 MBMA -- METAL BUILDING MANUFACTURERS ASSOCIATION

1.131 MFMA -- METAL FRAMING MANUFACTURERS ASSOCIATION

1.132 MIAMI -- MIAMI-DADE COUNTY

A. Miami (APD) - Approved Products Directory; Miami-Dade County Current Edition.

1.133 MPI -- MASTER PAINTERS INSTITUTE (MASTER PAINTERS AND DECORATORS ASSOCIATION)

A. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.

1.134 MSS -- MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC.

1.135 NAAMM -- THE NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS

1.136 NACE -- NACE INTERNATIONAL

1.137 NAGDM -- NATIONAL ASSOCIATION OF GARAGE DOOR MANUFACTURERS

1.138 NASSPA -- NORTH AMERICAN STEEL SHEET PILE ASSOCIATION

1.139 NBBI -- THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

1.140 NBI -- NEW BUILDINGS INSTITUTE

1.141 NCAA -- NATIONAL COLLEGIATE ATHLETIC ASSOCIATION

1.142 NCMA -- NATIONAL CONCRETE MASONRY ASSOCIATION

1.143 NCWPB - NATIONAL CERTIFIED PIPE WELDING BUREAU

1.144 NEBB -- NATIONAL ENVIRONMENTAL BALANCING BUREAU

1.145 NECA -- NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

1.146 NEMA -- NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

1.147 NETA -- INTERNATIONAL ELECTRICAL TESTING ASSOCIATION

1.148 NFHS -- NATIONAL FEDERATION OF STATE HIGH SCHOOL ASSOCIATIONS:

1.149 NFPA -- NATIONAL FIRE PROTECTION ASSOCIATION

1.150 NFRC -- NATIONAL FENESTRATION RATING COUNCIL, INC.

1.151 NIBS -- NATIONAL INSTITUTE OF BUILDING SCIENCES

1.152 NIST -- NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (U.S. DEPARTMENT OF COMMERCE)

1.153 NLA -- NATIONAL LIME ASSOCIATION

1.154 NPA -- NATIONAL PARTICLEBOARD ASSOCIATION

1.155 NPCA -- NATIONAL PAINT AND COATINGS ASSOCIATION

1.156 NRCA -- NATIONAL ROOFING CONTRACTORS ASSOCIATION

1.157 NSF -- NSF INTERNATIONAL (THE PUBLIC HEALTH AND SAFETY ORGANIZATION)

1.158 NSI -- NATURAL STONE INSTITUTE

1.159 NTMA -- NATIONAL TERRAZZO AND MOSAIC ASSOCIATION, INC., THE

1.160 NTMA -- NATIONAL TILE AND MARBLE ASSOCIATION

1.161 NWWDA -- NATIONAL WOOD WINDOW AND DOOR ASSOCIATION (NAME CHANGED TO WDMA)

1.162 ORACLE -- ORACLE INTEGRATED CLOUD APPLICATIONS & PLATFORM SERVICES

1.163 PCA -- PORTLAND CEMENT ASSOCIATION

1.164 PCI -- PRECAST/PRESTRESSED CONCRETE INSTITUTE

1.165 PPI -- PLASTICS PIPE INSTITUTE

1.166 PR - COMMONWEALTH OF PUERTO RICO

A. Puerto Rico Building Code 2018 Ed. - Adopting (ICC) 2018 International Building Code with amendments.

1.167 PTI -- POST-TENSIONING INSTITUTE

1.168 RCSC -- RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS

1.169 RFCI -- RESILIENT FLOOR COVERING INSTITUTE

1.170 SAE -- SAE INTERNATIONAL

1.171 SBCA -- STRUCTURAL BUILDING COMPONENTS ASSOCIATION

1.172 SBCCI -- SOUTHERN BUILDING CODE CONGRESS INTERNATIONAL, INC.

1.173 SCAQMD -- SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

1.174 SCS - SCIENTIFIC CERTIFICATION SYSTEMS

1.175 SCTE -- SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS

1.176 SDI -- STEEL DECK INSTITUTE

1.177 SDI -- STEEL DOOR INSTITUTE

1.178 SEFA -- SCIENTIFIC EQUIPMENT AND FURNITURE ASSOCIATION

A. SEFA 2 - Installations 2010.

B. SEFA 3 - Laboratory Work Surfaces 2010.

C. SEFA 7 - Laboratory Fixtures 2010.

D. SEFA 8P - Laboratory Grade Polypropylene Casework 2014.

1.179 SJI -- STEEL JOIST INSTITUTE

1.180 SMACNA -- SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.

1.181 SPIB -- SOUTHERN PINE INSPECTION BUREAU, INC.

1.182 SPRI -- SINGLE PLY ROOFING INDUSTRY

1.183 SSPC -- SOCIETY FOR PROTECTIVE COATINGS

1.184 STI -- STEEL TANK INSTITUTE

1.185 SWRI -- SEALANT, WATERPROOFING AND RESTORATION INSTITUTE

1.186 TCNA -- TILE COUNCIL OF NORTH AMERICA, INC.

1.187 TIA -- TELECOMMUNICATIONS INDUSTRY ASSOCIATION

1.188 TMS -- THE MASONRY SOCIETY

1.189 TPI -- TRUSS PLATE INSTITUTE

1.190 UL -- UNDERWRITERS LABORATORIES INC.

A. UL (FRD) - Fire Resistance Directory Current Edition.

1.191 USGBC -- U.S. GREEN BUILDING COUNCIL

1.192 W3C SSG - WEB OF SERVICES STANDARDS COLLECTION (HTTP, XML, WSDL, UDDI, AND OTHERS);CURRENT EDITION.

1.193 WDMA -- WINDOW AND DOOR MANUFACTURERS ASSOCIATION (FORMERLY NWWDA)

1.194 WI -- WOODWORK INSTITUTE

PART 3 UNITED STATES GOVERNMENT AND RELATED AGENCIES DOCUMENTS

2.01 ATBCB -- US ARCHITECTURAL AND TRANSPORTATION BARRIERS COMPLIANCE BOARD (THE ACCESS BOARD)

2.02 CFR -- CODE OF FEDERAL REGULATIONS

A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.

B. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.

C. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.

2.03 EPA -- ENVIRONMENTAL PROTECTION AGENCY

2.04 FAA -- FEDERAL AVIATION ADMINISTRATION

2.05 FDA -- FOOD AND DRUG ADMINISTRATION

2.06 FEMA -- U.S. FEDERAL EMERGENCY MANAGEMENT AGENCY

2.07 FHWA -- FEDERAL HIGHWAY ADMINISTRATION

2.08 FS -- FEDERAL SPECIFICATIONS AND STANDARDS (GENERAL SERVICES ADMINISTRATION)

2.09 GSA -- U.S. GENERAL SERVICES ADMINISTRATION

2.10 HHS -- U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, CENTERS FOR DISEASE CONTROL AND PREVENTION

2.11 MIL -- MILITARY SPECIFICATIONS AND STANDARDS

2.12 PS -- PRODUCT STANDARDS

2.13 USAB -- UNITED STATES ACCESS BOARD

A. ABA Standards - ABA Accessibility Standards 2004, with Amendments (2015).

2.14 USDA -- UNITED STATES DEPARTMENT OF AGRICULTURE

2.15 USDHUD -- UNITED STATES DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

2.16 USGS -- UNITED STATES GEOLOGICAL SURVEY

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:
   1. Temporary electricity.
   2. Temporary lighting for construction purposes.
   3. Temporary ventilation.
   4. Temporary Cooling.
   5. Telephone service.
   6. Facsimile service.
   7. Temporary water service.
   8. Temporary sanitary facilities.

B. Construction Facilities:
   1. Field offices and sheds.
   2. Vehicular access.
   3. Parking.
   4. Progress cleaning and waste removal.
   5. Project identification.

C. Temporary Controls:
   1. Barriers.
   2. Enclosures and fencing.
   3. Water control.
   4. Erosion and sediment control.

D. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

A. Cost: Provide and pay for power service required from utility source as needed for construction operation.

B. Provide temporary electric feeder from electrical service at location as directed. Do not disrupt Owner's use of service.

C. Complement existing power service capacity and characteristics as required for construction operations.

D. Provide power outlets, with branch wiring and distribution boxes located as required. Provide flexible power cords as required for portable construction tools and equipment.

E. Provide meter.

F. Permanent convenience receptacles may not be utilized during construction.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain incandescent lighting for construction operations to achieve minimum lighting level of 2 watt/sq ft (21 watt/sq m)].

B. Provide and maintain 1 watt/sq ft (10.8 watt/sq m) lighting to exterior staging and storage areas after dark for security purposes.

C. Provide and maintain 0.25 watt/sq ft (2.7 watt/sq m) HID lighting to interior work areas after dark for security purposes.

D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps for specified lighting levels.

E. Maintain lighting and provide routine repairs.

F. Permanent building lighting may not be utilized during construction.

1.4 TEMPORARY VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.5 TEMPORARY COOLING

A. Provide and pay for cooling devices and cooling as needed to maintain specified conditions for temporary offices and construction operations. As describe in the Special Conditions.

1.6 TELEPHONE SERVICE

A. Provide, maintain, and pay for telephone service to field office at time of project mobilization. As describe in the Special Conditions.

1.7 PHOTOCOPIER AND FACSIMILE SERVICE

A. Provide, maintain and pay for photocopier and facsimile service and dedicated telephone line to field office at time of project mobilization.

1.8 TEMPORARY WATER SERVICE

A. Provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations.

B. Extend branch piping with outlets located so water is available by hoses with threaded connections.

1.9 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of project mobilization. As describe in Special Conditions.

B. At end of construction, return existing facilities used for construction operations to same or better condition as original condition.

1.10 FIELD OFFICES AND SHEDS

A. Offices: Weather tight, with lighting, electrical outlets, cooling and ventilating equipment, and equipped with sturdy office furniture, drawing rack, and drawing display table and other items. As describe in the Uniform General Conditions.

B. Provide space for Project meetings, with table and chairs. As describe in the Uniform General Conditions.

C. Provide computer equipments for use by Owner's Representatives as describe in the Uniform General Conditions.

1.11 VEHICULAR ACCESS

A. Construct temporary access roads from public thoroughfares to serve construction area.

B. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.

C. Provide unimpeded access for emergency vehicles.

D. Provide and maintain access to fire hydrants and control valves free of obstructions.

E. Provide means of removing mud from vehicle wheels before entering streets.

F. Do not use existing on-site roads for construction traffic.

1.12 PARKING

A. Arrange for and Provide temporary parking areas to accommodate construction personnel, Owner's Representative, and Architect/Engineer.

B. When site space is not adequate, provide additional off-site parking.

1.13 PROGRESS CLEANING AND WASTE REMOVAL

A. Contractor shall provide daily janitorial services.

B. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.

C. Remove debris and rubbish from closed or remote spaces, prior to enclosing spaces.

D. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

E. Collect and remove waste materials, debris, and rubbish from site periodically and dispose off-site.

F. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.14 PROJECT IDENTIFICATION

A. Project Identification Sign:
   1. Provide 8 ft by 6 ft (2.4m x 1.8m) project sign of exterior grade plywood and wood frame construction, painted, with exhibit lettering by professional sign painter and self-adhesive corporate logo.

B. Design sign and structure to withstand 60 miles/hr (100 km/hr) wind velocity.

C. Installation:
   1. Install project identification sign within 15 days after date fixed by Notice to Proceed.
   2. Erect at designated location.
   3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
   4. Install sign surface plumb and level, with butt joints. Anchor securely.
   5. Paint exposed surfaces of sign, supports, and framing.

D. Maintenance: Maintain signs and supports clean, repair deterioration and damage.

E. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.15 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way.

C. Provide protection for plants designated to remain. Replace damaged plants.

D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.16 ENCLOSURES AND FENCING

A. Construction: Design, materials, paints will be selected by Owner's representative.

B. Exterior Enclosures:

1. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.17 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion

1.18 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.

B. Minimize surface area of bare soil exposed at one time.

C. Provide temporary measures to prevent water flow.

D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.

E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

1.19 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.

B. Remove underground installations to minimum depth of 2 feet (600 mm). Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

2 PRODUCTS

Not Used.

3 EXECUTION

Not Used.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product delivery requirements.

C. Product storage and handling requirements.

D. Product options.

E. Product substitution procedures.

1.2 PRODUCTS

A. Furnish products of qualified manufacturers suitable for intended use.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

C. Furnish interchangeable components from same manufacturer for components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, enclosures in an environment favorable to product.

D. For exterior storage of fabricated products, place on sloped supports above ground.

E. Cover products subject to deterioration with impervious sheet covering.

F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

1.6 PRODUCT SUBSTITUTION PROCEDURES

A. Architect/Engineer will consider requests for Substitutions only within 15 days after date of Owner-Contractor Agreement.

B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that Bidder:
   1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
   2. Will provide same warranty for Substitution as for specified product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.

5. Will reimburse Owner and Architect/Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. Architect/Engineer will notify Contractor in writing of decision to accept or reject request.

2 PRODUCTS

Not Used

3 EXECUTION

Not Used.

END OF SECTION

SECTION 01700

EXECUTION REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

1. Closeout procedures.
2. Final cleaning.
3. Protecting installed construction.
4. Project record documents.
5. Operation and maintenance data.
6. Spare parts and maintenance products.

1.2 CLOSEOUT PROCEDURES

1. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer's review.
2. Provide submittals to Architect/Engineer required by authorities having jurisdiction.
3. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

1.3 FINAL CLEANING

1. Execute final cleaning prior to final project assessment.
2. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
3. Clean debris from roofs, gutters, downspouts, and drainage systems.
4. Clean site; sweep paved areas, rake clean landscaped surfaces.
5. Remove waste and surplus materials, rubbish, and construction facilities from site.

1.4 PROTECTING INSTALLED CONSTRUCTION

1. Protect installed Work and provide special protection where specified in individual specification sections.

2. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

3. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

4. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

5. Prohibit traffic from landscaped areas.

1.5 PROJECT RECORD DOCUMENTS

1. Maintain on site one set of the following record documents; record actual revisions to the Work:
    1. Drawings.
    2. Specifications.
    3. Addenda.
    4. Change Orders and other modifications to the Contract.
    5. Reviewed Shop Drawings, Product Data, and Samples.
    6. Manufacturer's instruction for assembly, installation, and adjusting.

2. Ensure entries are complete and accurate, enabling future reference by Owner.

3. Store record documents separate from documents used for construction.

4. Record information concurrent with construction progress, not less than weekly.

5. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
    1. Manufacturer's name and product model and number.
    2. Product substitutions or alternates utilized.
    3. Changes made by Addenda and modifications.

6. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
    1. Measured depths of foundations in relation to finish first floor datum.
    2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
4. Field changes of dimension and detail.
5. Details not on original Contract drawings.

7. Submit documents to René Acosta-Arquitectos with claim for final Application for Payment.

1.6 OPERATION AND MAINTENANCE DATA

1. Submit data bound in 8-1/2 x 11 inch text pages, capacity expansion binders with durable plastic overs.

2. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project , and subject matter of binder when multiple binders are required.

3. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

4. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

5. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
    1. Part 1: Directory, listing names, addresses, and telephone numbers of René Acosta-Arquitectos, Contractor, Subcontractors, and major equipment suppliers.
    2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
        1. Significant design criteria.
        2. List of equipment.
        3. Parts list for each component.
        4. Operating instructions.
        5. Maintenance instructions for equipment and systems.
        6. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
    3. Part 3: Project documents and certificates, including the following:
        1. Shop drawings and product data.
        2. Air and water balance reports.
        3. Certificates.
        4. Photocopies of warranties.

1.7 SPARE PARTS AND MAINTENANCE PRODUCTS

1. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.

2. Deliver to Project site and place in location as directed; obtain receipt prior to final payment.

1.8 PRODUCT WARRANTIES AND PRODUCT BONDS

1. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.

2. Verify documents are in proper form, contain full information, and are notarized.

3. Co-execute submittals when required.

4. Include Table of Contents and assemble in three D side ring binder with durable plastic cloth cover.

5. Submit prior to final Application for Payment.

6. Time Of Submittals:
    1. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
    2. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02 41 00

SELECTIVE DEMOLITION

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

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

1.2 SUBMITTALS

A. Schedule:

1. Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Owner for review prior to commencement of work. Include coordination for shut-off, capping, and continuation of utility services as required, together with detail for dust and noise control protection.

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

1.3 JOB CONDITIONS

A. Existing Conditions:

1. The Owner assumes no responsibility for actual condition of items or structures to be demolished.

B. Storage and Sale: Storage or sale of removed items on site will not be permitted.

C. Provide temporary barricades and other forms of protection as required to protect Employees and general public from injury due to selective demolition work.

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

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

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

G. Remove protections at completion of work.

H. Damage: Promptly repair damages caused to adjacent occupied facilities by demolition work at no cost to Owner.

I. Traffic:

1. Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with other adjacent occupied or used facilities.

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

J. Utilities:

1. Maintain existing utilities indicated to remain, keep in service and protect against damage during demolition operations.

2. Do not interrupt existing utilities serving occupied or used facilities. Provide temporary services during interruptions to existing utilities.

k. Environmental Controls: Use water sprinkling, temporary enclosures and/or other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.

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

M. Partial Demolition and Removal: Items indicated to be removed. Contractor shall remove from structure as work progresses.

N. Mechanical Demolition:

1. Disconnect, demolish and remove work as indicated on Construction Drawings.

2. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new product of equal capacity and quality.

3. Remove indicated exposed pipe and ductwork in it's entirely.

4. Remove indicated piping, A/C ducts from project.

5. Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocated.

O. Electrical Demolition:

1. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality and functionality.

• Electrical Demolition (Cont.'):

2. Remove exposed electrical equipment and installations, indicated to be demolished, in their entirely.

3. Remove demolished and removed materials from project site.

4. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 INSPECTION:

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

B. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes.

3.2 PREPARATION

A. Provide weatherproofing closures for exterior openings resulting from demolition work.

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

3.3 DEMOLITION

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

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

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

D. If unanticipated mechanical, electrical which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner's Representative in written with accurate details. Pending receipt of directive from

Architect rearrange selective demolition schedule as necessary to continue overall job progress without delay.

3.4 DISPOSAL OF DEMOLISHED MATERIALS

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

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

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

3.5 CLEAN-UP AND REPAIR

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

B. Repair demolition performed in excess of that required. Return structures and surfaces to remain to condition existing prior to commencement of selective demolition work. Repair adjacent construction or surfaces soiled or damage by selected demolition work.

END OF SECTION 02 41 00

SECTION 02711

CHAIN LINK FENCES

1. RELATED DOCUMENTS:

   The general provisions of the Contract, including the General and Special Conditions apply to the work specified in this section.

2. DESCRIPTION OF WORK:

   The extent of chain link fences and gates is shown on the drawings.

3. QUALITY ASSURANCE:

   Standards of Manufacture: Comply with the standards of the Chain link Fence Manufacturer's Institute.

   Provide fences and gates as complete unit produced by a single manufacturer including necessary erection accessories, fittings and fastenings.

4. SUBMITTALS:

   Manufacturer's Data: Submit for approval two (2) copies of manufacturer's data, specifications, and installation instructions for chain link fencing and gates.

5. GENERAL:

   Pipe sizes indicated are commercial pipe sizes. Equivalent tubular sections, H-sections or roll-formed sections may be substituted for pipe sections, if acceptable to the P.B.A.

6. MATERIALS AND FABRICATION:

   a. Fabric: No. 9 gage (0.148") steel wires, 2" mesh, with both top and bottom selvages twisted and barbed. Provide one-piece fabric widths for fencing up to 12' high. Fabric finish, galvanized, ASTM A 392, Class I, with not less than 1.2 oz. zinc per square feet.

   b. Rails & Framework: Galvanized steel, ASTM A120, with not less than 1.8 oz. zinc per square feet.

• MATERIALS AND FABRICATION (Cont.):

c. Hardware & Accessories: Galvanized, ASTM A152, with zinc weights per Table I.

d. End, Corner and Pull Posts: Minimum sizes and weights as follows:

1. Up to 6' fabric height, 2.375" O.D. steel pipe, 3.65 lbs. per linear feet.

2. Over 6' fabric height, 2.875" O.D. steel pipe, 5.79 lbs. per linear feet.

e. Line Posts: Space 10'o.c. maximum, unless otherwise shown, of following minimum sizes and weights.

1. Up to 6'fabric height, 1.90" O.D. steel pipe, 2.72 lbs, per linear feet.

2. Over 6' fabric height, 2.375" O.D. steel pipe, 3.65 lbs, per linear feet.

f. Gate Posts: Provide posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:

1. Up to 6' wide, 2.875" O.D. pipe.

2. Over 6' and up to 12' wide, 4.0" O.D. pipe.

g. Top and Bottom Rails: 1.660" O.D. pipe, manufacturer longest lengths, with expansion type couplings, approximately 6" long, for each joint. Attach rails securely to each gate, corner, pull, and end post as approved by P.B.A.

h. Post Brace Assembly: Provide manufacturer's standard adjustable brace at gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use 1.660" O.D. pipe for horizontal brace and 0.375" diameter adjustable length diagonal truss rod.

i. Post Tops: Weather tight closure cap, one cap for each post. Furnish caps with openings to permit passage of top rail.

j. Stretcher Bar Bands: Space not over 15"o.c., to secure stretcher bars to end, corner, pull, and gate posts.

k. Extension Arms (when shown): Galvanized pressed steel or galvanized malleable iron, 3 strands of barbed wire.

l. Barbed Wire: Federal Specification RR-F-221, Type A, 12 ½ gauge, galvanized steel wire, 4 point barbs spaced not over 4" on center.

• MATERIALS AND FABRICATION (Cont.):

m. Gates: Provide horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories. Space so that frame members are not more than 8' apart. Fabricate gate perimeter frames of tubular members as follows:

1. Up to 6'-0" high, or leaf width under 8': 1.660" O.D. steel pipe.

2. Over 6'-0" high or leaf width over 8': 1.90" O.D. steel pipe.

Assemble gate frames by welding or with special fittings and rivets, for rigid connections. Use same fabric as for fence. Install fabric with stretcher bars at vertical edges. The Contractor shall attach stretchers to gate frame (at not more than 15"o.c.) and hardware to provide security against removal or breakage. Provide diagonal cross-bracing consisting of ⅜" diameter adjustable length truss rods on gates to provide frame rigidity without sag or twist, if required.

n. Gate Hardware: Provide the following hardware and accessories for each gate:

• Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180º gate opening. Provide 1-½ pair of hinges, for each leaf over 6' nominal height or over 8' wide.

• Latch: Forked type or plunger-bar type to permit operation from either side of gate. Provide padlock eye as integral part of latch.

• Padlock: One padlock equal as approved to Yale 871 ½ master keyed with the building locksets.

• Wire Ties: For tying fabric to line posts, use wire ties spaced 12"o.c. For tying fabric to rails and braces, use wire spaced 24"o.c. For tying fabric to tension wire, use hog rings spaced 24"o.c.

Manufacturer's standard procedure will be accepted if of equal strength and durability.

o. Concrete: Comply with applicable requirements of Division 3. Provide concrete with a minimum 28 day compressive strength of 2500 psi.

7. INSTALLATION:

Do not begin installation and erection before final grading is completed, unless otherwise permitted.

a. Excavation: Dig holes for posts of sizes and spacing shown, in firm, undisturbed or compacted soil. Excavate deeper as required for firm support in soft and loose soils, and for posts with heavy lateral loads.

b. Setting Posts: Center and align posts in holes 3" above bottom of excavation. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

c. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

d. Center Rails: Provide center rails only where shown. Install in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.

e. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.

f. Tension Wire: Install tension wires by weaving through the fabric and tying to each post with not less than 6 gage galvanized wire, or by securing the wire to the fabric.

g. Fabric: Leave approximately 1" between finish grade and bottom selvage, unless otherwise shown. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.

h. Stretcher Bars: Thread through or clamp to fabric 4"o.c., and secure to posts with metal bands spaced 15"o.c.

i. Gates: Install gates plumb, level, and secure for full opening with-out interference. Install ground-set items in concrete for anchorage, as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

j. Tire Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two (2) full turns. Bend ends of wire to minimize hazard to persons or clothing.

k. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

END OF SECTION 02711

SECTION 02763

PAINTED PAVEMENT MARKINGS

1 PART GENERAL

1.1 SUMMARY

A. Section Includes:
1. Traffic lines and markings.
2. Legends.
3. Paint.

B. Related Sections:
1. Section 02740 Flexible Pavement.

1.2 REFERENCES

A. American Society for Testing and Materials:
1. ASTM D34 - Standard Guide for Chemical Analysis of White Pigments.
2. ASTM D126 - Standard Test Methods for Analysis of Yellow, Orange, and Green Pigments Containing Lead Chromate and Chromium Oxide Green.
3. ASTM D562 - Standard Test Method for Consistency of Paints Using the Stormer Viscometer.
4. ASTM D711 - Standard Test Method for No-Pick-Up Time of Traffic Paint.
5. ASTM D713 - Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials.
6. ASTM D969 - Standard Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint.
7. ASTM D1301 - Standard Test Methods for Chemical Analysis of White Lead Pigments.
8. ASTM D1394 - Standard Test Methods for Chemical Analysis of White Titanium Pigments.
9. ASTM D1475 - Standard test Method for Density of Liquid Coatings, Inks, and Related Products.
10. ASTM D1640 - Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature.
11. ASTM D2202 - Standard Test Method for Slump of Sealants.
12. ASTM D2371 - Standard Test Method for Pigment Content of Solvent-Reducible Paints.
13. ASTM D2621 - Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints.
14. ASTM D2743 - Standard Practices for Uniformity of Traffic Paint Vehicle Solids by Spectroscopy and Gas Chromatography.

1.3 PERFORMANCE REQUIREMENTS

A. Paint Adhesion: Adhere to road surface forming smooth continuous film one minute after application.

B. Paint Drying: Tack free by touch so as not to require coning or other traffic control devices to prevent transfer by vehicle tires within two minutes after application.

1.4 SUBMITTALS

A. Section 01330 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit paint formulation for each type of paint.

C. Samples:
   1. Submit eight sample plates of each color of material. After approval, Owner will retain these plates for field comparisons of applied paint.
   2. Submit two gallons and four one quart paint samples accompanied by properly executed test reports.
   3. Submit samples of glass bead in compliance with AASHTO M247.

D. Test Reports: Submit source and acceptance test results in accordance with AASHTO M247.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Puerto Rico Public Work's standard.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing work of this section with minimum 3 years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Invert containers several days prior to use when paint has been stored more than 2 months. Minimize exposure to air when transferring paint. Seal drums and tanks when not in use.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01600 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

C. Do not apply exterior coatings during rain or snow when relative humidity is outside humidity ranges, or moisture content of surfaces exceed those required by paint product manufacturer.

D. Volatile Organic Content (VOC). Do not exceed State or Environmental Protection Agency maximum VOC on traffic paint.

1.9 WARRANTY

A. Section 01700 - Execution Requirements: Requirements for warranties.

B. Furnish three year manufacturer's warranty for traffic paints.

1.10 MAINTENANCE SERVICE

A. Section 01700 - Execution Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of traffic paints for three years from Date of Substantial Completion.

2PART PRODUCTS

2.1 PAINTED PAVEMENT MARKINGS

A. Manufacturers:
1. "Traffic Paint" by Pervo Paint Company.
2. "Traffic Paint" by Pathmark Traffic Products.
3. Traffic and Zone Marking Paint" by PPG.
4. "Romark Traffic" by Glidden-Durkee.
5. Substitutions: Section 01600 - Product Requirements Not Permitted.

B. Paint: Ready mixed, conventional and fast dry waterborne traffic paints, lead-free, non-toxic, NASSHTO Test Deck, minimum retroreflectance of 100 mcds, durability rating of 6 or more after in place for 9 months; within following limits:

1. Pigment, percent by weight: 60 plus or minus 2.
2. Vehicle, percent by weight: 40 plus or minus 2.
3. Non-Volatile, percent by weight of paint: 76.0.
4. Weight per gallon, pounds (kilograms) minimum 13.0 6.
5. Viscosity: 80-95Kreb Units at 77 degrees F (25 degrees C).
6. Grind (Hegman Guage), minimum Field Tested no tracking time under ambient conditions: 20-90 seconds.
7. Dry Through Time, 15 mils (0.4 mm) wet at 90 percent relative humidity, 72 degrees F (22 degrees C), ASTM D1640: 125 minutes maximum.
8. VOC (Volatile Organic Content): One lbs/gal (120 g/L) maximum.

2.2 EQUIPMENT

A. Continuous Longitudinal Line Application Machine: Use application equipment with following capabilities.
   1. Dual nozzle paint gun to simultaneously apply parallel lines of indicated width in solid or broken patterns or various combinations of those patterns.
   2. Measuring device to automatically and continuously measure length of each line placed, to nearest foot (tenth of meter).

B. Machine Calibration:
   1. Paint Line Measuring Device: Calibrate automatic line length gauges to maintain tolerance of plus or minus 25 feet per mile (4.75 m per km).
   2. Cycle Length/Paint Line Length Timer: Calibrate cycle length to maintain tolerance of plus or minus 6 inches per 40 feet (12mm per m); calibrate paint line length to maintain tolerance to plus or minus 3 inches per 10 feet (25 mm per m).
   3. Paint Guns: Calibrate to simultaneously apply paint binder at uniform rates as specified with an allowable tolerance of plus or minus 1 mil.

C. Other Equipment:
   1. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section. Do not use hand brushes or rollers.

2.3 SOURCE QUALITY CONTROL

A. Section 01400 - Quality Requirements: Testing, inspection and analysis requirements.

B. Test and analyze traffic paints in accordance with ASTM D34, ASTM D126 and ASTM D562.

C. Allow witnessing of factory inspections and test at manufacturer's test facility. Notify Architect/Engineer at least seven days before inspections and tests are scheduled.

3PART EXECUTION

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Verification of existing conditions before starting work.

B. Do not apply paint to concrete surfaces until concrete has cured for 28 days.

3.2 PREPARATION

A. Maintenance and Protection of Traffic:
   1. Provide short term traffic control in accordance with Section 01500.
   2. Prevent interference with marking operations and to prevent traffic on newly applied markings before markings dry.
   3. Maintain travel lanes between 7: 00 AM to 9: 00 AM, and between 4: 00 PM and 6: 00 PM.
   4. Maintain access to existing businesses, and other properties requiring access.

B. Surface Preparation.
   1. Clean and dry paved surface prior to painting.
   2. Blow or sweep surface free of dirt, debris, oil, grease or gasoline.
   3. Spot location of final pavement markings as specified and as indicated on Drawings by applying pavement spots 25 feet (8.0 m) on center.
   4. Notify Architect/Engineer after placing pavement spots and minimum 3 days prior to applying traffic lines.

3.3 EXISTING WORK

A. Remove existing markings in an acceptable manner. Do not remove existing pavement markings by painting over with blank paint. Remove by methods that will cause least damage to pavement structure or pavement surface. Satisfactorily repair any pavement or surface damage caused by removal methods.

B. Clean and repair existing lines and legends.

3.4 APPLICATION

A. Agitate paint for 1-15 minutes prior to application to ensure even distribution of paint pigment.

B. Dispense paint at 110 degrees F (43.3 degrees C) to wet-film thickness of 15 mils (0.4 mm), except dispense edge markings to wet-film thickness of 12 mils (0.3 mm).

C. Apply markings to indicated dimensions at indicated locations.

D. Prevent splattering and over spray when applying markings.

E. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.

F. Collect and legally dispose of residues from painting operations.

3.5 APPLICATION TOLERANCES

A. Section 01400 - Quality Requirements: Tolerances.

B. Maximum Variation from Wet Film Thickness: 1 mil.

C. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8 inch (3 mm).

D. Maintain cycle length for skip lines at tolerance of plus or minus 6 inches per 40 feet (12 mm per m) and line length of plus or minus 3 inches per 10 feet (25mm per m).

3.6 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements.

B. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

C. Repair lines and markings, which after application and curing do not meet following criteria:
   1. Incorrect Location: Remove and replace incorrectly placed patterns.
   2. Insufficient Thickness, Line Width, Paint Coverage, Glass Bead Coverage or Retention: Prepare defective material by acceptably grinding or blast cleaning to remove substantial amount of beads and to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface in accordance with this Section.
   3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings in accordance with this Section and clean pavement surface one foot (300 mm) beyond affected area. Apply new markings on cleaned surface in accordance with this Section.

D. Replace defective pavement markings as specified throughout 3 year warranted period. Replace markings damaged by anti-skid materials, studded tires, tire chains, chemical deicers, or other loss of marking material regardless of cause.

E. A three member team will evaluate warranty provisions. Team will consist of one member from Owner, one member from Contractor, and third person who is mutually acceptable to Owner and Contractor. Any costs for third person will be equally shared between Owner and Contractor. At least once each year, beginning with year after acceptance, team shall:

1. Observe Owner taking readings by retroreflectometer, or review Owner records of such evaluation. The number of readings will be as large as necessary to ensure that minimum criteria are satisfied. Readings will be during period from March 15 through October, when pavement is clean and dry.

2. Determine magnitude of material loss.

F. Prepare list of defective areas and areas requiring additional inspection and evaluation to decide where material may need replaced. Provide traffic control as necessary if markings require more detailed evaluation.

G. Replace failed or defective markings in entire section of defective markings within 30 days after notification when any of the following exists during warranty period:

1. Average retroreflectivity within any 528 foot (161 m) section is less than 1225 mcd/m2/1x for white pavement markings and 100 mcd/m2/1x for yellow pavement markings.
2. Marking is discolored or exhibits pigment loss, and is determined to be unacceptable by three member team based on visual comparison with beaded color plates.
3. More than 15 percent of area of continuous line, or more than 15 percent of combined area of skip lines, within any 528 foot (161 m) section of roadway is missing.

H. When eradication of existing paint lines is necessary, eradicate by shot blast or water blast method. Do not gouge or groove pavement more than 1/16 inch (1.5 mm) during removal. Limit area of removal to area of marking plus 1 inch (25 mm) on all sides. Prevent damage to transverse and longitudinal joint sealers, and repair any damage according to requirements in Section 02750 or Section 02740.

I. Maintain daily log showing work completed, results of above inspections or tests, pavement and air temperatures, relative humidity, presence of any moisture on pavement, and any material or equipment problems. Make legible entries in log in ink, sign and submit by end of each work day. Enter environmental data into log prior to starting work each day and at two additional times during day.

3.7 PROTECTION OF FINISHED WORK

A. Section 01700 - Execution Requirements: Requirements for protecting finished Work.

B. Protect painted pavement markings from vehicular and pedestrian traffic until paint is dry and track free. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than 2 minutes dry time.

3.8 SCHEDULES

A. As indicated on drawings.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

1. Section Includes:
    1. Reinforcing bars.
    2. Welded wire fabric.
    3. Reinforcement accessories.

2. Related Sections:
    1. Section 03100 - Concrete Forms and Accessories.
    2. Section 03300 - Cast-in-Place Concrete.

1.2 REFERENCES

1. American Concrete Institute:
    1. ACI 301 - Specifications for Structural Concrete.
    2. ACI 318 - Building Code Requirements for Structural Concrete.
    3. ACI 318M - Metric Building Code Requirements for Structural Concrete.
    4. ACI SP-66 - ACI Detailing Manual.

2. American Society for Testing and Materials:
    1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
    2. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
    3. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
    4. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
    5. ASTM A616/A616M - Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.

3. Concrete Reinforcing Steel Institute:
    1. CRSI - Manual of Standard Practice.
    2. CRSI - Placing Reinforcing Bars.

1.3 SUBMITTALS

1. Section 01330 - Submittal Procedures: Submittal procedures.

2. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules.

3. Certificates: Submit AWS qualification certificate for welders employed on the Work.

4. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

5. Submit certified copies of mill test report of reinforcement materials analysis.

1.4 QUALITY ASSURANCE

1. Perform Work in accordance with CRSI - Manual of Standard Practice ACI 301.

1.5 COORDINATION

1. Section 01300 - Administrative Requirements: Coordination and project conditions.

2. Coordinate with placement of formwork, formed openings and other Work.

PART 2 PRODUCTS

2.1 REINFORCEMENT

1. Reinforcing Steel: ASTM A615/A615M, 60 ksi (420 MPa) yield grade; deformed billet steel bars, unfinished.

2. Stirrups Steel: ASTM A82, unfinished.

3. Welded Steel Wire Fabric: ASTM A497 Deformed Type; in coiled rolls; unfinished.

2.2 ACCESSORY MATERIALS

1. Tie Wire: Minimum 16 gage annealed type.

2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor retarder puncture.

3. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic-

coated steel type; size and shape to meet Project conditions.

2.3 FABRICATION

1. Fabricate concrete reinforcement in accordance with CRSI Manual of PracticeACI SP-66, ACI 318 and ANSI/ASTM A184..

2. Weld reinforcement in accordance with AWS D1.4.

3. Locate reinforcement splices not indicated on Drawings, at point of minimum stress. Review location of splices with Architect/Engineer.

PART 3 EXECUTION

3.1 PLACEMENT

1. Place, support and secure reinforcement against displacement. Do not deviate from required position.

2. Do not displace or damage vapor retarder.

3. Accommodate placement of formed openings.

4. Conform to applicable code for concrete cover over reinforcement.

5. Bond and ground reinforcement in accordance with requirements of Section 16060

3.2 FIELD QUALITY CONTROL

1. Section 01400 - Quality Requirements: Testing and Inspection Services.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:

1. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content.

a. Include statement indicating costs for each product having recycled content.

2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for Portland cement or other Portland cement replacements, and for equivalent concrete mixtures that do not contain Portland cement replacements.

C. Design Mixtures: For each concrete mixture.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

F. Welding certificates.

G. Material certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Cementitious materials and aggregates.
2. Form materials and form-release agents.
3. Steel reinforcement and reinforcement accessories.
4. Fiber reinforcement.
5. Admixtures.
6. Water-stops.
7. Curing materials
8. Floor and slab treatments.

9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Epoxy joint filler.
13. Joint-filler strips.
14. Repair materials.

H. Material Test Reports.

I. Floor surface flatness and levelness measurements.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction**,** qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete,"
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

F. Pre-installation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

1. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class I or Class II zinc coated after fabrication and bending.
2. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

E. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

F. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, deformed steel.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or Type II or Type I/II, gray.

   a. Fly Ash: ASTM C 618, Class F or C.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS, Portland blast-furnace slag, Type IP, Portland-pozzolan, Type I (PM), pozzolan-modified Portland, and Type I (SM), slag-modified Portland cement.

B. Normal-Weight Aggregates: ASTM C 33, graded.

1. Maximum Coarse-Aggregate Size: **1-1/2 inches (38 mm)** at slabs on grade, **1 inch (25 mm)**, at columns and **3/4 inch (19 mm)** at beams and slabs nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Lightweight Aggregate: ASTM C 330, **3/8-inch (10-mm)** nominal maximum aggregate size.

D. Water: ASTM C 94/C 94M and potable.

2.4 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, **1 to 2-1/4 inches (25 to 57 mm)** long.

2.6 WATERSTOPS

A. Flexible Rubber Water-Stops: CE CRD-C 513, with factory-installed metal eyelets**,** for embedding in concrete to prevent passage of fluids through joints. Factory fabricated corners, intersections, and directional changes.

B. Chemically Resistant Flexible Water-Stops: Thermoplastic elastomeric rubber water-stops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricated corners, intersections, and directional changes.

C. Flexible PVC Water-stops: CE CRD-C 572, with factory-installed metal eyelets**,** for embedding in concrete to prevent passage of fluids through joints. Factory fabricated corners, intersections, and directional changes.

D. Self-Expanding Butyl Strip Water-Stops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

E. Self-Expanding Rubber Strip Water-stops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class **C**. Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or *kenaf*, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating**,** certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.10 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength at 28 days: **4000 psi (27.6 MPa)** w/c= 0.60 at Foundations, walls, and stairs, **3000 psi (20.7 MPa)** w/c = 0.7 at sidewalks, slabs on ground, and miscellaneous architectural elements.
2. Maximum Water-Cementitious Materials Ratio: see item D.1 above.
3. Slump Limit: **4 inches (100 mm) and 8 inches (200 mm)** for concrete with verified slump of **2 to 4 inches (50 to 100 mm)** before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
4. Air Content: **5.5** percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
5. Air Content: **6** percent, plus or minus 1.5 percent at point of delivery for **3/4-inch (19-mm)** nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than **1.5 lb/cu. yd. (0.90 kg/cu. m)**.

E. Proportion structural lightweight concrete mixture as follows:

1. Minimum Compressive Strength: **3000 psi (20.7 MPa)** at 28 days.
2. Calculated Equilibrium Unit Weight: **110 lb/cu. ft. (1762 kg/cu. m)**, plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C 567.
3. Slump Limit: **4 inches (100 mm),** plus or minus 1 inch (25 mm).
4. Air Content: 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch (10 mm).
5. Air Content: 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch (10 mm) or less.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than **1.5 lb/cu. yd. (0.90 kg/cu. m)**.

2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches (150 mm) and seal with manufacturers' recommended tape.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Water-Stops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

C. Cold-Weather Placement: Comply with ACI 306.1.

D. Hot-Weather Placement: Comply with ACI 301.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, and to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part Portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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

3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce profile amplitude of 1/4 inch (6 mm) in one direction.

1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces as indicated or to receive trowel finish, and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, and ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed **1/8 inch (3.2 mm)**.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer, unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 03300

SECTION 03310 CONCRETE WORKS

PART 1 GENERAL

1.1_ RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. Extent of concrete work is shown on drawings.

1.3 SUBMITTALS:

A. Product dada: submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Contracting Officer.

B. Shop Drawings; Reinforcement: Submit original shop drawings prepared by registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

C. Shop Drawings; Formwork: Submit shop drawings prepared by a registered Professional Engineer for fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually.

1. Contracting Officer'S review is for general architectural applications and feature only. Design of formwork for structural stability and efficiency is Contractor's responsibility.

D. Samples: Submit samples of materials as requested by Contracting Officer, including names, sources, and descriptions.

E. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test.

F. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Contracting Officer. Materials certificates shall be signed by manufacturer and contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.4 QUALITY ASSURANCE:

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

a. ACI 301 "Specifications for Structural Concrete for Buildings".
b. ACE 318 "Building Code Requirements for Reinforced Concrete"
c. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice"

B. Concrete Testing Service: Engage a testing laboratory acceptable to Contracting Officer and Structural Engineer to perform material evaluation test and to design concrete mixes.

C. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractors's expense.

1.4 PROJECT CONDITIONS:

A. Protect adjacent finish materials against spatter during concrete placement.

1.5 PROJECT CONDITIONS:

A. Protect adjacent finish materials against spatter during concrete replacement.

PART 2 PRODUCTS

2.1 FORM MATERIALS:

A. Forms for exposed finish concrete: Plywood, metal, metal framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for unexposed finish concrete: plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Forms for textured finish concrete: units of face design, size, arrangement, and configuration to match contracting officer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

D. Forms for Columns and Supports: metal, fiberglass reinforced plastic, or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.

E. Form Coatings: provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces.

F. Form Ties: factory-fabricated, adjustable-length, removable or snap off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units which will leave not metal closer than 1-1/2" to surface.

a. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.

2.2. REINFORCING MATERIALS:

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Galvanized Reinforcing Bars: ASTM A 767, Class I (3.0 oz. Zinc. Psf) hot dip galvanized, after fabrication and bending.

C. Epoxy-Coated Reinforcing Bars: ASTM A 775.

D. Steel Wire: ASTM A 82, plain, cole-drawn steel.

E. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.

F. Welded Deformed Steel Wire Fabric: ASTM A 497.

G. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, sporting and fastening reinforcing bases and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.3 CONCRETE MATERIALS:

A. Portland Cement: ASTM C 150, Type I.

B. Use one brand of cement throughout project, unless otherwise acceptable to Contracting Officer.

C. Fly Ash: ASTM C 618, Type C or Type F.

D. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single course for exposed concrete.

a. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.

b. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Contracting Officer.

E. Lightweight Aggregates: ASTM C 330.

F. Water: Drinkable.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with

other required admixtures.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

a. "Air-Mix", Euclid Chemical Co.
b. "Sika Aer" Sika Corp.
c. "MB-VR or MB-AE", Master Builders.
d. "Darex AEA" or "Daravair", W.R. Grace.
e. "Edoco 2001 or 2002, Edoco Technical Products.
f. "Air-Tite", Gifford-Hill/American Admixtures.

H. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

a. WRDA Hycol, W. R. Grace
b. PSI N, Gifford-Hill/American Admixtures
c. Eucon WR-75, Euclid Chemical. Co.
d. Pozzolith Normal, Master Builders
e. Plastocrete 160, Sika Chemical Corp.
f. Chemtard, Chem-Masters Corp.
g. Pro-Kete, N, Protex Industries, Inc.

I. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G and containing not more than 0.1 percent chloride ions.

a. WRDA 19, or Daracem, W.R. Grace.
b. PSP; Protex Industries, Inc.
c. Super P, Anti-Hydro
d. Sikament; Sika Chemical Corp.
e. Mighty 150, ICI Americas Corp.
f. Eucon 37; Euclid Chemical Corp
g. PSI Super, Gifford-Hill
h. Reheoubuild; Master Builders

J. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, type E, and containing not more than 0.1 percent chloride ions.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   a. Accelguard 80, Euclid Chemical Co.
   b. Pozzolith High Early; Master Builders
   c. Gilco Accelerator; Gifford-Hill/American Admixtures

K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and containing not more than 0.1 percent chloride ions.

1. Availabe Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   a. Edoco 20006; Edoco Technical Products
   b. Pozzolith Retarded; Master Builders
   c. Eucon Retarded 75, Euclid Chemical Co.
   d. Daratard; W.R. Grace
   e. PSI R; Gifford-Hill American Admixtures
   f. Plastiment; Sika Chemical Co.
   g. Protard, Protex Industries, Inc.

L. Prohibited Admixtures: Calcium chloride thiocyanate or admixtures containing more than 0.1. percent chloride ions are not permitted.

M. Fibrous Reinforcement: Collated fibrillated, polypropylene fiber for secondary reinforcement of concrete slabs.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   a. Forta CR; Forta Corp.
   b. Fibermesh; Fibermesh Inc.

2.4. RELATED DOCUMENTS:

A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

B. Waterstops: Provide flat, dumbbell type or center bulb type waterstops at construction joints and other joints as indicated. Size to suit joints.

C. Rubber Waterstops: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to the following:

The Burke Co.

1. Progress Unlimited
2. Williams Products
3. Edoco Technical Products.

D. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
   a. AFCO Products
   b. The Burke Co
   c. Edoco Technical Products
   d. Greenstreet Plastic Products
   e. Harbour Town Products
   f. W.R. Meadows
   g. Progress Unlimited
   h. Schleigel Corp.
   i. Vinylex Corp.

E. Granular Base: Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.

F. Vapor Retarder: Provide vapro retarder cover over prepared base material below slabs on grade. Use only materials which are resistant to decay when tested in accordance with ASTM E 154, as follows:

1. Polyethylene sheet not less than 8 mils thick.

G. Non-Shrink Grout: CRD-C 621, factory pre-mixed grout.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
   a. Metallic
      1. Vibrofoil, A.C. Horn, Inc.
      2. Metallic Spec. Grout, The Burke Co.
      3. Embeco 636, Master Builders

4. Ferrolith GDS, Sonneborn Rexnord
5. Hi-Mod Grout, Euclid Chemical Co.
6. Kemox G, Sika Chemical Co.
7. Ferrogrout, L&M Const. Chemical Co.
8. Supreme Plus, Gifford-Hill/American Admixtures

a. Non-Metallic
   1. Set Grout, Master Builders
   2. Sonogrout, Sonneborn Rexnord
   3. Euco-NS, Euclid Chemical Co.
   4. Supreme, Gifford-Hill/American Admixtures
   5. Crystex, L & M Const. Chemical Co.
   6. Sure-Grip Grout, Dayton Superior Corp.
   7. Horngrout, A.C. Horn, Inc.
   8. Five Star Grout, U.S. Grout Corp.

2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   b. Surfhard, Euclid Chemical Co.
   c. Lapidolith, Sonnerborn-Rexnord.
   d. Saniseal, Master Builders
   e. Burk-O-Lith, The Burke Co.

H. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.

I. Colored Wear-Resistant Finish: Packaged, dry, combination of materials, consisting of Portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, non-fading mineral oxides, and underground with cement. Color as selected by contracting officer, unless otherwise indicated.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   a. Colorcron, Master Builders
   b. Harcol Redi-Mixed, Sonneborn-Contech
   c. Surflex, Euclid Chemical Co.
   d. Colorundum, A.C. Horn, Inc.

e. Quartz Plate, L & M Const. Chemical Co.
f. Lithochrome, L.M. Scofield Co.
g. Floorcron, Gifford-Hill American Admixtures

J. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. Per sq. yd., complying with AASHTO M 182, Class 2.

K. Moisture Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper
2. Polyethylene film
3. Polyethylene coated burlap

L. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C 309, Type I, Class a. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft. /gal.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

a. Masterseal, Master Builders.
b. A-H 3 Way Sealer, Anti-Hydro Waterproofing Co.
c. Ecocure, Euclid Chemical Co.
d. Clear Seal, A.C. Horn, Inc.
e. Sealco 309, Gifford-Hill/American Admixtures
f. J-20 Acrylic Cure, Dayton Superior
g. Spartan-Cote; the Burke Co.
h. Sealkure; Toch Div. - Carboline
i. Kure-N-Seal, Sonneborn-Rexnord.
j. Polyclear, Upco Chemical/USM Corp.
k. L & M Cure, L & M Construction Chemicals
l. Klearseal, Set Con Industries
m. LR-152, Protex Industries
n. Hardtop, Gifford-Hill

M. Underlayment Compound: Free flowing, self leveling, pump able cementations base compound.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

a. Flo-Top, Euclid Chemical Co.
b. ACD Purable Underlayment, ACD International Inc.
c. Thoro Underlayment Self-Leveling, thore System Products

N. Bonding Compound: Polyvinyl acetate or acrylic base.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
2. Polyvinyl Acetate (Interior Only):

a. J-40 Bonding Agent; Dayton Superior Corp.
b. Everbond, L & M Construction Chemicals
c. Hornweld, A.C. Horn, inc.
d. Sonocrete, Sonneborn-Rexnord
e. Acrylic bondcrete, The Burke, Co.
f. SBR Latex, Euclid Chemical Co.
g. Daraweld C, W.R.

O. Epoxy Adhesive: ASTM C 881, two component material suitable for use on dry or damp surfaces. Provide material "Type", Grade, and Class to suit project requirements.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

a. Thiopoxy, W.R. Grace
b. Epoxtite, A.C. Horn, Inc.
c. Edoco 2118 Epoxy Adhesive, Edoco Technical Prod.
d. Sikadur Hi-Mod, Sika Chemical Corp.
e. Euco Epoxy 452 or 620, Euclid Chemical Co.
f. Patch and Bond Epoxy, The Burke Co.
g. Concressive 1001, Adhesive Engineering Co.

2.5 PROPORTIONING AND DESIGN OF MIXES:

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use and independent testing facility acceptable to Contracting Officer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
1. Limit use of fly ash to not exceed 25 percent of cement content by weight.

B. Submit written reports to Contracting Officer and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work . Do not begin concrete production until mixes have been reviewed by Contracting Officer. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules.

1. 3000 psi 28-day compressive strength; W/C ratio, 0.58 maximum (non-air-entrained) 0.46 maximum (air-entrained)

C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Contracting Officer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Contracting Officer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Contracting Officer before using in work.

D. Admixtures:

1. Use water-reducing admixture or high range water-reducing admixture (super-plasticizer) in concrete as required for placement and work ability.

2. Use high-range water-reducing admixture in pumped concrete, architectural concrete, concrete required to be watertight, and concrete with water/cement ratios below 0.50.

3. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1 ½ percent within following limits:

   a. Concrete structures and slabs exposed or subjected to hydraulic pressure:
      1. 4.5 percent, 1" aggregate
      2. 5.0 percent, 3/4" max. aggregate
      3. 5.5 percent, ½" max. aggregate

   b. Other Concrete (not exposed to hydraulic pressure): 2 percent to 4 percent air.

4. Use admixtures for water-reducing, and set-control in strict compliance with manufacturer's directions.

E. Water-Cement-Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:

1. Subjected to hydrostatic pressure; W/C 0.45.

F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement

as follows:

1. Ramps, slabs, and sloping surfaces: Not more than 3".
2. Reinforced foundation systems: not less than 1" and not more than 3".
3. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.
4. Other concrete: Not less than 1" nor more than 4".

2.6. CONCRETE MIXING:

A. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

PART 3 EXECUTIONS

3.1 GENERAL:

A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.2 FORMS:

A. Design, erect, support, brace, and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustication, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces.

Provide crush plates or wrecking plates where striping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for ease removal.

E. Provide temporary openings where interior area of formwork is inaccessible for clean out, for inspection before concrete placement and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades.

H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to revive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER INSTALLATION:

A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.

B. Lap joints 6" and seal with appropriate tape.

C. After placement of moisture barrier, cover with granular material and compact to depth as shown on drawings.

3.4 PLACING REINFORCEMENT:

A. Comply with Concrete Reinforcing Steel Institute" recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports, and as herein specified.

1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers as required.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces..

E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.5 JOINTS:

A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Contracting Officer.

B. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.

D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.

E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

1. Joint filler and sealant materials are specified in Division 7 sections of these specifications.

F. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on

ground to form panels of patterns as shown. Use saw cuts 1/8" x 1/4 slab depth or inserts 1/4" wide x 1/4 of slab depth, unless otherwise indicated.

G. Form contraction joints by inserting premolded plastic, hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

1. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.

H. If joint pattern not shown, provide joints not exceeding15' in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, thirdbays).

1. Joint sealant material is specified in Division-7 sections of these specifications.

3.6 INSTALLATION OF EMBEDDED ITEMS:

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, instructions, and directions provided by suppliers of items to be attached thereto.

B. Install reglets to receive top edge of foundation sheet waterproofing, and to receive thru-wall flashing in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.

C. Edge Forms and Screed Strips for Salbs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

3.7 PREPARATION OF FORM SURFACES:

A. Clean re-used forms of concrete matrix residue, repair and patch as required returning forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions
of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Applied in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining rust preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.8 CONCRETE PLACEMENT:

A Replacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

B. General: comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transportation, and Placing Concrete" and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be place continuously, provide weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while proceeding layer is still plastic to avoid cold joints.

E. Consolidated placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

H. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

I. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

J. Maintain reinforcing in proper position during concrete placement operations.

K. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

L. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

M. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed to ambient air temperature immediately before embedment in concrete.

N. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.

O. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.9 FINISH OF FORMED SURFACES:

A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fin and other projections exceeding 1/4" in height rubbed down or chipped off.

B. Smooth Form Finish: for formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

C. Smooth Rubbed Finish: Provide smooth rubbed finished to scheduled concrete surfaces, which have received smooth form finish treatment, not later than one day after form removal.

D. Moisten concrete surfaces and rub with Carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.

E. Grout Cleaned Finish: Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment.

F. Combine one part Portland cement to 1-1/2 parts fine sand by volume, and mix with water to consistency of thick paint. Proprietary additives may be used at Contractor's option. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.

G. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

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

3.10 MONOLITHIC SLAB FINISHES:

A. Scratch Finish: Apply scratch to monolithic slab surfaces that are to receive floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.

B. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 15 and floor levelness (Ff) of 13. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.

C. Float Finish: Apply float finish to monolithic slab surface to receive trowel finish and other finishes as hereinafter specified and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.

D. After screding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of Ff 18 -Fl 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

F. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidated concrete surface by final hand-trowling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of FF 20 - FL-17. Grind smooth surface defects which would telegraph through applied floor covering system.

G. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

H. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

I. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with contracting officer before application.

J. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water (parts of hardener/water as follows), and apply in 3 coats; first coat 1/3-strength; second coat, ½ strength; third coat, 2/3 strength. Evenly apply each coat, and allow 24 hours for drying between coats.

K. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions.

L. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

M. Non-slip Aggregate Finish: Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere as indicated.

N. After completion of coat finishing, and before starting trowel finish, uniformly spread 25 lbs. Of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.

O. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose non-slip aggregate. Apply curing compound immediately after final finishing.

3.11 CONCRETE CURING AND PROTECTION:

A. General: Protect freshly placed concrete from disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

B. Start final curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures.

Avoid rapid drying at end of final curing period.

D. Curing methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

E. Provide moisture curing by following methods.
   1. Keep concrete surface continuously wet by covering with water.
   2. Continuous water fog spray.
   3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

F. Provide moisture-cover curing as follows:

   1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by water proof tape of adhesive. Immediately repair any holes or tears during curing period using cover material and water proof tape.

G. Provide curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs, as follows:

   1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are completed (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

H. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, water proofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, and other coatings and finish materials, unless otherwise acceptable to Contracting Officer.

I. Curing Formed Surfaces: Cure formed concrete surfaces including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

J. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs. Floor topping, and other flat surfaces by application of appropriate curing method.

K. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

L. Sealer and Dustproofer: Apply a second coat of specified curing and sealing compound only to surfaces given a first coat.

3.12 SHORES AND SUPPORTS:

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

B. Extend shoring from ground to roof for structures 4 stories or less, unless otherwise permitted.

C. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

D. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.13 REMOVAL FORMS:

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field cured specimens representative of concrete location or members.

C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.14 RE-USE OF FORMS:

A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to

Contracting Officer.

3.15 MISCELLANEOUS CONCRETE ITEMS:

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

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

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

E. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast in safety inserts and accessories as shown on drawings. Screed, tamps, and finishes concrete surfaces as scheduled.

F. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as schedule. Maintain accurate location of reinforcing steel during concrete placement

3.16 CONCRETE SURFACE REPAIRS:

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Contracting Officer.

B. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

C. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching.

Compact mortar in place and strike-off slightly higher than surrounding surface.

D. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Contracting Officer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discoloration that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

E. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

F. Repair of Unformed Surfaces: test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.

G. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

H. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.

I. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Contracting Officer.

J. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

K. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area

continuously moist for not less than 72 hours.

L. Perform structural repairs with prior approval of Contracting Officer or Structural Engineer for method and procedure, using specified epoxy adhesive and mortar.

M. Repair methods not specified above may be used, subject to acceptance may be achieved by use of specified underlayment material.

N. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material.

3.17 QUALITY CONTROL TESTING DURING CONSTRUCTION:

A. Sampling and testing for quality control during placement of concrete shall include the following, as directed by contracting officer. Contractor shall procure and pay for concrete quality control and testing services by a qualified testing laboratory acceptable to Structural Engineer and Contracting Officer.

B. Sampling Fresh Concrete:"ASTM C 172, except modified for slump to comply with ASTM C 94.

1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
2. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; one for each day's pour of each type of air-entrained concrete.
3. Concrete Temperature: test hourly when air temperature is 80 deg F (27 deg C) and above; and each time a set of compression test specimens made.
4. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
5. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. Plus additional sets for each 50 cu yds. Over and above the first 25 cu. yds. Of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

6. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or form each batch if fewer than 5 are used.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
8. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and

no individual strength test result falls below specified compressive strength by more than 500 psi.

C. Test results will be reported in writing to Contracting Officer, Structural Engineer and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7 day test and 28 day tests.

D. Nondestructive Testing: Impact hammer, son scope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Contracting Officer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION

SECTION 03 52 16

LIGHTWEIGHT CELLULAR INSULATING CONCRETE (LWIC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including all General and Supplementary Conditions apply to this section.

1.2 SUMMARY

A. This section includes cast-in-place cellular lightweight insulating concrete for roof decks, concrete, steel or approved existing roofing assemblies.

B. Related Sections include:

1. Metal Decking, Division 05000
2. Rough Carpentry, Wood blocking and curbs, Division 06000
3. Roof Membrane, Division 07000 Single Ply Feltback PVC Membranes

1.3 DEFINITIONS

A. *Cellular* Lightweight Insulating Concrete: Low-density concrete produced using preformed foam.

1.4 REFERENCES

A. ASTM C 150, Standard Specification for Portland Cement.

B. ASTM C 138, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

C. ASTM C 172, Standard Practice for Sampling Freshly Mixed Concrete.

D. ASTM E 329, Standard Specification for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

E. ASTM C 495, Standard Test Method for Compressive Strength of Lightweight Insulating Concrete.

F. ASTM C 796, Standard Test Method for Foaming Agents for use in Producing Cellular Concrete Using Preformed Foam.

G. ASTM C 869, Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.

H. ASTM C 578, Standard Specification for Rigid Cellular Polystyrene Thermal Insulation.

I. ASTM C 177, Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

J. ASTM C 518, Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

K. ASTM C 513, Standard Test Method for Obtaining and Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength.

L. ASTM C 1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.

1.5 SUBMITTALS

A. Product data for the cellular lightweight insulating concrete and the polystyrene insulating board indicating compliance with all applicable Approvals, Standards and required physical property values.

B. Florida Product Approval Number, 2020 Code Version, including HVHZ Approval.

C. Miami Dade County, Notice of Product Acceptance - NOA

D. Shop drawings indicating polystyrene insulation layout and thicknesses, slope and drain locations, high and low point thickness from atop the structural deck.

E. Applicator shall be a firm Approved in writing by the foam concentrate Manufacturer. The Manufacturer provided Approval letter shall mention the project by name.

F. Certificates from manufacturers certifying that each of the following materials comply with referenced standards:

1. Portland Cement
2. Foaming Agent
3. Admixtures
4. Expanded Polystyrene (EPS) Holey Board Insulation 1lb. minimum density.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualification: An independent testing agency shall be qualified in accordance with ASTM C 1077 and ASTM E 329 for testing indicated.

B. FM Global Approval: provide cellular lightweight insulating concrete that has been evaluated by FM Approvals as part of a roof assembly and is listed in the FM RoofNav data base for Class 1 and non-combustible construction.

C. UL Fire Resistance Ratings: where indicated, provide cellular lightweight insulating concrete identical to those assemblies tested for fire resistance per ASTM E 119 and listed in UL's Fire Resistance Directory. The cellular lightweight insulating concrete shall be UL Classified and listed in the current UL Fire Resistant Design Directory under Category COXX, Floor and Roof Topping Mixtures.

D. The Applicator shall submit evidence that the proposed roof system meets the requirements of the local building code (Puerto Rico Building Code 2018) and has been tested and approved or listed by an approved, codified testing organization. These requirements are minimum standards, and no roofing work shall commence without written documentation of the system's compliance.

1.7 DELIVERY AND STORAGE

A. Deliver materials unopened in the manufacturer’s original packaging or by acceptable bulk delivery.

B. Materials shall be identifiable by manufacturers labeling.

C. Where applicable materials shall bear the following Approval Marks:

1. Underwriters Laboratories - UL
2. Factory Mutual - FM
3. Local Building Code Conformance

1.8 PROJECT CONDITIONS

.

A. Do not place during precipitation, or when there is a likely expectation that precipitation will occur. Do not place upon surfaces covered with water, debris, or other types of containments.

1.9 WARRANTY / GUARANTEE

A. Upon successful completion of the project, after all post installations have been completed, furnish the Owner a roof deck system manufacturer’s warranty. The warranty shall be a term type and shall be issued to the Owner at no additional cost. Specific items covered under the warranty shall include:

1. The actual resistance to heat flow through the roof insulation will be at least 80% of the designed thermal resistance, provided the insulation is dry and the roof membrane is free of leaks.

2. The roof insulation will remain in a re-roof able condition should the roof membrane require replacement during the original term of the warranty (excluding damage caused by fastener withdrawal during the removal of the roof cover).

3. The roof insulation will not cause structural damage to the building because of expansion from thermal or chemical reaction.

4. The roof insulation will not cause the roof membrane to leak because of vapor pressure build-up from batching (mixing) water used to produce the insulating concrete.

5. The roof insulation warranty period shall be 20 years from the date of substantial completion.

6. All thermoplastic PVC single ply Fleece Back 60 mils minimum membranes fully adhere using water-based adhesives to the LWIC to achieve an FM 1-525 PSF

uplift rating. Initial Solar Reflectance of 85. Membrane manufacture to provide a minimum 20-year NDL single ply warranty over the LWIC.

PART 2 - PRODUCTS

2.1 APPROVED LWIC MANUFACTURERS

A. Manufacturers whose products are listed and meet or exceed the requirements of this specification are approved for use.

B. Basis of Design: Celcore Incorporated, www.celcoreinc.com.

C. Manufacturers listed below may be considered, subject to compliance with the specification:

1. Elastizell, Elastizell.com
2. Mearlcrete, Aerix Industries

2.2 MATERIALS

A. Cement: Portland type I, I/II meeting ASTM C150

B. Water: shall be clean, potable, free from injurious quantities of acid, alkali, salt, oil, organic matter, and other impurities. The maximum permissible chloride level is 250 ppm.

C. Foaming Agent: meeting ASTM C 869 when tested in accordance with ASTM C 796. Foam concentrate shall be labeled bearing FM, UL, and Local Construction Code Compliance. Approval Marks.

D. Admixtures: admixtures shall not be used unless approved in writing by the Foam Manufacturer.

E. Insulating Board: shall be a product of expanded polystyrene meeting ASTM C 578, 1 lb/ft^3 nominal density with holes comprising approximately 3% of the gross surface area. Approved manufacturers include:

1. Carpenter Company: www.carpenter.com
2. Cellofoam North America: www.cellofoam.com
3. Dyplast Products, LLC: www.dyplastproducts.com
4. Insulfoam: www.insulfoam.com
5. All local approved equal meeting specifications.

F. Curing Compound: as required by the insulating concrete manufacturer and applied in accordance with the manufacturer's instructions.

2.3 CELLULAR INSULATING CONCRETE

A. Mix materials in strict accordance with recommendations of the foam manufacturer to yield the proper physical properties. Use the minimum amount of mix water required to produce concrete having good placement and working properties.

B. Mix and pump the cellular lightweight insulating concrete into place using a batch

plant approved by the foam manufacturer. Thoroughly blend all materials before discharging the mixer.

C. Wet cast density: 38-42 lbs/ft³ (+/- 3 lbs/ft³) at the point of placement when sampled in accordance ASTM C 172 except as modified by the applicable sections of ASTM C 495. End of hose wet density shall be determined in accordance ASTM C 138. Do not rod or vibrate sample.

D. Oven dry density: 26 - 36 lbs/ft³ when tested at 28 days in accordance with the applicable sections of ASTM C 495.

E. The cellular insulating concrete shall have *a minimum 28-day compressive strength of 300 -350 psi when tested in accordance with ASTM C 495.*

F. The insulating concrete deck shall be designed to provide an ¼" in 12 slope and ½" tapered crickets to drains. R-value of: R = **20**

PART 3 - EXECUTION

3.1 EXAMINATION

A. Structural Concrete Deck: verify that the surface of the structural concrete deck to receive the cellular insulating concrete is free from any materials, debris, standing water, other coverings and/or substances that may prevent bond.

B. Steel Deck: examine the decking for inadequate anchorage, foreign materials, debris, moisture, or unevenness that would prevent proper application or adequate bond. Report inadequacies for correction. Consult manufacturer for best venting practice.

3.2 PREPARATION

A. Cover and protect all equipment, stands, curbs, drains, etc., prior to beginning placement of the cellular insulating concrete.

B. Protect all elements that interface with or are beneath the insulating concrete placement from application damage or disfigurement.

3.3 INSTALLATION

A. Place a slurry layer of cellular concrete to a minimum thickness of 1/8 inch over top of the approved substrate (concrete, steel or recovering conditions).

B. Immediately place the EPS holey board insulation into the fresh cellular concrete layer in a manner which causes the boards underside to make full contact with the concrete. Cellular concrete shall be caused to enter the keying holes of the board. The insulation board shall be placed in a brick like pattern of staggered joints butted together.

C. When required, install the EPS holey board in a stepped configuration with maximum steps of 1 inch.

D. The installed EPS holey board layer shall be allowed to set overnight undisturbed

prior to receiving topping.

F. Place a minimum 2-inch-thick topping layer of cellular insulating concrete above the insulation board. Screed and hand finished the placement to a smooth surface.

G. Apply curing compound to the surface of the deck after topping placement once the layer has hardened sufficiently to receive foot traffic without causing damage. Curing shall be applied at a rate and in a manner recommended by the foam manufacturer.

3.4 FIELD QUALITY CONTROL

A. End-of-hose wet density checks shall be taken every thirty minutes during placement. Density information shall be recorded by the placement foreman and kept as a written project record. Sampling shall be done in accordance ASTM C 172 except as modified by the applicable sections of ASTM C 495.

B. Cylindrical test specimen shall be cast during each day's placement or at every 5,000 sq/ft of placement. Specimens shall be cast in accordance with the applicable sections of ASTM C 495. Do not rod. A set of test specimens shall be considered (6) 3 x 6 cylinders. (4) specimens of each set shall be tested for compressive strength and (2) shall be for oven-dry density determination. Testing shall be conducted at age 28 days in accordance with ASTM C 495.

C. Retesting for compressive strength and oven dry density, if required, shall be done in accordance with ASTM C 513.

3.5 PROTECTION

A. The installed cellular insulating concrete roof deck shall be protected from work traffic for a minimum of 48 hours after topping placement. The roof deck shall be protected from concentrated loads of construction materials. Load distribution materials such as plywood shall be used by other trades when stocking materials.

B. Coordinate installation of the roof cover such that the installed insulating concrete deck is not exposed for unnecessary extended periods of time. Membrane installation is recommended to begin within 3 to 7 days following roof deck topping placement.

3.6 REPAIRS

A. Where required to provide a surface condition acceptable to receive the roof cover, repairs to smooth the deck surface, correct depressions or fill divots shall be done in accordance with written guidance provided by the foam concentrate manufacturer.

3.7 DEFECTIVE WORK

A. Remove and replace any area of the roof deck placement that fails to comply with the requirements of the foam manufacturer, this specification or applicable product Approvals.

END OF SECTION 03 52 16

SECTION 03732

CONCRETE REPAIR

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preparation of concrete and application of repair materials.
B. Rehabilitation and Restoration of concrete surfaces.
C. Repair of concrete internal reinforcement.

1.2 RELATED SECTIONS

A. Section 03300 – Cast-In-Place Concrete.
B. Section 04500 – Masonry Restoration and Cleaning.

1.3 REFERENCES

A. ASTM A82 Cold Drawn Steel Wire for Concrete Reinforcement.
B. ASTM A615/A615M Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
C. ASTM A616/A616M Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
D. ASTM A617/A617M Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.
E. ASTM C33 Specifications for Concrete Aggregates.
F. ASTM C150 Portland Cement.
G. ASTM C404 Aggregates for Masonry Grouts.
H. ASTM C882 Bond Strength of Epoxy Resin Systems Used with Concrete.
I. ASTM D638 Test Method for Tensile Properties of Plastics.
J. ASTM D695 Compressive Properties of Rigid Plastics.
K. ASTM D790 Flexural Properties of Plastics and Electrical Insulating Materials.
L. AWS D1.4 Structural Welding Code for Reinforcing Steel

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 Submittals: Procedures for submittals.
B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.

1.5 SUBMITTALS FOR INFORMATION

A. Section 01300 – Submittals: Procedures for submittals.
B. Manufacturer's Certificate: Certify that specified products meet or exceed specified requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

A. Accurately record actual locations of structural reinforcement repairs, and type of repair.

1.7 QUALITY ASSURANCE

A. Perform welding work in accordance with AWS D1.4.
B. Materials Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.
C. Design reinforcement splices under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located or in the Commonwealth of Puerto Rico.
D. Applicator: Company specializing in concrete repair approved by manufacturer.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Section 01600 Material and Equipment: Transport, handle, store, and protect products.
B. Comply with instructions for storage, shelf life limitations, and handling.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. Epoxy Resin: Two-part epoxy adhesive containing 100 percent solids, meeting the following minimum characteristics:

Characteristic	Test Method	Results
1. Bond Strength	ASTM C882	2,700 psi. (18.6 MPa)
2. Tensile Strength	ASTM D638	6,600 psi. (45 MPa)
3. Elongation	ASTM D638	2 percent at 7 days at 70 degrees F (21 degrees C)
4. Flexural Strength	ASTM D790	8,000 psi. (45 MPa)
5. Compressive Strength	ASTM D695	6,500 psi. (55 MPa)

B. Bonding Agent: Polyvinyl acetate emulsion, dispersed in water while mixing, non-coagulant in mix, water resistant when cured.
C. Portland Cement: ASTM C150, Type I, grey color.
D. Sand: ASTM C 33; uniformly graded, clean.
E. Water: Clean and potable.
F. Cleaning Agent: Commercial muriatic acid.

2.2 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, 60 *ksi* (414 *mPa*) yield grade billet-steel deformed bars, unfinished finish.
B. Stirrup Steel: ASTM A82.

2.3 MIXING EPOXY MORTARS

A. Mix epoxy mortars in accordance with manufacturer's instructions for purpose intended.
B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

2.4 MIXING CEMENTITIOUS MATERIALS

A. Mix cementitious [mortar] [grout] in accordance with manufacturer's instructions for purpose intended.
B. [Include] [Exclude] bonding agent as additive to mix.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.
B. Beginning of installation means acceptance of existing surfaces.

3.2 PREPARATION

A. Clean concrete surfaces of dirt, laitance, corrosion, or other contamination: wire brush using acid; rinse surface and allow to dry.
B. Flush out cracks and voids muriatic acid to remove laitance and dirt. Chemically neutralize by rinsing with water.
C. Provide temporary entry ports spaced to accomplish movement of fluids between ports; no deeper than the depth of the crack to be filled or port size diameter no greater than the thickness of the crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.
D. For areas patched with epoxy mortar, remove broken and soft concrete ¼ inch (6 mm) deep. Remove corrosion from steel. Clean surfaces mechanically; wash with acid; rinse with water.
E. Sandblast clean the exposed reinforcement steel surfaces. Mechanically cut away damaged portions of bar.

3.3 REPAIR WORK

A. Repair exposed structural, shrinkage, and settlement cracks of concrete as indicated on Drawings by the epoxy injection method.
B. Repair spalls. Fill voids flush with surface. Apply surface finish.
C. Repair reinforcement by welding new bar reinforcement to existing reinforcement. Strength of welded splices and reinforcement to exceed original stress values.

3.4 INJECTION – EPOXY RESIN ADHESIVE

A. Inject adhesive into prepared ports under pressure using equipment appropriate for particular application.
B. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port. Continue from port to port until entire crack is filled.
C. Remove temporary seal and excess adhesive.
D. Clean surfaces adjacent to repair and blend finish.

3.5 APPLICATION – EPOXY MORTAR

A. Trowel-applied mortar mix to an average thickness of ¼ inches (6mm). Tamp into place filling voids at spalled areas.
B. For patching honeycomb, trowel mortar onto surface, work mortar into honeycomb to bring surface flush with surrounding area. Finish trowel surface to match surrounding area.
C. Cover exposed steel reinforcement with epoxy mortar, feather edges to flush surface.

3.6 APPLICATION – CEMENTITIOUS MORTAR

A. Apply roller coating of bonding agent to dry concrete surfaces. Provide full surface coverage.
B. Apply cementitious mortar by steel trowel to an average thickness of ¼ inches (6mm). Tamp into place filling voids at spalled areas. Work mix into honeycomb.
C. Damp cure cementitious mortar for four days.

3.7 FIELD QUALITY CONTROL

A. Test concrete for calcium chloride content during the execution of the Work.

END OF SECTION 03732

FOR REFERENCE ONLY

CONCRETE RESTORATION SYSTEMS

DIVISION 3 -CONCRETE

Section 03930 – Concrete Rehabilitation
Epoxy-Injected Crack Repair

Part 1 - General

1.01 Summary

A. This specification describes the pressure injection of cracks with an epoxy resin adhesive.

1.02 Quality Assurance

A. Manufacturing qualifications: The manufacturer of the specified product shall be ISO 9001/9002 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. Contractor qualifications: Contractor shall be qualified in the field of concrete repair and protection with a successful track record of 5 years or more. Contractor shall maintain qualified personnel who have received product training by a manufacturer's representative.

C. Install materials in accordance with all safety and weather conditions required by the manufacturer, or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult Material Safety Data Sheets for complete handling recommendations.

1.03 Delivery, Storage, and Handling

A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Store all materials off the ground and protect from rain, freezing or excessive heat until ready for use.

C. Condition the specified product as recommended by the manufacturer.

1.04 Job Conditions

A. Environmental Conditions: Do not apply material if it is raining or snowing or if such conditions appear to be imminent. Minimum application temperature 40°F (5°C) and rising.

B. Protection: Precautions should be taken to avoid damage to any surface near the work zone due to mixing and handling of the specified product.

1.05 Submittals

A. Submit two copies of manufacturer's literature, to include: Product Data Sheets, and appropriate Material Safety Data Sheets (MSDS).

1.06 Warranty

A. Provide a written warranty from the manufacturer against defects of materials for a period of five (5) years, beginning with date of substantial completion of the project.

FOR REFERENCE ONLY

Part 2 - Products

2.01 Manufacturers

A. **Sikadur 35 Hi-Mod LV**, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302 is considered to conform to the requirements of this specification.

B. **Sikadur 31 Hi-Mod Gel**, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302 is considered to conform to the requirements of this specification

2.02 Materials

A. Epoxy resin adhesive for pressure injection of cracks shall be **Sikadur 35 Hi-Mod LV:**

1. Component "A" shall be a modified epoxy resin of the diglycidiether bisphenol A Type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidiether bisphenol A Type containing suitable viscosity control agents, pigments, and accelerators.
3. The ratio of component A: componet B shall be 2:1 by volume
4. The material shall not contain asbestos.

B. Epoxy resin adhesive for sealing of cracks & porting devices shall be **Sikadur 31 Hi-Mod Gel.:**

1. Component "A" shall be a modified epoxy resin of the diglycidiether bisphenol A Type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidiether bisphenol A type containing suitable viscosity control agents, pigments, and accelerators.
5. The ratio of component A: componet B shall be 2:1 by volume
6. The material shall not contain asbestos.

C. Porting devices as required for either manual or automated application. Porting devices for automated application shall be supplied from maufacturer of the pressure injection equipment.

2.03 Performance Criteria

A. Properties of the mixed epoxy resin adhesive used for the pressure injection grouting::

1. Pot Life: min. 25 minutes (60 gram mass) @ 73° F
2. Tack-FreeTime: 90°F (32°C) 1.5 to 2 hours
   75°F (24°C) 3 to 3.5 hours
   40°F (5°C) 14-16 hours
3. Viscosity: Approx. 375 cps.
4. Color: Clear, Amber

B. Properties of the cured epoxy resin adhesive used for pressure injection of grout:

1. Compressive Strength (ASTM D-695) .min.
   a 3 day: 10000 psi (69.9 MPa)
   b. 7 day: 11000 psi (75.8 MPa)
   c. 28 day: 13000 psi (89.6 MPa)
   Compressive Modulus, Psi : min.
   a. 7 day 21.6×10^5 psi (1500 Mpa)
2. Shear Strength (ASTM D-732)
   a. 14 day: 5100 psi (35 MPa)
3. Flexural Strength (ASTM D-790) min.
   a. 14 day: 14000 psi (97 MPa

FOR REFERENCE ONLY

Tangent Modulus of Elasticity in Bending min.
b. 14 day: 3.7 x 10^5 psi (2600 Mpa)

4. Bond Strength (ASTM C-882)

14 days (moist cure) min.
a. Hardened Concrete to Hardened Concrete: 2200 psi (15 Mpa)

5. Water Absorption (ASTM D-570) max.

a. 24 hour 0.90%

6. Tensile properties (ASTM D-638) min.

a. 7 day Tensile Strength 8900 psi (61 Mpa)

Elongation at Break 5.4%

b. 14 day Modulus of Elasticity 4.1 x 10^5 psi (2800 Mpa)

C. Properties of the mixed epoxy resin adhesive used for sealing of cracks & porting devices::

1. Pot Life: min. 30 minutes (60 gram mass) @ 73° F
2. Tack-FreeTime: 75°F (24°C) 2 to 3.5 hours
   40°F (5°C) 14-16 hours
3. Consistency: Non-Sag paste
4. Color: Concrete Gray

D. Properties of the cured epoxy resin adhesive used for sealing of cracks & porting devices:

1. Compressive Strength (ASTM D-695) .min. @ 73F
   a 1 day: 9000 psi (62.0 MPa)
   b. 3 day: 11000 psi (75.8 MPa)
   c. 28 day: 12000 psi (82.8 MPa)
   Compressive Modulus, Psi : min.
   a. 7 day 3.9 x 10^5 psi (Mpa)
2. Shear Strength (ASTM D-732)
   a. 14 day: 3400 psi (23.4 MPa)
3. Flexural Strength (ASTM D-790) min.
   a. 14 day: 4400 psi (30.3 MPa)
   Tangent Modulus of Elasticity in Bending .min.
   b. 14 day: 1.0 x 10^5 psi
5. Bond Strength (ASTM C-882)

14 day (moist cure) min.
a. Hardened Concrete to Hardened Concrete 2400 psi (16.6 Mpa)

5. Water Absorption (ASTM D-570) max.

a. 24 hour 0.79%

3. Tensile properties (ASTM D-638) min.

a. 7 day Tensile Strength 3600 psi (24.8 Mpa)

Elongation at Break 0.4%

b. 14 day Modulus of Elasticity 1.0 x 10^5 psi (2800 Mpa)

Note: Tests above were performed with material & curing conditions at 73F & 45-55% relative humidity.

FOR REFERENCE ONLY

Part 3 - Execution

3.01 Mixing and Application

A. Mixing the epoxy resin adhesive for sealing the cracks & porting devices: Premix each component. Proportion two parts by volume of Component "A" to one part Component "B" into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its potlife (25-35 minutes 73F).

B. Mixing of the epoxy resin adhesive used for the pressure injection grouting:

1. Manual: Premix each component. Proportion two parts by volume of Component "A" to one part Component "B" into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its potlife (20-30 minutes 73F).

C. Placement procedure:

1. The epoxy resin adhesive for sealing the cracks & porting device: Set the porting devices as required by the epuipment manufacturer. Spacing of the porting devices shall be accomplished as required to achieve the travel of the epoxy resin for the pressure injection grouting between ports and fill the cracks to the maximum. On structures open on both sides, provide porting devices on opposite sides at staggered elevations. Apply the mixed epoxy resin adhesive for sealing over cracks and around each porting device to provide an adequate seal to prevent the escape of the epoxy resin adhesive for the injection grouting. Where required by the Engineer, apply the epoxy resin adhesive for sealing in such a manner that minimal defacing or discoloration of the substrate shall result.

2. The epoxy resin adhesive for the pressure injection grouting:

   Manual: Load the mixed epoxy resin adhesive for grouting into a disposable caulking cartridge or bulk-loading caulking gun. Inject the prepared cracks with a consant pressure in order to achieve maximum filling & penetration without the inclusion of air pockets or voids in the epoxy resin adhesive. Begin the pressure injection at the widest part of the crack being injected and continue until there is the appearance of epoxy resin adhesive at an adjacent port, thus indicating travel. When travel is indicated, to discontinue or continue the pressure injection from that port should be made by the contractor based on his experience, with the approval of the Engineer. Continue procedure until pressure injectable cracks has been filled.

   Automated: Dispense the epoxy resin adhesive for grouting under constant pressure in accordance with procedures recommended by the equipment manufacturerer as required to achieve maximum filling and penetration of the prepared cracks without the inclusion of air pockets or voids in the epoxy resin adhesive. The pressure injection of single or multiple ports, by use of a manifold system, is possible. This decision should be made by the contractor, with the approval of the Engineer. Continue the approved procedure until all pressure injectable cracks have been filled.

D. If penetration of any cracks is impossible, consult the Engineer before discontinuing the injection procedure. If modification of the proposed procedure is required to fill the cracks, submit said modification in writing to the Engineer for acceptance prior to proceeding.

E. Adhere to all limitations and cautions for the epoxy resin adhesive in the manufacturers current printed literature.

3.02 Cleaning

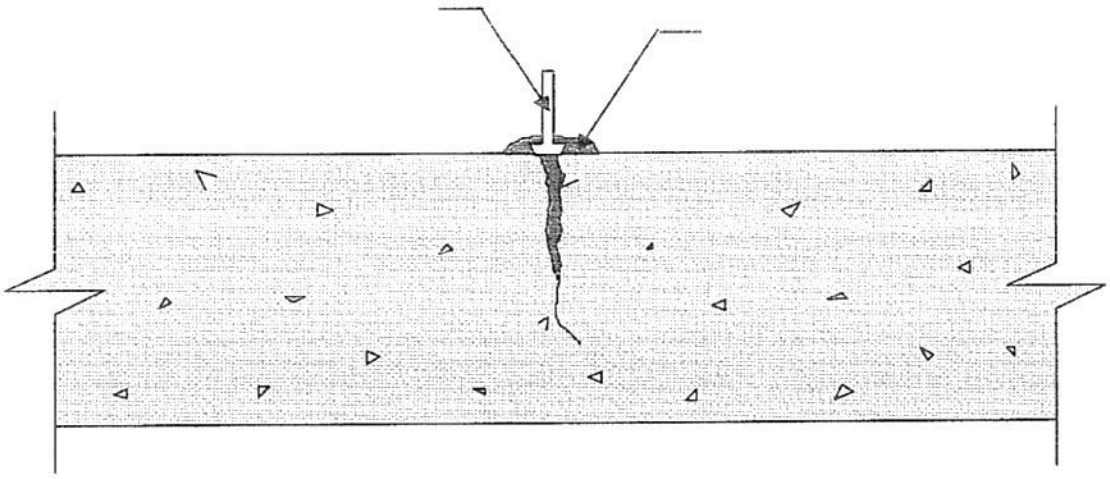
A. After the epoxy resin adhesive for grouting has cured, the epoxy resin adhesive for sealing cracks and porting devices shall be removed as required by the Engineer. Clean the substrate in a manner to produce a finish appearance acceptable to the Owner.

B. The uncured epoxy resin adhesive can be cleaned from tools with approved solvent. The cured epoxy resin adhesive can only be removed mechanically.

C. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

FOR REFERENCE ONLY

SC001 Sikadur® 35 Hi-Mod LV/ Sikadur 31 Hi-Mod Gel Crack Filler / Cap Seal



1. Set porting devices over cracks.
2. Place mixed Sikadur 31, Hi-Mod Gel epoxy resin adhesive over cracks and around each injection port a minimum of 1" wide by a ¼" thick.
3. Allow sufficient time for epoxy resin adhesive cap seal to set before injecting.
4. When the cap seal has cured, inject Sikadur 35, Hi-Mod LV with steady pressure.
5. Use automated injection equipment or manual method.

SECTION 05120

STRUCTURAL STEEL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions

B. Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes structural steel.

B. This Section includes structural steel and architecturally exposed structural steel.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section “Quality Control” for independent testing agency procedures and administrative requirements.
2. Division 5 Section “Steel Deck” for field installation of shear connectors.
3. Division 5 Section “Metal Fabrications” for loose steel bearing plates and miscellaneous steel framing.
4. Division 9 Section “Special Coatings” for surface preparation and priming requirements.
5. Division 9 Section “Painting” for surface preparation and priming requirements.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.

B. Engineering Responsibility: engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

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 for each type of product specified.

C. Shop Drawings detailing fabrication of structural steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Indicated welds by standard AWS symbols, distinguishing between shop and filed welds, and show size, length, and type of each weld.
3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
4. Include Shop Drawings signed and sealed by a qualified professional engineer responsible for their preparation.

D. 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.

E. Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements.

1. Structural steel, including chemical and physical properties.
2. Bolt, nuts, and washers, including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Shear stud connectors.
5. Shop primers.
6. Non-shrink grout.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.

1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC Certified Plant as follows:

a. Category: Category I, conventional steel structures.
b. Category: Category II, complex steel building structures.
c. Fabricator shall be registered with and approved by authorities having jurisdiction.

C. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design".
2. AISC's "Load and Resistance Factor Design (LFRD) Specification for Structural Steel Buildings".

3. AISC's "Specification for Allowable Stress Design of Single-Angle Members".
4. AISC's "Specification for Load and Resistance Factor Design of Single-Angle Members".
5. AISC's "Seismic Provisions for Structural Steel Buildings".
6. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use".
7. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".
8. Research Council on Structural Connections' (RCSC) "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

D. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

E. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code-Steel".

1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

F. Mockups: Prior to installing architecturally exposed structural steel, construct mockups for each form of construction and finish required to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect one week in advance of the dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship of steel surfaces and welded and bolted connections.

    a. Coordinate finish painting requirements of mockups with Division 9 Section "Painting".

4. Obtain Architect's approval of mockups before start of final unit of Work.
5. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

    a. When directed, demolish and remove mockups from Project site.
    b. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

G. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 SEQUENCING

A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Structural Steel Shapes, Plates, and Bars: As follows:

1. Carbon Steel: ASTM A 36 (ASTM A 36M).
2. High-Strength, Low-Alloy Columbium-Vanadium Steel: ASTM A 572 (ASTM A 572M), Grade 50.
3. High-Strength. Low-Alloy Structural Steel: ASTM A 588 (ASTM A 588M), Grade 50, corrosion resistant.

B. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.

C. Hot-Formed Structural Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Type E or S, Grade B.

1. Weight Class: Standard.
2. Weight Class: Extra strong.
3. Weight Class: Double-extra strong.
4. Finish: Black
5. Finish: Galvanized.
6. Finish: Black, except where indicated to be galvanized.

E. Carbon-Steel Castings: ASTM A 27, Grade 65-35 (ASTM A 27M, Grade 450-240), medium-strength carbon steel.

F. High-Strength Steel Castings: ASTM A 148, Grade 80-50 (ASTM A 148M), (Grade 550-345).

G. Shear Connectors: ASTM A 108, Grade 1015 through 1020, headed-stud type, cold-finished carbon steel, AWS D 1.1, Type B.

H. Anchor Rods, Bolts, Nuts, and Washers: As follows:

1. Un-headed Rods: ASTM A 36 (ASTM A 36M).
2. Un-headed Rods: ASTM A 572, Grade 50 (ASTM A 572M, Grade 345).
3. Un-headed Bolts: ASTM A 687, high strength.
4. Headed Bolts: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; and carbon-steel nuts.
5. Headed Bolts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
6. Headed Bolts: ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
7. Washers: ASTM A 36 (ASTM A 36M).

I. Non-high Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; carbon-steel nuts: and flat, unhardened steel washers.

1. Finish: Plain, uncoated.
2. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.
3. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50.

J. High Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain, uncoated.
2. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.
3. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50.
4. Direct-Tension Indicators: ASTM F 959, Type 325.

    a. Finish: Plain, uncoated.
    b. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50.
    c. Finish: Mechanically deposited zinc-coating, ASTM B 695, Class 50, epoxy coated.

K. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers, uncoated.

1. Direct-Tension Indicators: ASTM F 959, Type 490, uncoated.

L. Welding Electrodes: Comply with AWS requirements.

2.2 PRIMER

A. Primer Fast-curing, lead- and chromate-fee, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

B. Primer: SSPC-Paint 25; red iron oxide, zinc oxide, raw linseed oil and alkyd primer.

C. Primer, SSPC-Paint 23, Type I, latex primer.

D. Primer SSPC-Paint 15, Type I, red oxide.

E. Primer: Fabricator's standard lead-and chromate-free, non-asphaltic, rust-inhibiting primer.

F. Primer: Non-asphaltic primer complying with SSPC's "Painting System Guide No. 7.00".

G. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DODP-21035A or SSPC-Paint 20.

2.3 GROUT

A. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Metallic, Shrinkage-Resistant Grout: Premixed, factory-packaged, ferrous aggregate grout, complying with ASTM C 1107, of consistency suitable for application, and a 30 minute working time.

C. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, non-staining grout containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.4 FABRICATION

A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.

1. Camber structural steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 (ASTM A 6M) and maintain markings until steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
5. Complete structural steel assemblies, including welding of units, before starting shop-priming operation.

6. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

B. Fabricate architecturally exposed structural steel with exposed surfaces smooth, square, and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.

1. Remove blemishes by filling, grinding, or by welding and grinding, prior to cleaning, treating and shop priming.
2. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded.

D. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.

E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors: Use automatic end welding of headed-stud hear connectors according to AWS D1.1 and manufacturer's printed instructions.

F. Steel Wall Framing: Select true and straight members for fabricating steel wall framing to be attached to structural steel framing. Straighten as required to provide uniform, square, and true members in completed wall framing.

G. Welded Door Frames: Build up welded door frames attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches (250 mm) o.c., unless otherwise indicated.

H. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.

1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.5 SHOP CONNECTIONS

A. Shop installs and tightens non-high strength bolts, except where high-strength bolts are indicated.

B. Shop installs and tightens high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

C. Shop installs and tightens high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

1. Bolts: ASTM A 325 (ASTM A 325M) high-strength bolts, unless otherwise indicated.
2. Bolts: ASTM A 490 (ASTM A 490M) high-strength bolts, unless otherwise indicated.
3. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.
4. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.

D. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds ½ inch (13 mm) and larger. Grind flush butt welds. Dress exposed welds.

2.6 PREFABRICATED BUILDING COLUMNS

A. Definition: Prefabricated building columns consist of assemblies composed of load-bearing structural steel members encased in manufacturer's standard insulating material for fire protection and wrapped in outer non-load bearing steel sheet enclosures.

B. Fire-Test-Response Characteristics: Provide prefabricated building column assemblies identical to those of assemblies tested for the following fire-resistance ratings per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify columns with appropriate markings of applicable testing and inspecting agency.

1. Fire-Resistance Rating: 4 hours.
2. Fire-Resistance Rating: 3 hours.
3. Fire-Resistance Rating: 2 hours.
4. Fire-Resistance Rating: As indicated.

C. Column Configuration: Provide columns of sizes and shapes indicated. Fabricate connections to comply with details shown or required to suit type of structure indicated.

1. Concrete Fill: Structural concrete, manufacturer's standard mix, with a minimum 28-day compressive strength of 5000 psi (34.5 MPa), machine mixed and mechanically vibrated during placement to produce a concrete core free of voids.

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering prefabricated building columns that may be incorporated in the Work include, but are not limited to, the following.

E. Manufacturers: Subject to compliance with requirements, provide prefabricated building columns by one of the following:

1. Black Rock Column, Inc.
2. *Dean Lally* L.P.; *Firetrol* Division.

2.7 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surface embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed-on fireproofing.
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC specifications as follows:

1. SSPC-SP 2 “Hand Tool Cleaning”.
2. SSPC-SP 3 “Power Tool Cleaning”.
3. SSPC-SP 5 “White Metal Blast Cleaning”.
4. SSPC-SP 6 “Commercial Blast Cleaning”.
5. SSPC-SP 7 “Brush-Off Blast Cleaning”.
6. SSPC-SP 8 “Pickling”.
7. SSPC-SP 10 “Near-White Blast Cleaning”.
8. SSPC-SP 11 “Power Tool Cleaning to Bare Metal”.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer’s instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply 2 coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Apply a 1-coat, non-asphaltic primer complying with SS PC’s “Painting System Guide No. 7.00” to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.8 GALVANIZING

A. Hot-Dip Galvanize Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123.

2.9 SOURCE QUALITY CONTROL

A. Owner will engage and independent testing and inspecting agency to perform shop inspections and test and to prepare test reports.

1. Testing agency will conduct and interpret test and state in each report whether test specimens comply with or deviate from requirements.
2. Provide testing agency with access to places where structural steel Work is being fabricated or produced so required inspection and testing can be accomplished.

B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.

C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

D. Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

E. Shop-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.

F. In addition to visual inspection, shop-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T".
4. 4. Ultrasonic Inspection; ASTM E 164.

G. In addition to visual inspection, shop-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed when visual inspections reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.

B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and gracing are in place, unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.

B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.

    a. Comply with manufacturer's instructions for proprietary grout materials.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges".

1. Maintain erection tolerances of architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges".

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature al time of erection and mean temperature at which structure will be when completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Finish sections thermally cut during erection equal to a sheared appearance.

I. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. Install and tighten non-high strength bolts, except where high-strength bolts are indicated.

B. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

C. Install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

1. Bolts: ASTM A 325 (ASTM A 325M) high-strength bolts, unless otherwise indicated.
2. Bolts: ASTM A 490 (ASTM A 490M) high-strength bolts, unless otherwise indicated.
3. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.
4. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.

D. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds ½ inch (13 mm) and larger. Grind flush butt welds. Dress exposed welds.

3.5 PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with AISC specifications referenced in this Section, manufacturer's recommendations, and requirements of the testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.

B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.

C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

E. Field-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.

F. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.

1. Liquid Penetrate Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T".
4. Ultrasonic Inspection: ASTM E 164.

G. In addition to visual inspection, field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed when visual inspections reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

3.7 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils (0.038 mm).

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on structural steel are included in Division 9, Section "Painting".

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION 05120

SECTION 05520 – HANDRAILS AND RAILINGS

1- RELATED DOCUMENTS:

The general provisions of the Contract, including General and Special Conditions, apply to the work specified in this section.

2- DESCRIPTION OF WORK:

The extent of handrails and railing is shown on the drawings.

3- MATERIALS:

Steel Pipe: Standard weight, galvanized, ASTM A-120

4- FABRICATION:

Welded Connections: Cope intersections of rails and posts, excepts where otherwise shown on drawings, weld joints and grind smooth.

Brackets, Flanges and Anchors: Provide galvanized cast metal brackets, flanges and anchors for handrails supports. Furnish inserts as required for anchorage to concrete.

5- INSTALLATION:

Cutting, Fitting and Placement:

Perform cutting, drilling and fitting required for installation. Set the work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.

Use welding connectors to join sections of railings. Grind joints smooth.

Adjust railing prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building construction as shown on drawings.

Secure handrails to walls with wall brackets. Locate brackets at not more than 8’ – 0” o.c. use anchorage to secure wall brackets to building construction as follows:

For concrete anchorage, use bolt anchor expansion shields and lag bolts. For hollow masonry anchorage, use toggle bolts having square heads.

SECTION 05520 – HANDRAILS AND RAILINGS (Cont.)

6- PAINTING:

Follow indications of Section 09900 for finishing of metals.

7- SUBMITTALS:

Shop Drawings:

Submit shop drawings for the fabrication and erection of handrails and railings. Show anchorage and accessory items. Do not start fabrication until shop drawings are approved in writing.

SECTION 05700

ORNAMENTAL METALS

PART 1 - GENERAL

1.1 SUMMARY:

A. Related Sections:

1. Section 05740 – Ornamental Metal Restoration.

1.2 REFERENCES:

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

1. A 47: Malleable Iron Castings.
2. A 48: Gray Iron Castings.
3. A 576: Steel Bars, Carbon, Hot-Wrought, Special Quality.

B. Copper Development Association (CDA): Standards handbook-Copper and Copper Alloys.

C. Steel Structures Painting Council, National Association of Corrosion Engineers (SSPC): Steel Structures Painting Manual.

1.3 SUBMITTALS:

A. Submit under provisions of Section 01340:

1. Shop Drawings:

a. Show dimensions, sizes, thicknesses, gauges, finishes, joining, attachments and relationship of work to adjoining construction.
b. Show shop and erection details, including connections and fastenings.

2. Samples: Minimum 6 inch long samples of material and profile.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Steel: ASTM A 576.

B. Iron: ASTM A 48, Class 30, or ASTM A 47.

2.2 ACCESSORIES:

A. Fasteners: Material compatible with base metal; countersunk Phillips's flat head where exposed.

B. Paint: primer and touch-up for ferrous metals: SSPC Paint 15, Type 1, red oxide.

C. Anchoring Cement: There Products *Thorogrip* or accepted substitute.

2.3 FABRICATION:

A. Field Measurements: Prior to fabrication of items take required field measurements for correct fit.

B. General:

1. Form metal work to shape and size with sharp lines, angles and arises. Details of metal, details of assembly and support shall give ample strength and stiffness for intended purpose.
2. Include supplementary parts necessary to complete each item.
3. Wherever possible, shops fit and assemble work to eliminate field jointing. Fit joints and intersections accurately with proper fastenings.
4. Fabricate trim from longest lengths possible; locate joints symmetrically. Fit adjacent pieces with hairline joints and aligned surfaces. Space exposed screws evenly and symmetrically. Miter corners and angles of exposed moldings and frames.

C. Rails:

1. Fabricate with minimal joints. Fabricate and finish joints and slope transitions in shop. Joint location is subject to Architect's approval.
2. Miter ends of rail stock at corners and slope transitions.

D. Fastenings:

1. Conceal fastenings wherever possible.
2. Where screws must be used from permanent connections, use flat head type, countersunk, with screw slots filled and finished smooth and flush.

E. Finishes:

1. Steel and iron: Shop paint steel and iron fabrications.
   a. Surface preparation: SSPC SP2 or SP3.
   b. Application: One coat; follow coating manufacturer's directions.
   c. Minimum dry film thickness: 2.0 mils.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install items in accordance with approved Shop Drawings.

B. Install plumb and level, accurately finished, free from distortion and defects.

C. Install metal shapes with hairline joints, free from warp, waves, buckles, scratches and other defects on exposed faces.

D. Install sleeved components with anchoring cement.

E. Isolate dissimilar metals from contact with bituminous paint, non-absorptive gasket, or other approved method.

3.2 ADJUSTING:

A. Clean and touch up shop paint at welded and abraded surfaces.

3.3 SCHEDULE:

A. Ornamental Brass Handrail Components: As manufactured by LAVI Industries, or accepted substitute.

1. Handrail: 2" Ø brass pipe.
2. Railing Posts: 2" Ø brass pipe.
3. Floor Corner Flange: 4" Ø brass lower flange No. 530/2.
4. Tee Ball Fitting: 3 3/16" brass fitting.
5. Angle Ball Fitting: 3 3/16" brass fitting.

B. Ornamental Kiosk's: Fabricate according to drawings in material, profile and design. Drawings indicate general concept; minor modifications will be required to the job conditions and security system electrical adjust requirements.

C. Ornamental Kiosk's Bronze Columns: Fabricate according to drawings in material, profile and design. Drawings indicate general concept; minor modifications will be required to the job conditions and security system electrical adjust requirements.

D. Ornamental Fountain's Bronze Spouts: Fabricate according to drawings in material, profile and design. Drawings indicate general concept; minor modifications will be required to the job conditions and security system electrical adjust requirements.

E. Ornamental Columbus Monument Cast Stone Grate: Fabricate according to drawings in material, profile and design. Drawings indicate general concept; minor modifications will be required to the job conditions and security system electrical adjust requirements.

END OF SECTION

SECTION 05810

EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing 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. Parking deck expansion joint cover assemblies.
2. Plaza deck expansion joint cover assemblies.
3. Floor expansion joint cover assemblies.
4. Wall expansion joint cover assemblies.
5. Ceiling expansion joint cover assemblies.
6. Soffit expansion joint cover assemblies.
7. Fire-rated expansion joint cover assemblies.
8. Seismic expansion joint cover assemblies. Equal to *Twinline* model SSR400.
9. Compression seals.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section “Cast-In-Place Concrete” for cast in anchorage and frames for expansion joints cover assemblies in concrete floors, parking decks, and walls.
2. Division 7 Section “Flashing and Sheet Metal” for sheet metal roof and wall expansion joint systems.
3. Division 7 Section “Roof Accessories” for curb-type expansion joints.
4. Division 7 Section “Joint Sealants” for elastomeric sealants and preformed foam sealants without metal frames.
5. Division 9 Sections for walls, partitions, ceilings, and floor finishes with expansion joints.

1.3 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of expansion joint cover assembly specified, including manufacturer’s product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.

C. Shop drawings showing fabrication and installation of expansion joint cover assembly including plans, elevations, section, detail of components, joints, splices, and attachments to other units of Work.

D. Samples for verification purposes in full-size units of each type of expansion joint cover assembly indicated; in sets for each finish, color, texture, and pattern specified, showing full range of variations expected in these characteristics:

1. Install elastomeric material for joints samples to verify color selected.

E. Single-Source Responsibility: Obtain expansion joint cover assemblies specified in this Section from one source from a single manufacturer. Coordinate compatibility with expansion joint cover assemblies specified in other sections.

F. Fire-Test-Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined per ANSI/UL 263, NFPA 251, U.B.C. 431, or ASTM E 119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Not less than the rating of adjacent construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the products specified in each Expansion Joint Cover Assemblies Product Data Sheet at end of this Section.

2.2 MATERIALS

A. Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063-T5 for extrusions; ASTM B 209 (ASTM B 209M), alloy 6061-T6, sheet and plate.

1. Protect aluminum surfaces to be placed in contact with cementitious materials with a protective coating.

B. Bronze: ASTM B 455, alloy C38500 for extrusions; alloy C28000 *Muntz* Metal for plates.

C. Extruded Preformed Seals: Single or multicellular elastomeric profiles as classified under ASTM D 2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color indicated or, if not indicated, as selected by ARCHITECT from manufacturer's standard colors.

D. Preformed Sealant: Manufacturer's standard elastomeric sealant complying with ASTM C 920. Use T, factory-formed and-bonded to metal frames or anchor members; in color indicated or, if not indicated, as selected by ARCHITECT from manufacturer's standard colors.

1. Joints 2 inches (50 mm) Wide and Less: Withstand plus or minus 35 percent movement of the joint width without failure.

2. Joints Greater Than 2 inches (50 mm) to 4 inches (100 mm) Wide: Withstand plus or minus 50 percent movement of the joint width without failure.

E. Seismic Seals: Typically for exterior application, two single-layered elastomeric profiles, one interior and one exterior, as classified under ASTM D 2000; retained in a set of compatible frames, in color indicated or, if not indicated, as selected by ARCHITECT from manufacturer's standard colors. At manufacturer's option, omit interior profile for interior application.

F. Fire Barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM e 119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.

G. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.3 EXPANSION JOINT COVER ASSEMBLIES

A. General: Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials. Include closure materials and transition pieces, tee-joints, comers, curbs, cross-connections, and other accessories as required to provide continuous joint cover assemblies.

B. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated.

C. Fire-Rated Joint Covers: Provide manufacturer's continuous standard flexible fire barrier seals at locations indicated to provide fire-resistive rating not less than the rating of adjacent construction.

D. Coverless Fire Barrier: Provide manufacturer's continuous standard flexible fire barrier seals at locations indicated to provide fire-resistive rating not less than the rating of adjacent construction.

E. Metal Floor-to-Floor Joint Cover Assemblies: Provide continuous extruded metal frames of profile indicated with seating surface and raised floor rim or exposed trim strip to accommodate flooring and concealed bolt and anchors embedded in concrete. Provide assemblies formed to receive cover plates of design indicated and to receive filler materials (if any) between raised rim of frame and edge of plate. Furnish depth and configuration to suit type of construction and to produce a continuous flush wearing surface with adjoining finish floor surface:

1. Partially Concealed Cover: Provide one frame on each side of joint, designed to accommodate manufacturer's floor cover plate and filler.
2. Exposed Cover: Provide one frame on each side of joint, designed to support floor plate and filler.
3. Flat Cover Plates: Provide cover plates of profile and wearing surface indicated. Extend flat plates to lap each side of joint.

a. Filler Insert: Furnish abrasive-resistant flexible gasket filler between edge of cover plate and raised rim of frame to accommodate required movement.

4. Fixed Cover Plates: Attach one side of the cover plate to a frame or finished wearing surface, with other side resting on other frame or finished wearing surface to allow free movement.
5. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames as to have free movement on both sides.
6. Floor Cover Plate Wearing Surfaces: Provide cover plates with the following type of wearing surfaces.

a. Plain.
b. Fluted.
c. Recessed to receive full thickness of flooring material.
d. Abrasive plate.
e. Adhesive filled plate.
f. Adhesive strip plate.

F. Floor-to-Wall Joints: Provide one frame on floor side of joint only. Provide wall side frame where required by manufacturer's design.

1. Angle Cover Plates: Attach angle cover plates for floor-to-wall joints to wall with countersunk, flathead exposed fasteners secured to drilled-in-place anchor shields, unless otherwise indicated, at spacing recommended by joint cover manufacturer.

G. Wall, Ceiling, and Soffit Joint Cover Assemblies: Provide interior wall and ceiling expansion joint cover assemblies of same design and appearance. Provide exterior wall and soffit expansion joint cover assemblies compatible with floor expansion joint cover assemblies design and appearance.

1. Fixed Metal Cover Plates: Provide a concealed, continuously anchored frame fastened to wall, ceiling, or soffit only on one side of joint. Extend cover to lap each side of joint and

to permit free movement on one side. Attach cover to frame with cover in close contact with adjacent finish surfaces.

2. Floating Metal Cover Plates: Cover plate secured in or on top of frames to permit free movement on both sides.

3. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames to permit free movement on both sides.

4. Flexible Filler: Secure the approved flexible filler between frames to compress and expand with movement.

H. Joint Cover Assemblies with Preformed Seals: Provide joint cover assemblies consisting of continuously anchored aluminum extrusions and continuous extruded preformed seals of profile indicated or required to suit types of installation conditions shown. Furnish extrusions designed to be embedded in or attached to concrete with lugs. Vulcanize or heat-weld splices (if any) to ensure hermetic joint condition.

1. Cover Plate: Include extruded aluminum cover plate fastened to one side of joint and extend plate to lap each side of joint to permit free movement with cover in close contact with adjacent contact surfaces.

I. Joint Cover Assemblies with Elastomeric Sealant: Provide continuous cover joint assemblies consisting of elastomeric sealant factory-bonded to extruded aluminum frames of profile indicated or required to suit types of installation conditions shown. Provide frames for floor joints with means for embedding in or anchoring to concrete without using exposed fasteners and that will result in exposed surfaces of sealant and aluminum frames finishing flush with adjacent finished floor surface without exposing anchors.

J. Compression Seals: Preformed, elastomeric extrusions having internal baffle system in sizes and profiles shown or as recommended by the manufacturer. Provide lubricant and adhesive for installation recommended by the manufacturer.

K. Foam Seal: Non-extruded, low-density, cross-linked, nitrogen-blown ethylene vinyl acetate polyethylene copolymer foam; *Evazote* 380 E.S.P. Provide adhesive for installation recommended by the manufacturer.

2.4 METAL FINISHES

A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes to products in factory after fabrication. Protect finishes on exposed surfaces before shipment.

B. Aluminum Finishes: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

1. Mill Finish: AA-M10 (unspecified mill finish).

2. Class II, Clear-Anodized Finish: AA-M12C22A31 [Mechanical Finish: as fabricated, non-specular; Chemical Finish: etched, medium matte; Anodic Coating: Class II ARCHITECTURAL, clear film thicker than 0.4 mil (0.01 mm)].

3. Class I, Color-Anodized Finish: AA-M12C22A42/A44 [Mechanical Finish: as fabricated, non-specular; Chemical Finish: etched, medium matte; Anodic Coating: Class I ARCHITECTURAL, film thicker than 0.7 mil (0.02 mm) with integral color or electrolytically deposited color] complying with AAMA 606.1 or AAMA 608.1.

    a. Color: As selected by ARCHITECT from within standard industry colors and color density range.

4. Baked Enamel Finish: AA-C12C42R1x (Chemical finish: cleaned with inhibited chemical; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.

    a. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.

    b. Color: As selected by Architect from manufacturer's standard colors.

5. High-Performance Organic Coating: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.

    a. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat thermocured system, composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.

        1) Resin Manufacturers: Subject to compliance with requirements, provide fluoropolymer coating systems containing resins produced by one of the following manufacturers:
            a) *Ausimont* USA, Inc. (*Hylar* 5000).
            b) Elf Atochem North America, Inc. (*Kynar* 500).

        2) Color and Gloss: As selected by ARCHITECT from manufacturer's standard choices for color and gloss.

6. Factory-Primed Concealed Surfaces: Protect concealed metal surfaces to be placed in contact with concrete or masonry with a shop coat of manufacturer's standard primer on the contact surfaces.

C. Bronze Finish: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

1. Natural Satin Finish: CDA Designation M32, mechanical finish, directional textured, medium satin.

D. Stainless Steel Finishes: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

1. Bright, Cold-Rolled Unpolished Finish: AISI No. 2B finish.
2. Bright, Directional Polish: AISI No. 3 finish.

E. Factory Finish: Manufacturer's standard factory finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Manufacturer's Instructions: In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.

B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

3.2 INSTALLATION

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush with adjacent finished floor materials. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) on center.

B. Continuity: Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere-flexible filler materials (if any) to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

C. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant-adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.

D. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.

E. Seismic Seals: Install interior seals in continual lengths; vulcanize or heat-weld field splice joints in interior seal material to provide watertight joints using manufacturer's recommended procedures. Install exterior seal in standard lengths. Seal transitions and end joints according to manufacturer's instructions.

F. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire-rated construction is continuous.

3.3 CLEANING AND PROTECTION

A. Do not remover protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION 05810

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 (new) roof deck and all flashing substrates.
   2. Thermal Barrier
   3. Insulation
   4. 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 071416 – Cold Fluid-Applied Waterproofing
D. Division 072713 – Modified Bituminous Sheet Vapor Retarders
   Division 075216 – Styrene-Butadiene-Styrene (SBS) Modified Bitumen Membrane Roofing
E. Division 075419 – Polyvinyl-Chloride (PVC) Roofing
F. 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 726 - Standard Specification for Mineral Wool Roof Insulation Board.
   2. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board.

3. ASTM C 1325 – Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units.
4. 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 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.

H. PUERTO RICO BUILDING CODE 2018

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 at all times 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.

C. ENERGY CONSERVATION REQUIREMENTS:

1. Polyisocyanurate Insulation "R" Value: Shall be determined in accordance with ASTM C1289-11a.

2. 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 (20)

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: Hunter, RMax, Atlas

2.02 ROOFING SYSTEM

A. ROOFING SYSTEM BASIS OF DESIGN: The Applicator shall submit evidence that the proposed roof system meets the requirements of the local building code (Puerto Rico Building Code 2018) and has been tested and approved or listed by an approved, codified testing organization. These requirements are minimum standards, and no roofing work shall commence without written documentation of the system's compliance.

2.03 THERMAL INSULATION SYSTEM

A. RIGID INSULATION
    1. POLYISOCYANURATE INSULATION:
        a. Flap Panels: Closed cell polyisocyanurate foam core bonded on each side to a glass fiber-reinforced felt facer.
            i. Thickness: 1.5 in minimum board thickness. Total thickness to meet specified insulation system thermal resistance 'R' value 20.
            ii. Dimensions: 4 x 4 ft or 4 x 8 ft boards
            iii. Meets or exceeds ASTM C1289, Type II, Class 1, (20 psi).
        b. Tapered Panel: Closed cell polyisocyanurate foam core bonded on each side to a glass fiber-reinforced felt 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

B. COVER-BOARD

1. ASPHALTIC ROOF BOARD

a. 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, and 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)

2. GYPSUM ROOF BOARD

a. Georgia Pacific Gypsum LLC, DensDeck Prime Roof Board: Gypsum core, glass fiber-faced, factory primed, roof Cover-board.

i. Thickness: 1/2 in

ii. Dimensions: 4 x 4 ft or 4 x 8 ft boards.

iii. Facer: Factory primed, glass fiber.

iv. Meets or exceeds ASTM C1177/C1177M.

C. INSULATION CANT AND TAPERED STRIP

1. CANT STRIP, MODIFIED BITUMEN

a. Modified bitumen cant strips.

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. 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) Perimeter of Roof (Zone 2): 6 in on-centers

c) Corners of Roof (Zone 3): 4 in on-centers

2.04 ACCESSORIES

A. PRIMERS:

1. 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.

B. INSULATION FASTENERS AND PLATES

1. MP FASTENER and INSULATION PLATE: Insulation system fasteners and metal stress plates.
2. HD FASTENER and IN INSULATION PLATE: Insulation system fasteners and metal stress plates.
3. SFS isoweld Fastener and Plate: Non-penetrating membrane fastener and plate.
4. Fastener and Plate: Insulation system fasteners and metal stress plates.

C. BOARD FASTENERS AND PLATES

1. #14 MP Fastener: Membrane base ply fastener.
2. #15 HD Fastener: Membrane base ply fastener.
3. #15 EL Fastener: Membrane base ply fastener.
4. 2 in SEAM PLATE: Membrane base ply seam plate.
5. 2.4 in SEAM PLATE: Membrane base ply seam plate.

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. 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 CONCRETE ADHESIVE APPLICATION

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. Perimeter of Roof (Zone 2): 6 in on-centers.
    c. Corners of Roof (Zone 3): 4 in on-centers.

3.05 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.

3.06 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 075200 - MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Modified bituminous roofing membrane, conventional application.

B. Insulation, flat and tapered.

C. Roofing cant strips and walkway pads.

1.02 REFERENCE STANDARDS

A. ASTM C728 - Standard Specification for Perlite Thermal Insulation Board 2017a (Reapproved 2022).

B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board 2022.

C. ASTM D41/D41M - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing 2011 (Reapproved 2016).

D. ASTM D312/D312M - Standard Specification for Asphalt Used in Roofing 2016a.

E. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method 1983 (Reapproved 2018).

F. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free 2007 (Reapproved 2018).

G. ASTM D6163/D6163M - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements 2021.

H. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings 2020a.

I. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces 2011 (Reapproved 2019).

J. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.

K. FM (AG) - FM Approval Guide current edition.

L. NRCA (RM) - The NRCA Roofing Manual 2022.

M. UL (FRD) - Fire Resistance Directory Current Edition.

N. Puerto Rico Building Code 2018 Ed. - Adopting (ICC) 2018 International Building Code with amendments.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's catalog data for membrane and bitumen materials, base flashing materials, insulation, vapor retarder, and surfacing.
   1. Sustainable Design Submittal: Include testing documentation of solar reflectance index.

B. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, setting plan for tapered insulation, and mechanical fastener layout.

C. Manufacturer's Installation Instructions: Indicate special procedures.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Installer's qualification statement.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum twenty years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience, and approved by manufacturer.

C. The Applicator shall submit evidence that the proposed roof system meets the requirements of the local building code (Puerto Rico Building Code 2018) and has been tested and approved or listed by an approved, codified testing organization. These requirements are minimum standards, and no roofing work shall commence without written documentation of the system's compliance.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact unless otherwise indicated.

B. Store materials in weather protected environment, clear of ground and moisture; ballast materials may be stored outdoors.

C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

D. Protect foam insulation from direct exposure to sunlight.

1.06 FIELD CONDITIONS

A. Do not apply roofing membrane when environmental conditions are outside the ranges recommended by manufacturer.

B. Do not apply roofing membrane during unsuitable weather.

C. Do not apply roofing membrane to damp deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.07 WARRANTY

A. Correct defective work within a 5 -year period after Date of Substantial Completion.

B. Provide 20-year manufacturer's material warranty to cover failure to prevent penetration of water.

PART 2 PRODUCTS

2.01 ROOFING - CONVENTIONAL APPLICATION

A. Modified Bituminous Membrane Roofing: Two-ply membrane, with insulation.

B. Roofing Assembly Requirements:
   1. Solar Reflectance Index (SRI): 78, minimum, calculated in accordance with ASTM E1980, based on 3-year aged data.
      a. Field applied coating may not be used to achieve specified SRI.
   2. External Fire Exposure Classification: ASTM E108 Class A, UL (FRD) listed.
   3. Internal Fire Spread Classification: Factory Mutual Class 1, FM-approved.
   4. Wind Uplift Performance as per Roofing Application Standard (RAS) No. 128; Florida Building Code.
      a. Roof System Design Pressures calculated as per ASCE 7.
      b. Field of Roof (Zone 1): -88 psf
      c. Perimeter of Roof (Zone 2): -117 psf
      d. Corners of Roof (Zone 3): -160 psf.
   5. Insulation Thermal Resistance (R-Value): 2 minimum; provide insulation of thickness required.
   6. Surfacing: Mineral granules.

C. Acceptable Insulation Types - Constant Thickness Application: Any of the types specified.
   1. Minimum 2 layers of polyisocyanurate board.

2. Top layer of perlite board.

D. Acceptable Insulation Types - Tapered Application: Any of the types specified.
1. Tapered polyisocyanurate board covered with uniform thickness perlite board.

2.02 MEMBRANE AND SHEET MATERIALS

A. Membrane: Polymer modified asphalt, reinforced with nonwoven fabric; granule surfaced; with the following characteristics:
1. Minimum Quality: ASTM D6163/D6163M Type I; styrene-butadiene-styrene (SBS) modified, glass fiber reinforced.
2. Solar Reflectance: 0.78, minimum, initial, and 0.62, minimum, 3-year, certified by Cool Roof Rating Council.
3. Thermal Emissivity: 0.9, minimum, initial, and 0.9, minimum, 3-year, certified by Cool Roof Rating Council.
4. Color: White.
5. Thickness: 138 mils, .138 inch (3.5 mm).
6. Sheet Width: 39.4 inch (1000 mm).

B. Base Sheet: ASTM Type I; asphalt-coated glass fiber; unperforated.

C. Flexible Flashing Material: ASTM-D-6164, Type I; SBS modified, non-woven polyester reinforced and mineral granule top surface.

2.03 BITUMINOUS MATERIALS

A. Bitumen: Asphalt, ASTM D312/D312M Type IV; for adhering insulation, use Type III.

B. Asphalt Primer: ASTM D41/D41M, asphalt type.

C. Asphalt Roof Cement: ASTM D4586/D4586M, Type II, asbestos-free.

2.04 INSULATION

A. Perlite Board Insulation: Expanded perlite mineral aggregate complying with ASTM C728.
1. Board Thickness: 1/2 inch (12.7 mm).
2. Board Edges: Square.
3. Thermal Resistance, R-value (RSI-value): 1.4 (0.25) at 1/2 inch (12.7 mm) nominal thickness.

B. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam complying with ASTM C1289.
1. Classifications:
a. Type II: Faced with either cellulosic facers or glass fiber mat facers on both major surfaces of the core foam.
1) Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of the core foam.
2) Compressive Strength: Classes 1-2-3, Grade 1 - 16 psi (110 kPa), minimum.
3) Thermal Resistance, R-value (RSI-value): At 1-1/2 inches (38 mm) thick; Class 1, Grades 1-2-3, 8.4 (1.48) at 75 degrees F (24 degrees C).
2. Board Size: 48 by 96 inches (1,220 by 2,440 mm).
3. Board Thickness: 1.5 inches (37.5 mm).
4. Tapered Board: Slope as indicated; minimum thickness 4.5 inch (114.3 mm); fabricate of fewest layers possible.
5. Board Edges: Square.

2.05 SURFACING MATERIALS - CONVENTIONAL APPLICATION

A. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
1. Composition: Asphaltic with mineral granule surface.
2. Size: Manufacturers standard size.
3. Surface Color: Yellow.

2.06 ACCESSORIES

A. Cant and Edge Strips: Perlite board, compatible with roofing materials ; cants formed to 45

degree angle.

B. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches (152 mm) wide; self adhering.

C. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
   1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.

D. Sealants: As recommended by membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 PREPARATION - CONCRETE DECK

A. Verify adjacent precast concrete roof members do not vary more than 1/4 inch (6 mm) in height, and grout keys are filled flush.

B. Fill surface honeycomb and variations with latex filler.

C. Do not begin work until elevated concrete substrate has cured at least 28 days and moisture content is five percent or less.
   1. Test for Concrete Moisture Content: No beading water under plastic after 16 hours when tested in accordance with ASTM D4263.
   2. Test for Relative Humidity in Concrete: Not greater than 75 percent when tested in accordance with ASTM F2170.

3.03 INSTALLATION - INSULATION, CONVENTIONAL

A. Attachment of Insulation on metal decks:
   1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instruction and FM (AG) Factory Mutual requirements.
   2. Embed each subsequent layer of insulation into flood coat mopping of hot bitumen in accordance with roofing and insulation manufacturers' instructions.
   3. Use fastener type and fastening pattern as required to achieve wind resistance specified.

B. Attachment of Insulation on concrete decks:
   1. Embed first layer of insulation in flood coat mopping of hot bitumen in accordance with roofing and insulation manufacturers' instructions.
   2. Embed each subsequent layer of insulation into flood coat mopping of hot bitumen in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.

C. Lay subsequent layers of insulation with joints staggered minimum 6 inches (152 mm) from joints of preceding layer.

D. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

E. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.

F. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.

G. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.

H. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches (457 mm).

I. Do not apply more insulation than can be covered with membrane in same day.

3.04 INSTALLATION - MEMBRANE

A. Install modified bituminous membrane roofing system in accordance with manufacturer's recommendations and NRCA (RM) applicable requirements.

B. Install membrane; lap and seal edges and ends permanently waterproof.

C. Install smooth, free from air pockets, wrinkles, fish-mouths, or tears. Ensure full bond of membrane to substrate.

D. At end of day's operation, install waterproof cut-off. Remove cut-off before resuming roofing.

E. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 8 inches (203 mm) onto vertical surfaces.
   2. Apply flexible flashing over membrane.

F. Around roof penetrations, mop in and seal flanges and flashings with flexible flashing.

G. Coordinate installation of roof drains and sumps and related flashings.

3.05 FIELD QUALITY CONTROL

A. Provide daily on-site attendance of roofing and insulation manufacturer's representative during installation of this work.

3.06 CLEANING

A. Remove bituminous markings from finished surfaces.

B. In areas where finished surfaces are soiled by bitumen or other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

C. Repair or replace defaced or damaged finishes caused by work of this section.

3.07 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

SECTION 075400
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Adhered system with thermoplastic roofing membrane.

B. Flashings.

C. Roofing cant strips, stack boots, roofing expansion joints, and walkway pads.

1.02 RELATED REQUIREMENTS

A. Section 035216 - Lightweight Insulating Concrete: Substrate for this section.

B. Section 076200 - Sheet Metal Flashing and Trim: Counterflashings and reglets.

C. Section 077200 - Roof Accessories: Roof-mounted units; prefabricated curbs.

1.03 REFERENCE STANDARDS

A. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method 1983 (Reapproved 2018).

B. ASTM D4434/D4434M - Standard Specification for Poly(Vinyl Chloride) Sheet Roofing 2021.

C. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces 2011 (Reapproved 2019).

D. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.

E. FM (AG) - FM Approval Guide current edition.

F. FM DS 1-28 - Wind Design 2016.

G. NRCA (RM) - The NRCA Roofing Manual 2022.

H. NRCA (WM) - The NRCA Waterproofing Manual 2021.

I. Puerto Rico Building Code 2018 Ed. - Adopting (ICC) 2018 International Building Code with amendments.

1.04 SUBMITTALS

A. Product Data: Provide data indicating membrane materials, flashing materials and fasteners.

B. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and walkway pad layout.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Specimen Warranty: For approval.

H. Warranty Documentation:
   1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
   2. Submit installer's written verification that installation complies with warranty conditions for waterproof membrane.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years of documented experience.

B. Installer Qualifications: Company specializing in performing work of this section with at least three years of documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact, unless otherwise indicated.

B. Store materials in weather protected environment, clear of ground and moisture.

C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

D. Protect foam insulation from direct exposure to sunlight.

1.07 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.

B. Do not apply roofing membrane to damp deck surface or when precipitation is expected or occurring.

C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

D. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.08 WARRANTY

A. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
   1. Warranty Term: 20 years.
   2. For repair and replacement include costs of both material and labor in warranty.

B. Roofing Contractor Warranty:
   1. Warranty Term: 5 years.
   2. For repair and replacement include costs of labor in warranty.

PART 2 PRODUCTS

2.01 ROOFING

A. Thermoplastic Membrane Roofing: One ply membrane, fully adhered, over insulation.

B. Roofing Assembly Requirements:
   1. Solar Reflectance Index (SRI): 104, minimum, calculated in accordance with ASTM E1980.
      a. Field applied coating may not be used to achieve specified SRI.
   2. Factory Mutual Classification: Class 1 and windstorm resistance of 1-540, in accordance with FM DS 1-28.
   3. Insulation Thermal Resistance (R-Value): R-20, minimum.

2.02 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

A. Membrane Roofing Materials:
   1. PVC: Polyvinyl chloride (PVC) complying with ASTM D4434/D4434M, Type II, sheet contains reinforcing fibers or reinforcing fabrics.
      a. Thickness: 72 mil, .072 inch (1.8 mm), minimum.
   2. Sheet Width: Factory fabricated into widest possible sheets.
   3. Solar Reflectance: 0.83, minimum, initial, and 0.65, minimum, 3-year, certified by Cool Roof Rating Council.
   4. Thermal Emissivity: 0.90, minimum, initial, and 0.79, minimum, 3-year, certified by Cool Roof Rating Council.
   5. Color: White.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Flexible Flashing Material: Material recommended by membrane manufacturer.

D. Perimeter Edge Flashing: Material recommended by membrane manufacturer.

E. Separation Sheet: Material recommended by membrane manufacturer.

2.03 ACCESSORIES

A. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.

B. Cant and Edge Strips: As recommended by membrane manufacturer, compatible with roofing materials; cants formed to 45 degree angle.

C. Membrane Adhesive: As recommended by membrane manufacturer.

D. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.

E. Fasteners and Anchors: Post-galvanized steel, aluminum or stainless steel. Avoid galvanic corrosion when mixing metal types. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins.
   1. Concrete fasteners and anchors: minimum embedment of 1-1/4 inch (32 mm); as approved by membrane manufacturer.
   2. Wood fasteners and anchors used for flashing: minimum embedment of 1 inch (25 mm); as approved by membrane manufacturer.

F. Sealants: As recommended by membrane manufacturer.

G. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
   1. Composition: Roofing membrane manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 PREPARATION - CONCRETE DECK

A. Verify adjacent precast concrete roof members do not vary more than 1/4 inch (6 mm) in height. Verify grout keys are filled flush.

B. Fill surface honeycomb and variations with latex filler.

C. Do not begin work until elevated concrete substrate has cured at least 28 days and moisture content is five percent or less.
   1. Test as Follows:
      a. Concrete Moisture Content: No beading water under plastic after 16 hours when tested in accordance with ASTM D4263.
      b. Relative Humidity in Concrete: Not greater than 75 percent when tested in accordance with ASTM F2170.

3.03 INSTALLATION, GENERAL

A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.

B. Do not apply roofing membrane during wet weather conditions.

C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

D. Do not apply roofing membrane to damp deck surface or when precipitation is expected or occurring.

E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

F. Coordinate this work with installation of associated counterflashings installed by other sections as the work of this section proceeds.

3.04 INSTALLATION - MEMBRANE

A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

B. Shingle joints on sloped substrate in direction of drainage.

C. Fully Adhered Application: Apply adhesive to substrate at rate recommended by membrane manufacturer. Fully embed membrane in adhesive except in areas directly over or within 3 inches (76 mm) of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches (76 mm) . Seal permanently waterproof. Weld cover strips at all seams that do not have a factory selvage edge. .

E. Hot-air weld seam overlaps as per membrane manufacturer's recommendations.

F. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 4 inches (102 mm) onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and up to nailing strips.
   3. Secure flashing to nailing strips at 4 inches (102 mm) on center.
   4. Insert flashing into reglets and secure.

G. Around roof penetrations, seal flanges and flashings with flexible flashing.

H. Install roofing expansion joints where indicated. Make joints watertight.
   1. Install prefabricated joint components in accordance with manufacturer's instructions.

I. Coordinate installation of roof drains and sumps and related flashings.

3.05 CLEANING

A. Remove bituminous markings from finished surfaces.

B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

C. Repair or replace defaced or damaged finishes caused by work of this section.

3.06 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

Thermoplastic PVC Feltback EnergyStar Single Ply Membrane Adhered to LWIC

PART 1 - GENERAL CONDITIONS

1.01 DESCRIPTION

A. Scope of Work: Install a complete Thermoplastic PVC Feltback membrane adhered system including field membrane, base flashings, lightweight insulating cellular concrete and other related metal components. Existing roofing assemblies shall be completely removed.

B. Related Work: The work includes but is not limited to the installation of:
1. Removal of existing roofing and insulation
2. Substrate preparation
3. Roof drains
4. Vapor retarder
5. Insulation
6. Separation layers
7. Roof membrane
8. Fasteners
9. Adhesive for flashings
10. Roof membrane flashings
11. Walkways
12. Metal Flashings
13. Sealants

C. Upon successful completion of work the following warranties may be obtained:
1. Single Source Manufacturer's Warranty
2. Roofing Applicators Limited Labor Warranty

1.02 QUALITY ASSURANCE

A. The completer roofing system shall be applied only by a roofing applicator approved for the manufacturer issuing the single source warranty.

B. A Technical Service Representative will review the installed roof system for the System Warranty requested.

C. All work pertaining to the installation of membrane, flashings, and accessories shall only be completed by Applicator authorized in those procedures. Applicators must be prequalified prior to bidding scope of project.

D. Roofing membrane manufacturer must have a demonstrated performance history of producing PVC roof membranes no less, in duration of years, than the warranty duration specified.

E. Roofing membrane and membrane flashings to be manufactured by membrane supplier and not private labeled.

F. Manufacturer to have a minimum ten years of experience recycling their membranes at the end of their service life back into new membrane products. Provide a minimum of five reference projects completed with new membrane produced from recycled membrane.

G. Applicable code/insurance requirements shall be identified by the Owner or Owner's representative.

1.03 SUBMITTALS

A. At the time of bidding, the Applicator shall submit to the Owner (or Representative) the following:

1. Copies of Specification.

2. Samples of each primary components to be used in the roof system and the manufacturer's current product data sheet for each component.
3. Written approval by the insulation manufacturer (as applicable) for use of the product in the proposed system.
4. Sample copy Manufacture's Corporation warranty.
5. Sample copy of Applicator's warranty.
6. Safety Data Sheets (SDS)
7. Product Data Sheets (PDS)

1.04 CODE REQUIREMENTS

The Applicator shall submit evidence that the proposed roof system meets the requirements of the local building code (Puerto Rico Building Code 2018) and has been tested and approved or listed by an approved, codified testing organization. These requirements are minimum standards, and no roofing work shall commence without written documentation of the system's compliance.

A. System shall be designed to meet the minimum wind design requirements of the applicable version of ASCE 7.

B. Factory Mutual Research Corporation (FM) - Norwood, MA
System shall be designed to meet 4470 requirements and the most recent versions of FM Global LPDS 1-28 and 1-29.

C. Underwriters Laboratories, Inc. - Northbrook, IL
1. Class A Assembly
2. FMG RoofNav# 30112-0-51016 or 30112-0-51017 Windstorm rating.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All products delivered to the job site shall be in the original unopened containers or wrappings bearing all seals and approvals.

B. Handle all materials to prevent damage. Place all materials on pallets and fully protect from moisture.

C. Membrane rolls shall be stored lying down on pallets and fully protected from the weather with clean tarpaulins. Unvented tarpaulins are not accepted due to the potential accumulation of moisture beneath the tarpaulin which may affect the membrane weldability.

D. As a rule, all adhesives shall be stored at temperatures around 80°F (27°C) and protected while on the roof. Read product data sheets and instructions contained on adhesive canisters for specific storage instructions.

E. All flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow precautions outlined on containers and read product Safety Data Sheets (SDS).

F. Any materials which the Owner's representative determine to be damaged are to be removed from the job site and replaced at no cost to the Owner.

G. Safety Data Sheets (SDS) shall be always available at the job site.

1.06 JOB CONDITIONS

A. Only as much of the new roofing as can be made weathertight each day, including all flashing and detail work, shall be installed. All seams shall be heat welded before leaving the job site that day.

B. Temporary overnight tie-ins shall be installed at the end of each day's work and shall be completely removed (including any contaminated materials) before proceeding with the next day's work.

C. The Applicator shall follow all safety regulations as required by OSHA and any other applicable authority having jurisdiction. Roof and walkways may be slippery when icy, snow covered, or wet. Working on surfaces under these conditions is hazardous. Appropriate safety measures must be implemented prior to working on such surfaces. Always follow OSHA and other relevant fall protection standards when working on roofs.

D. Where applicable, the Applicator shall arrange for pullout tests in accordance with the latest versions of the SPRI/ANSI Standard Field Test Procedures FX-1 and IA-1 for fasteners and adhesives, respectively, to verify condition of the deck/substrate and to confirm expected pullout values.

E. The feltback membrane shall not be installed under the following conditions without consulting manufacturer's Technical Dept. for precautionary steps:

1. The roof assembly permits interior air to pressurize the membrane underside.
2. Any exterior wall has 10% or more of the surface area comprised of opening doors or windows.
3. The wall/deck intersection permits air entry into the wall flashing area.

1.07 BIDDING REQUIREMENTS

A. Pre-Bid Meeting: A pre-bid meeting shall be held with the Owner's Representative and involved trades to discuss all aspects of the project. The Applicator's field representative or roofing foreman for the work shall be in attendance.

B. Site Visit: Bidders shall visit the site and carefully examine the areas in question as to conditions that may affect proper execution of the work. All dimensions and quantities shall be determined or verified by the Applicator. No claims for extra costs will be allowed because of lack of full knowledge of the existing conditions unless agreed to in advance with the Owner or Owner's Representative.

1.08 WARRANTIES

A. Manufacturer's Warranty: Upon successful completion of the work to the manufacturer's satisfaction and receipt of final payment warranty shall be issued to the Owner.

1. 20 Year System Warranty

B. Contractor 5 Year Labor Warranty

1.09 WARRANTY DURATIONS

A. Membrane manufacturer's warranty shall be in effect for a 20-year duration.

PART 2 - PRODUCTS

2.01 GENERAL

A. Components of the roof system shall be products of the primary membrane manufacturer as indicated on the Detail Drawings and specified in the Contract Documents.

B. Consult respective product data sheets and selection guides for additional information.

2.02 MEMBRANE

A. Membrane shall conform to:
1. ASTM D-4434 (latest version), "Standard for Polyvinyl Chloride Sheet Roofing". Classification: Type II.

B. PVC thermoplastic membrane

1. Type of Membrane
   a) Adhered PVC membrane

b) Adhered Feltback membrane

2. Membrane Thickness
   a) 60 mil (1.5 mm)

C. Color of Membrane

1. Adhered
   a) EnergySmart White or approved equal

b) EnergySmart Reflective Gray or approved equal

2.03 INSULATIONS / ROOF BOARDS

A. Insulation

1. Rigid expanded polystyrene foam insulation board, meeting ASTM C-578 Type II or IX, minimum 20 psi compressive strength.

B. Lightweight Insulating Concrete

1. Celcore LWIC

2. Mearlcrete LWIC

3. Concrecel LWIC

2.04 ATTACHMENT COMPONENTS

A. Membrane Adhesive

1. Single-Step Membrane Adhesive: Water-based dispersion adhesive used to attach membrane.

2. Flashing Adhesive: Solvent-based reactivating adhesive used to attach membrane.

2.05 DECK PRIMERS

A. Vapor Retarder Primer SB: Solvent-based primer used to prime wood, concrete, primed gypsum boards and decks, prior to the application of self-adhered vapor retarders.

B. Vapor Retarder Primer WB: Polymer emulsion water-based primer used to prime wood, concrete, gypsum decks, and approved gypsum boards prior to the application of self-adhered vapor retarders.

C. Vapor Retarder Primer TA: Blend of bitumen and solvent-based primer for use prior to applying torch-applied vapor retarders.

D. Vapor Retarder Primer BE: Bituminous emulsion (water based) primer for use prior to applying torch-applied vapor retarders.

2.06 FLASHING MATERIALS

A. Wall / Curb Flashing

1. PVC Adhered Membrane

2. Flashing Membrane: Used over residual asphalt or other contaminated surfaces.

3. PVC Detail Membrane

4. Polymer Coated Metal

5. Adhesive: Solvent-based reactivating adhesive used to attach membrane to flashing substrate.

B. Perimeter Edge Flashing

1. Polymer clad: 24 gauge, G90 galvanized steel with PVC-coating on one side for heat-weldability.

2. Edge: Two-piece assembly of steel base rail and aluminum or steel snap-on fascia cover with spring clips.

3. Drip Edge: Two-piece assembly of galvanized steel cleat and PVC coated galvanized steel.

4. Coping: Aluminum or steel snap-on coping cover with concealed splice plates.

C. Miscellaneous Flashing

1. PVC circles: round circle patch.

2. Inside Corners – Injection molded inside corner.

3. Outside Corners – Injection molded outside corner.

4. Universal Stack - Injection molded stack/pipe boot to flash pipes, vent stacks and cylindrical penetrations.

5. Split A, B, C - Prefabricated stack/pipe boot open along one side to flash pipes, vent stacks and cylindrical penetrations when access is obstructed.

6. Open Post Flashing - Prefabricated pipe boot open along one side to flash rooftop conduits, pipes, and cylindrical penetrations when access is obstructed.

7. Termination Bar - 3/4” wide extruded aluminum bar used to terminate roofing membranes at walls and edges.

8. Liquid Flashing Primer - Two-component polymethyl methacrylate-based (PMMA) primer used to promote the adhesion of Liquid Flashing SW and Liquid Flashing WW over wood and concrete surfaces.

9. Liquid Flashing Fleece - Non-woven, needle-punched polyester fleece used as the reinforcement for liquid flashing details.

10. Liquid Flashing Catalyst - Reactive agent based on dibenzoyl peroxide to induce curing of \Liquid Flashing SW, Liquid Flashing WW, and Liquid Flashing Primer when mixed.

11. Liquid Flashing SW (summer-grade white)
Two-component polymethyl methacrylate-based (PMMA). The ambient temperature at application must be between 59°F (15°C) and 104°F (40°C). The surface temperature at application must be between 59°F (15°C) and 122°F (50°C).

2.07 WALKWAY PROTECTION

A. Polyester reinforced, 96 mil (2.4 mm) thick, weldable membrane with surface embossment similar to a chevron pattern. Used as a protection layer from rooftop traffic.

B. PVC, 79 mil (2.0 mm) thick, weldable membrane with pyramidal surface embossment. Used as a protection layer from rooftop traffic.

2.08 MISCELLANEOUS ACCESSORIES

A. Aluminum Tap - 2” (51 mm) wide pressure-sensitive aluminum tape used as a separation layer between small areas of asphalt contamination and the membrane and as a bond-breaker under the coverstrip at joints.

B. Perimeter Warning Membrane - 4” (10.2 cm) wide yellow membrane used in required areas.

C. Seam Cleaner
Used to clean adhesive out of seams. It is not to be used as a general membrane cleaner. It is also used to clean metal and reactivate existing Liquid Flashing prior to the application of new Liquid Flashing.

D. Stop - 1” wide extruded aluminum, low profile bar used with certain fasteners to secure membrane to the roof deck or to walls/curbs at terminations, penetrations and at angle changes of the substrate.

2.09 SEALANTS AND PITCH POCKET FILLERS

A. Moisture-cured, one-component polyurethane-based, non-sag elastomeric sealant used in wall, curb and drain terminations. It is also used as a sealant at pipe penetrations and under certain metal flashings or as a pourable sealer pocket filler.

2.10 MISCELLANEOUS FASTENERS AND ANCHORS

All fasteners, anchors, nails, straps, bars, etc. shall be post-galvanized steel, aluminum or stainless steel. Mixed metal type components shall be assembled in such a manner as to avoid galvanic corrosion. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins.

2.11 RELATED MATERIALS

A. Wood Nailer - Code compliant wood nailers shall be installed at the perimeter of the entire roof and around such other roof projections and penetrations as specified on Project Drawings. Thickness of nailers must match the height of the insulation and roof board to achieve a smooth transition.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION CONFERENCE

The Applicator, Owner's Representative/Designer and Manufacturer(s) shall attend a pre-construction conference.

3.02 SUBSTRATE CONDITION

A. Applicator shall be responsible for acceptance or provision of proper substrate to receive new roofing materials.

B. Applicator shall verify that the work done under related sections meets the following conditions:
1. Roof drains and scuppers have been reconditioned or replaced (as applicable) and installed properly.
2. Roof curbs, nailers, equipment supports, vents and other roof penetrations are properly secured and prepared to receive new roofing materials.

C. The substrate shall be clean, smooth, dry, free of water, ice and snow and free of flaws, sharp edges, loose and foreign material, oil, grease and other contaminants. Roofing shall not start until all defects have been corrected.

3.03 SUBSTRATE PREPARATION

The roof deck and existing roof construction must be structurally sound to provide support for the new roof system. The Owner's Representative shall ensure that the roof deck is secured to the structural framing according to local building code or insurance requirements and in such a manner as to resist all anticipated loads in that location.

A. New Construction

1. Poured Structural Concrete Deck - The surface shall be dry and free of moisture, have a level finish, and shall be free of dust, excess moisture, oil-based curing agents and loose debris. Under no circumstances shall a sealer be used in lieu of a curing agent. Sharp ridges or other projections above the surface shall be removed before roofing. In accordance with the ICRI Technical Guideline No. 310.2R-2013, newly poured concrete surfaces may be finished by forming, wood float, steel or power trowel, or broom finished to meet a concrete surface profile (CSP) of 2 – 5.

2. Poured Lightweight (Cellular or Insulating) Concrete Substrate - The surface shall be installed per lightweight concrete manufacturer's guidelines. The wet and dry densities shall be in accordance with the manufacturer's requirements. Sharp ridges or other projections above the surface shall be removed before roofing.

3. Precast / Prestressed Concrete Panel Deck - The surface shall have a smooth and level finish and shall be free of dust, moisture, oil or loose debris. All joints between precast units shall be grouted. Any differentials in height between precast units shall be feathered for a smooth transition. Sharp ridges or other projections above the surface shall be removed before roofing.

B. Reroofing with Removal of Existing Roofing System

All existing roofing, base flashing, deteriorated wood blocking or deteriorated metal flashings shall be removed. Remove only that amount of roofing and flashing which can be made weathertight with new materials during a one-day period or before the onset of inclement weather.

4. Poured Structural Concrete Deck - The surface shall be dry and free of moisture, have a level finish, and shall be free of dust, excess moisture, and loose debris. Sharp ridges or other projections above the surface shall be removed before roofing. In accordance with the ICRI Technical Guideline No. 310.2R-2013, newly poured concrete surfaces may be finished by forming, wood float, steel or power trowel, or broom finished to meet a CSP of 2 – 5.

5. Poured Lightweight (Cellular or Insulating) Concrete Substrate - Sharp ridges or other projections above the surface shall be removed before roofing. Fastening for recover board shall be into structural deck below insulating fill (see steel/concrete deck requirements).

6. Precast / Prestressed Concrete Deck - The roof deck shall be smooth, even, free of dust, dirt, excess moisture, or oil and be structurally sound. All joints between precast units shall be grouted. Any differentials in height between precast units shall be feathered for a smooth transition. Any deteriorated decking shall be repaired.

C. Recover Over Existing Bitumen Roofing - The Owner's Representative and Applicator shall determine the condition of the existing roof deck and old roof system. Areas with deteriorated decking or wet materials are to be removed and replaced.

3.04 WOOD NAILER INSTALLATION

A. Install continuous code compliant wood nailers at the perimeter of the entire roof and around roof projections and penetrations as shown on the Detail Drawings.

B. Wood nailers or wood blocking for penetrations, curbs, or snow protection systems shall be installed prior to the installation of the roof membrane whenever possible.

3.05 INSULATION / EPS ROOF BOARD INSTALLATION

General Criteria:

1. Boards shall be installed according to local building code, insurance requirements, and manufacturer's instructions.
2. Boards shall be neatly cut to fit around penetrations and projections.
3. Install tapered insulation in accordance with insulation manufacturer's shop drawings.
4. Do not install more board than can be covered with membrane by the end of the day or the onset of inclement weather.
5. When two or more layers of insulation and/or roof boards are used, stagger joints at least 12” (30.5 cm) in both directions between layers.

A. Lightweight Insulating Concrete - Install in accordance with selected manufacturer’s guidelines.

3.06 ADHERED FELTBACK PVC MEMBRANE INSTALLATION

The surface of the insulation, roof board, or substrate shall be inspected prior to installation of the feltback PVC 9 oz. roof membrane. The substrate shall be clean, dry, and free from debris and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged boards shall be removed and replaced. Tack welding of adhered membrane field sheets for purposes of temporary restraint during installation is not permitted and may result in voiding of manufacturer’s warranty.

A. Single-Step Membrane Adhesive:

1. Apply adhesive direct to substrate, rate may vary depending on porosity of substrate. Do not allow adhesive to skin-over or surface-dry prior to installation of membrane.

2. Refer to Single-Step Membrane Adhesive Product Data Sheet and *Adhered Systems: Water Based Adhesive Installation* section of the Roofing Applicator’s Handbook for detailed installation instructions.

B. Flashing Adhesive 2170

1. Apply adhesive direct to substrate, rate may vary depending on porosity of substrate. Only an area which can be completely covered in the same day's operations shall be coated with adhesive. The first layer of adhesive shall be allowed to dry completely prior to installing the membrane.

2. Refer to individual Product Data Sheets (PDS) and *Adhered Systems: Solvent Based Adhesive Installation* section of Manufacturer’s Roofing Applicator’s Handbook for detailed installation instructions.

C. Water based field membrane 2121 Adhesive:

1. Apply adhesive direct to substrate, rate may vary depending on porosity of substrate. Do not allow adhesive to skin-over or surface-dry prior to installation of membrane.

2. Refer to *Adhered Systems: Water Based Adhesive Installation* section of the manufacturer’s Roofing Applicator’s Handbook for detailed installation instructions.

3.07 HOT-AIR WELDING OF MEMBRANE OVERLAPS

A. All membrane overlaps shall be hot-air welded. The membrane shall be clean and dry prior to hot-air welding.

B. Field membrane overlaps for automatic machine-welding will vary in width depending on the plate and fastener combination used. A minimum of 4” (10.2 cm) wide overlap is required when hand-welding details.

C. 1” (25 mm) wide cross-section samples of welded seams shall be taken at least two times a day, once in the morning and once in the afternoon.

D. Refer to *Welding* section of manufacturer’s Roofing Applicator Handbook for detailed installation instructions.

3.08 MEMBRANE FLASHING INSTALLATION

All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and Manufacturer. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at the Applicator's expense. Flashing shall be adhered to compatible, dry, and smooth surfaces free of dirt, dust, and debris. Use caution to ensure adhesive fumes are not drawn into the building.

A. All flashings should extend a minimum of 8" (20.3 cm) above finished roofing level. Submit requests for exceptions in writing to the Owner's Representative and Manufacturer's Technical Department for signed approval.

B. No bitumen shall be in contact with the membrane.

C. All flashing membranes shall be mechanically fastened along the counter-flashed top edge with perimeter securement. Refer to manufacturer's installation instructions.

D. Flashings shall be terminated according to recommended details.

E. Refer to *Typical Flashing Procedures* section of the Manufacturer's Roofing Applicator Handbook for detailed installation instructions.

3.09 CLAD METAL BASE FLASHINGS / EDGE METAL INSTALLATION

A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and or manufacturer's acceptance. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Applicator's expense.

B. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:

1. ANSI SPRI ES-1 (latest issue).
2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.

C. Pre-formed metal flashing shall be installed according to metal manufacturer's guidelines.

D. Metal, other than that provided by primary manufacturer is not covered under the warranty.

E. Clad and other metal flashings shall be formed and installed per the Detail Drawings. Refer to individual Product Data Sheets (PDS) and *Metal Flashings* section of the membrane manufacturer's Roofing Applicator Handbook for detailed installation instructions.

3.10 WALKWAY INSTALLATION

F. PVC Walkway-20: Probe all existing deck membrane seams which are to be covered by Walkway-20. Install walkway in straight lines by either adhering and welding or just welding to the field membrane.

3.11 TEMPORARY CUT-OFF

A. All flashings shall be installed concurrently with the roof membrane to maintain a watertight condition as the work progresses. All temporary cut-offs shall be constructed to provide a watertight seal. The new membrane shall be carried into the temporary cut-off. Temporary cut-off shall be sealed to the deck or substrate so that water will not be allowed to travel under the new or existing roofing. When work resumes, the contaminated membrane shall be cut out.

B. If inclement weather occurs while a temporary cut-off is in place, the Applicator shall provide the labor necessary to monitor the situation to maintain a watertight condition.

C. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at the Applicator's expense.

3.12 COMPLETION

A. Prior to demobilization from the site, the work shall be reviewed by the Owner's Representative and the Applicator. All defects noted and non-compliances with the Specifications or the recommendations of the waterproofing membrane supplier shall be itemized in a punch list. These items must be corrected immediately by the Applicator to the satisfaction of the Owner's Representative and Membrane Manufacturer prior to demobilization.

B. All Warranties referenced in this Specification shall have been submitted and have been accepted by the owner or owner’s representative at time of contract award.

3.13 DETAILS

A.

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
E. Division 075419 – Polyvinyl-Chloride (PVC) 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.

Guide Specification

2. ANSI/SPRI FX-1, Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.

D. INTERNATIONAL CODES COUNCIL (ICC):
   1. Latest 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.

G. PUERTO RICO BUILDING CODE 2018

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.

Guide Specification

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 at all times 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

Guide Specification

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: -0 psf
         b) Vertical: -0 psf
      ii. Corners Region:
         a) Horizontal: -0 psf
         b) Vertical: -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:

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

2.02 SHEET METAL FLASHING

A. SHEET METAL, ROOF EDGE SYSTEM:

1. Roof edge system shall include all components and associated fasteners necessary to comply with specified performance requirements. Contractor shall provide all other related fasteners and sealants necessary for the roof edge system.

2. Cantilever Coping: Engineered two-piece fascia system with a formed cleat and metal fascia.
   a. Material: Aluminum

Guide Specification

b. Gauge/Thickness: Minimum .040
c. Finish: 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. 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:
   c. Finish: Color selected from manufacturer's color chart. Mill-Finished Aluminum.
2. 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:
   c. Finish: Color selected from manufacturer's color chart. Mill-Finished Aluminum.

C. SHEET METAL, COUNTERFLASHING SYSTEM:

1. 1PC Counterflashing: Engineered counterflashing system with formed counterflashing.
   a. Material: Aluminum, Galvanized Steel, Stainless Steel
   b. Gauge/Thickness:
   c. Finish: Color selected from manufacturer's color chart. Mill-Finished Aluminum.
2. 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:
   d. Finish: 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.

Guide Specification

5. Flat Head Screw w/ Extruded Washer:
    a. Length as required.

E. GENERAL PURPOSE ROOFING CEMENT AND MASTIC

1. 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. 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.

F. GENERAL PURPOSE SEALANT

1. General purpose, paintable, gun-grade, elastomeric, polyether moisture curing sealant for sealing SBS and PVC membrane terminations, 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

Guide Specification

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. 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 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.

3.05 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 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.

3.06 CLEAN-UP

Guide Specification

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

Guide Specification

SECTION 07900

JOINT SEALERS AND WATER REPELLENT COATING

• PART 1.0 GENERAL

1.1 Description

a. Provide all materials, equipment and labor necessary to prepare surfaces and applied new sealants and water repellent coating to exterior masonry & concrete surfaces and metal & glass window/skylight frames, as specified on all related Contract Documents.

b. The requirements of the General and Special Conditions shall govern work in this section.

c. Weather Conditions: Do not proceed with application of sealants and coatings when conditions are outside range recommended by manufacturer.

d. Applied coating to exhibit ability to permit 0.0 percent maximum moisture absorption in material treated.

1.2 Submittals

a. Product Data: Provide details of product description (including manufacturer's data sheets & standard color charts), field quality control test procedures for each coating, sealant and primer to be used, limitations to coating, cautionary procedures required during application and chemical properties, including percentage of solids.

b. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

c. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.3 Qualifications

a. Manufacturer: Company must have a minimum of three (3) years documented experience in manufacturing the products specified on this section.

b. Applicator: Contractor and job foreman specialized in performing work described on this section must have a minimum of five (5) years experience applying/installing silicone sealants and water repellent coatings.

1.4 Quality Assurance

a. Compatibility and Adhesion Tests: Contractor shall be responsible for verifying with the product manufacturer that all sealants and coatings to be used are compatible with and will satisfactorily adhere to all substrates. Tests are to be conducted in the field or by submission of representative substrate samples to sealant/coating manufacturer's laboratory.

b. Overall Application: Contractor shall apply material in strict compliance with manufacturer's latest published literature and specifications.

1.5 Mock-Up

a. If requested by the PBA designated representative, the Contractor shall apply/install, on 36" x 36" prepared surface, a sealant/coating mock-up to demonstrate appearance and workmanship technique.

b. Mock-Up shall be done by those personnel who will assign to the project.

c. Mock-Up may not remain as part of the Work.

1.6 Delivery, Storage and Handling

a. Delivery: Deliver materials to job site in original tightly sealed containers or unopened packages, all clearly labeled with the manufacturer's name, product identification and lot numbers.

b. Storage: Store materials out of the weather in their original tightly sealed containers, in accordance with manufacturer's requirements.

1.7 Warranty

a. Upon job completion, provide manufacturer's above-mentioned standard product whether-seal warranty.

b. Upon completion of the job, provide contractor's five (5) year workmanship warranty.

c. All warranties shall be from a single manufacturer, providing single recourse for this project's joint sealers and water repellent coating.

• PART 2.0 PRODUCTS

2.1 Materials

a. Coating: Allguard Elastomeric Coating or FS SS-W-110, silicone resin, colorless, with twenty-eight percent (28 %) minimum solids.

b. Sealant: DOW CORNING 791 or 795 Silicone Building Sealant for various substrates, including but not restricted to **metal window frames, glass, stone, concrete, masonry, metal, EIFS, etc.**

c. Performed Seal: DOW CORNING 123 Silicone Seal. Color to be selected by PBA designated representative.

d. Primer: DOW CORNING 1200 or 1593 Primer Coat. Type recommended by sealant manufacturer and/or based on field mock-up results.

e. Backer Rod: Open cell polyurethane, closed cell polyethylene or Sof-Rod. Use type recommended by sealant manufacturer for each application.

f. Bond Breaker Tape: Pressure sensitive adhesive polyethylene, TEFLON or polyurethane foam tape.

• PART 3.0 EXECUTION

3.1 WATER REPELLENT COATING

3.1.1 Examination

a. Verify joint sealants are installed and cured.

b. Verify surfaces to be coated are dry, clean and free of efflorescence, oil, or other matter detrimental to application of coating.

3.1.2 Preparation

a. Delay work until concrete substrate is cured a minimum of sixty (60) days.

b. Remove loose particles and foreign matter.

c. Remove oil or foreign substance with a chemical solvent which will not affect coating.

d. Scrub and rinse surfaces with water and let dry.

3.1.3 Application

a. Apply coating in accordance with manufacturer's instructions.

b. Apply at a rate of 250-300 sq. ft. / gal. airless spray.

c. Apply in one continuous, uniform coat.

d. Do not apply coating when surface temperature is lower than sixty-five (65) F degrees (19 C degrees) or higher than 100 F degrees (38 C degrees).

3.1.4 Protection to Finished and Adjacent Work

a. Protect adjacent surfaces not scheduled to receive coating.

b. Protect landscaping, property and vehicles.

c. If applied to unscheduled surfaces, remove immediately by a method instructed by coating manufacturer.

3.2 JOINT SEALERS: JOINT REMOVAL & REPLACEMENT

Use Section 3.2 for joints containing failed organic sealant which is sufficiently hardened to grind out without degrading the grinding wheel.

3.2.1 Preparation

a. Cut away the old sealant. Grind with a grinding wheel the failed sealant that new, uncontaminated substrate of the original joint's sidewall is visible to a depth of about ½" to ¾".

b. Blow out all dirt, dust, residue, old sealant, old backer rod, etc., using oil-free and moisture-free compressed air.

c. Mask if necessary.

3.2.2 Examination

a. Contractor shall verify that all joint surfaces are clean, sound, free of defects and that dimensions are within sealant manufacturer's size requirements.

b. Commencement of sealant installation shall be evidence that Contractor has verified compliance of existing conditions.

3.23 Installation

a. If required, apply primer according to manufacturer's instructions.

b. Install appropriate backer rod using blunt or rounded tools to assure uniform depth (½" ± ¼") without puncturing or twisting. Rod shall be a minimum twenty-five percent (25%) oversized. Install bond breaker tape in shallow joints.

c. To obtain full adhesion, sealants require a clean, dry, frost-free surface. Although silicone sealants have excellent wide temperature gunnability, the practical application temperature can be dictated by frost formation on the joint edges, which can begin to occur below 40° F. To assist in the drying of a frost-containing joint, a water soluble solvent such as MKE or IPA should be used.

d. Apply the sealant in a continuous operation using a caulking gun or pump. A positive pressure, adequate to fill the entire joint width, should be used. This can be accomplished by- "pushing" the sealant ahead of the application nozzle. Care must be taken to ensure complete fill of the sealant cavity.

e. Tool the sealant with light pressure before a skin begins to form (typically 10 to 20 minutes). Tooling forces the sealant against the back-up material and the side walls of the joint surfaces. **Do not use liquid tooling aids such as water, soap or alcohol; i.e. isopropyl alcohol (IPA).** These materials may interfere with sealant cure and adhesion and create aesthetic issues.

f. Remove the masking tape before the sealant skins over (within about 15 minutes of tooling).

g. Check adhesion after sealant has cured for 7-14 days (see Quality Assurance).

3.24 Clean-Up

a. Clean adjacent surfaces as work progresses. Leave finished work in neat, clean condition with no evidence of spills onto adjacent surfaces.

3.3 JOINT SEALERS JOINT OVERLAY SEAL

Use this section as guidance where failed joint sealers area reverted or gummy-as in the case of urethanes or butyl caulks-and/or where substrates are likely to be degraded by cutting or grinding-as is EIFS, exterior insulated finish systems.

3.31 Preparation

a. Clean and condition the substrate to assure adhesion. If power washing is not possible, use stiff nylon brush (like a toothbrush) and scrub substrate with a 50/50 blend of clean cloth containing IPI and water (in the case of EIFS) or a more aggressive solvent like xylene (on more resilient substrates) to remove residues of the old caulk and other contaminants. Dry with another dry cloth. Let conditioned substrate air dry for 1-2 hours.

b. Mask if necessary.

3.32 Examination

a. Contractor shall verify that all joint surfaces area clean, sound, free of contamination and the dimensions are within manufacturer's size requirements.

b. Commencement of sealant installation shall be evidence that Contractor has verified compliance of existing conditions.

3.33 Installation

a. Prime according to manufacturer's instructions, if proven necessary in mock-up.

b. When installing silicone seal, select a width that will allow a minimum of 3/8" bond on each side of the joint. Apply silicone building sealant out in approximately 1/4" diameter beads on each side of the joint. Press the extrusion lightly onto the sealant using a roller or block to provide consistent pressure and ensure uniform and continuous contact. Remove masking tape and excess sealant. Apply second bead along each edge and tool into place to adhere edges of silicone seal and soften the edge relief slightly.

c. Coating can be applied directly onto any silicone seal once sealants are cured.

d. Adhesion testing should be performed in about 7-14 days to verify adhesion of sealant and silicone seal to the existing EIFS.

3.34 Clean-Up

a. Clean adjacent surfaces as work progresses. Leave finished work in neat, clean condition with no evidence of spills onto adjacent surfaces.

Section 07951 – SEALANTS AND CALKING

1. Related Documents:

The general provisions of the contract, including General and Special Conditions, apply to the work specified in this section.

2. Description of Work:

The extent of each type of sealant and calking work is shown on the drawings.

The required applications of sealants and calking 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

3. General:

Obtain elastomeric materials from only manufacturers who will, if required, send a qualified technical representative to project movements for the temperature and condition of the project at the time of installation.

Compressibility:

Specific hardnesses and compressibilities 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, except as otherwise directed.

Color:

Provide each concealed material in manufacturer's standard color which has the best overall performance characteristics for the application shown.

Section 07951 – Sealants and Calking

3. General: (Con'd)

Provide exposed materials Light Grey except where another color is indicated.

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.

Provide size and shape of preformed sealant units as shown or, if not shown, as recommended by the manufacturer, either in his published data or upon consulation with his technical representative.

4. One-Component Elastomeric Sealant:

One-Component Polysulfide Sealant:

Polysulfied based, one-part elastomeric sealant, complying with FS TT-S-00230 Class A, Type 2 (non-sag) unless Type 1 is recommended by manufacturer for the application shown.

Provide compound bearing the Thiokol Chemical Corp. seal of approval.

Products offered by manufacturers to comply with the requirements include the following:

Ultratite 102; Cost Pro Seal
Flexiseal 900 Series; DAP, Inc.
Hornflex One-Component; W.R. Grace
Novacalk – 600; Novagard Corp.
Uniparseal; Parr Paint & Sealants
Rubber Calk 5000; Products Research & Chemical
Sonolastic 1-Part; Sonneborn
Thiotok Sealant R.M.; Toch Brothers

Section 07951 – SEALANTS AND CALKING

4. One-Component Elastomeric Sealant: (Con'd)

Acid-Type Products offered by manufacturers to comply with the requirements, include the following:

781 Building Sealant; Dow Corning
Silican Construction Sealant; General Electric Co.

5. Preformed Elastomeric Sealants:

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 Strucsureglaze; Presstile Interchem
PTI 606; Protective treatments

6. Miscellaneous Materials:

Joint Cleaner:

Provide the type of joint cleaning compound recommended by the sealant or calking compound manufacturer for the joint surfaces to be cleaned.

Joint Primer/Sealer:

Provide the type of joint primer/sealer recommended by the sealant manufacturer for the joint surfaces to be primed or sealed.

Section 07951 – SEALANTS AND CALKING

6. Miscellaneous Materials: (Con'd)

Bond Breaker Tape:

Polyethylene tape 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.

Sealant Backer Rod:

Compressible rod stock of polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absortive material as recommended for compatibility with sealant by the sealant manufacturer; to control the joint depth for sealant placement, to break bond of 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 possibiltiy of sealant extrusion when joint is compressed.

7. Joint Surface Preparation:

Clean joint surfaces immediately before installation of sealant or calking compound. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealat or calking compound.

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 unles 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.

Each concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkanity does not interfere with sealant bond and performance. Each with 5% solution of muriatic acid; neutralize with diluted ammonia solution, rince thoroughly with water and allow to dry before sealant installation.

Section 07951 – SEALANTS AND CALKING

7. Joint Surface Preparation: (Con'd)

Roughen joint surfaces on vitreous coated and similar non-porous 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.

The installer 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 notify the Contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the sealant work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

8. Sample Installation:

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 way 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.

9. Pre-Installation Meeting:

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 in coordination with other work. Review every major sealant application required on the project.

10. Weather Conditions:

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. Wherever 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.

Section 07951 – SEALANTS AND CALKING

11. Installation:

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.

Prime or seal the joint surfaces wherever shown or recommended by the sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

Install sealant backer rod for liquid elastomeric selants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown.

Install bond breaker tape wherever shown and wherever required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

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 o 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.

Install sealants to depths as shown or, if not shown, as recommended by the sealant manufacturer but within the following general limitations:

For joints sealed with elastomeric sealants and subject to traffic and other abrasion and identation exposures, fill joints to depth equal to 75% of joint width, but neither more than 5/8" deep nor less than 3/8" deep.

For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but not more than ½" deep or less than ¼" deep.

For joints sealed with non-elastomeric sealants and calking compounds, fill joints to a depth in the range of 75% to 125% of joint width.

Section 07951 – SEALANTS AND CALKING

11. Installation: (Con'd)

Spillage:

Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces including rough textures such as exposed aggregate panels. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer of the sealant/calking compound.

Remove excess and spillage of 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 or finishes.

Polysulfide Sealant Installation:

Comply with standards issued by Thiokol Chemical Corp., except wher more stringent requirements have been show or specified, or issued as recommendations by the sealant manufacturer.

12. Cure and Protection:

Cure sealants and calking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

The installer shall advise the Contractor of procedures required for the protection of sealants and calking compounds during the construction period, so that they will be without deterioration or damage (other than normal weathering) at the time or Owner's acceptance.

13. Tests for Performance:

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 ¾" 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 aproximate rate of 20 ft. per min.

Section 07951 – SEALANTS AND CALKING

13. Tests for Performance: (Con'd)

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 tests 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 extent of observed leakage, or lack thereof.

Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation as directed.

Wherever nature of observed leakage indicates the possibility of inadequate joint bond strength, P.B.A. may direct that additional testing be performed at a time when joints have been fully cured, folowed by natural exposure through both extreme temperatures and returned to the lowest range of temperature in which it is feasible to conduct testing. Repair or replace work as required.

14. Submittals:

Manufacturer's Data, Sealants and Calking:

Submit 2 copies of manufacturer's specifications, recommendations and installation instructions for each type or sealant, calking compound and associated miscellaneous material required. Include manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the applications shown. Show by transmittal that one copy of each recommendation and installation has been distributed to the Installer.

Samples, Sealants and Calking:

Submit 3, 12" long samples of each color required (except black) for each type of sealant or calking 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.

Section 07951 – SEALANTS AND CALKING

14. Submittals: (Con'd)

Guarantee, Sealants:

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, 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 manufacturer's data. Provide guarantee for a period of 1 year, signed by the Installer and Contractor.

SECTION 08 11 00

METAL DOORS AND FRAMES

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

A. The Contractor shall provide all material, labor and equipment necessary for this section as required by the drawings and/or herein specified, but not limited to:

1. Hollow Metal Doors.
2. Formed Sheet Steel Frames.
3. Formed Sheet Steel Louvers in Hollow Metal.
4. Reinforcing, Supporting and Attachment devices for work of this section.
5. Underwriter Laboratories, Inc., Labeled Doors and Frames.
6. Reinforcing for Hardware as required.
7. Prime Painting for all doors and frames.

B. All material used in the fabrication of metal doors and frames shall be free form defects impairing their strength, durability or appearance.

1.2 REFERENCED STANDARDS

A. American National Standards Institute (ANSI) in its test editions:

1. ANSI 156.1 - Butts and hinges
2. ANSI 156.2 - Bored & preassembled locks.
3. ANSI 156.3 - Exit devices.
4. ANSI 156.4 - Door control (Closers).
5. ANSI 156.5 - Auxiliary locks.
6. ANSI 156.6 - Architectural trim.
7. ANSI 156.13 - Mortise locks & latches.

8. ANSI 156.16 - Auxiliary hardware.

9. ANSI 156.18 - Materials & finishes.

10. ANSI 117.1 - Providing accessibility and usability for physically Handicapped people.

B. National Builders Hardware Association (NBHA):

1. Recommended Locations for Builders Hardware.

2. Basic Builders Hardware.

C. Builders Hardware Manufacturers Association:

1. Directory of Certified Locks & Latches.

2. Directory of Certified Door Closer.

D. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code.

2. NFPA 80 – Fire Doors and Windows.

3. NFPA 101 – Life Safety Code.

E. Building Code (*Reglamento de Edificación - P.R.*):

1. *Reglamento de Planificación Número 7*.

2. *Enmiendas al Reglamento de Edificación*.

3. UBC-97

F. Código para la Prevención de Incendios del Cuerpo de Bomberos de P.R.

G. ASTM A 153-82 (87) – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

H. ASTM A 366/A 366M-91 – Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.

I. ASTM A 525-91b – Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

J. ASTM A 526/A 526M-90 – Standard Specification for Steel, Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

K. ASTM A 568/A 568M-92 – Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

L. ASTM A 569/A 569M-91a – Standard Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.

M. ASTM B 749-85 (91) – Standard Specification for Lead and Lead Alloy sheet, Strip, and Plate Products.

N. ASTM E 152-81a – Standard Methods of Fire Test of Door Assemblies.

O. NFPA 80 – Standard for fire Doors and Windows; National Fire Protection Association.

P. SDI 100 – Recommended Specifications; Standard Steel Doors and Frames; Steel Door Institute.

Q. SDI 105 – Recommended Erection Instructions for Steel Frames; Steel Door Institute.

1.3 SHOP DRAWINGS

A. Submit copies of shop drawings as per section 01 33 23.

1. Drawings shall include sizes, details of construction, anchorage, methods of assembly, hardware details and complete information regarding materials, gauges and finish.

2. Shop drawing revision indicates general conformance with design, but does not relieve contractor of full responsibility for the correctness of the documents furnished or for conformance with the detailed provisions of this specifications.

1.4 SAMPLES

A. Submit for approval corner sections of metal frames and hollow metal doors, indicating all construction details, prime coat for frames and doors. Submit all required accessories and anchors.

1.5 PAINTING

A. All steel doors and frames are to be thoroughly cleaned, primed and filled to present a smooth surface, and given sufficient coats as required to receive finish painting.

1.6 STORAGE

A. Doors and frames shall be stored in upright position under cover at the building site on wood sills or on floors in a manner that will prevent damage.

1.7 LABELED WORK – FIRE PROTECTION

A. Doors and frames requiring labels as indicated on drawings shall meet the requirements for the ratings noted in accordance with the established procedures of the Underwriter Laboratories, Inc., no substitutions allowed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. The products specified under this section are intended to be the products of one single manufacturer. Hardware location, hinge, backsets, etc., shall be the published standards of one manufacturer unless specified differently in the Doors Hardware Section 08 71 00.

B. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be those considered, acceptable:

1. *Amweld*.

2. *North American Door*.

C. All other manufacturers which would like their products to be considered, Contractor shall follows section 01 25 00 – Substitutions.

D. Contractor can purchase the Hollow Metal Doors and Frames from a qualified local manufacturer or U.S. manufacturer's representatives. Qualification of manufacturer is subject to revision by the Architect based on the continued maintenance or quality standards required by Owner, and the ability to service these products.

2.2 MATERIALS

A. Steel Sheets, Galvanized; ASTM A 526 and ASTM A 525, commercial quality, G60 zinc coating mill phosphatized.

2.3 FABRICATION

A. General: Shop-fabricate assemblies to greatest extent possible, assuring that installed units will be without warp, twist, bow or other defect in appearance or function.

B. Exposed Door Faces: Fabricate form cold-rolled steel.

C. Frames: Fabricate from cold-rolled or hot-rolled steel.

D. Edge Channels, Stiffeners and Reinforcements: Fabricate from cold-rolled or hot-rolled steel.

E. Louvers: Fabricate blades from cold-rolled steel and frames from cold-rolled or hot-rolled steel.

F. Perimeter (Exterior) Doors: Fabricate from galvanized steel.

G. Seal top and bottom edges integrally with door construction, or use minimum 16 gauge steel channels to form flush closure.

H. Exposed Screws and bolts: Where required, provide only stainless steel countersunk, flat Phillips-head fasteners.

2.4 STEEL DOORS

A. General: Fabricate steel doors in accordance with requirements of SDI 100.

B. Doors shall be fabricated from Galvanized Steel sheets of gauges herein after specified. Interior doors shall be fabricated from Galvanized Steel.

C. Core Material: All interior doors shall be free of blemishes and spot welding marks with honeycomb core of not more than ¾ inches cell. All exterior doors shall have a polystyrene core.

D. Door Panels: Shall be of 16 gauge or of gauges shown on door schedule in contract drawings, and joined together by means of a positive mechanical interlocking system at door edges.

E. Closure Channels: Top and bottom closure channels of 16 gauge steel running the full width of the door to provide a flush cover top and bottom.

F. Meeting Styles: A flat bar astragal, continuous welded to active leaf of pair, shall be provided at meeting style of door at pair openings.

G. Door Louvers: Sight-proof louvers: Stationary type for interior doors as scheduled; 22 gauge Z-shaped, Y-shaped or inverted V-shaped blades set into 20 gauge frame.

2.5 STEEL FRAMES

A. General: Fabricate steel frames for scheduled openings, in styles and profiles as shown, using concealed fasteners.

B. Frames shall be fabricated from Galvanized steel.

C. Frames shall be of 14 gauge or of gauges shown on door schedule in contract drawings, notched, mitered and mechanically interlocked to a hairline joint at 45 degrees.

D. Guards: Weld protective covers to back of hardware openings at locations where grout, plaster or other materials might interfere with hardware operation.

E. Factory reinforce only for surface applied hardware. Drilling and tapping for surface applied hardware such as exit devices, pulls, closers, holders and escutcheon plates for exit devices and mortise locks, special hinges, pivots and floor closers is to be done at factory.

2.7 FINISH HARDWARE

A. Contractor shall obtain all required templates from hardware supplier and furnish same to hollow metal manufacturer to be used in the fabrication as directed. See hardware section 08 71 00 for detailed information.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Doors shall be installed plumb, straight and true, rigidly secured in place and properly braced. Frames shall be anchored securely to concrete floors.

B. Frame shall be installed plumb, straight and true, rigidly secured in place and properly braced. Frames shall be anchored securely to concrete floors. The frame installer shall be responsible for the squareness of the frames in place.

C. Except for frames located at in place concrete or masonry, place frames prior to the construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned and braced securely until permanent anchor are set.

D. Install one wall anchor for every hinge provided on frame. Provide no less than three wall anchors per jamb. Submit details of frame anchorage for in place concrete or masonry walls.

E. Do not finally install hardware until all plastering and painting is completed and the building is totally dry.

F. Door silencers shall be installed after installation is completed. Three silencers for single doors and two for head of pair of swing doors.

3.2 MAXIMUM CLEARANCES AT ALL OPENINGS

A.	At Top Rail	1/8 inch
B.	At Hinge and Lock	1/8 inch
C.	At Floor or Saddle	3/8 inch

END OF SECTION 08 11 00

SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Flush wood doors; flush configuration; fire rated, non-rated, and acoustical.

1.2 REFERENCES

A. ASTM E 1408 - Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems; 191.

B. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada.

C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.

D. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.

E. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.

F. UBC Std 7-2, Part II - Test Standard for Smoke- and Draft-control Assemblies; International Conference of Building Officials.

G. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.

H. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

I. WDMA NWWDA I.S.1-A - Architectural Wood Flush Doors; Window and Door Manufacturers Association.

1.3 SUBMITTALS

A. See Section 01 33 23 - Submittals.

B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.

C. Shop Drawings; Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, identify cutouts for glazing and louvers.

D. Samples: Submit two samples of door construction, 12 x 12 inch (30 x 30 mm) in size cut from top corner of door.

E. Samples: Submit two samples of door veneer, 12 x 12 inch (30 x 30 mm) in size illustrating wood grain, stain color, and sheen.

F. Manufacturer's Installation Instructions: Indicate special installation instructions.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.

B. Installed Fire Rated Door Assembly: Conform to NFPA 80 for fire rated class as scheduled.

C. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, comply with air leakage requirements of UBC Std 7-2, Part II; with "S" label; if necessary, provide additional gasketing or edge sealing.

1.5 DELIVERY, STORAGE, AND PROTECTION

A. Package, deliver and store doors in accordance with specified quality standard.

B. Accept doors on site in manufacturer's packaging. Inspect for damage.

C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.6 PROJECT CONDITIONS

A. Coordinate the work with door opening construction, door frame and door hardware installation.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals.

B. Provide warranty for the following term:
1. Exterior Doors: Five (5) years.
2. Interior Doors: Two (2) years.

C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wood & Doors:

1. Eggers Industries: VT- Architectural Wood Doors
2. Substitutions: Submit manufacturer for Architect evaluation.

2.2 DOORS AND PANELS

A. All Doors: See drawings for locations and additional requirements.

1. Quality Standard: WDMA I.S. 1-A, Premium Grade, Heavy Duty performance.
2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.

B. Exterior Doors: 1-3/4 inches (44 mm) thick unless otherwise indicated: flush solid core construction.

1. Wood veneer facing with factory opaque finish where indicated on drawings.

C. Interior Doors: 1-3/4 inches (44 mm) thick unless otherwise indicated; flush construction.

1. Provide solid core doors at all locations.
2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C or UBC Standard 7-2-97 ("positive pressure"); UL or WH (ITS) labeled without any visible seals when door is open.

2.3 DOOR AND PANEL CORES

A. Fire Rated Doors: Mineral core, Type FD, plies and faces as indicated above.

B. Sound Retardant Doors: Equivalent to Type PC construction with core as required to achieve rating specified; plies and faces as indicated above.

2.4 DOOR FACINGS

A. Veneer Facing for Opaque Finish: Medium density overlaid plywood.

2.5 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Fit door edge trim to edge of stiles after applying veneer facing.

C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

D. Factory fit doors for frame opening dimensions identified on shop drawings.

E. Cut and configure exterior door edge to receive recessed weather-stripping devices.

F. Provide edge clearances in accordance with AWI Quality Standards Illustrated Section 1700.

2.6 FACTORY FINISHING

A. Factory finish doors in accordance with approved sample.

B. Seal door top edge with color sealer to match door facing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Do not install doors and frames in openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.
   1. Install fire-rated doors in accordance with NFPA 80 requirements.

B. Trim door height by cutting bottom edges to a maximum of ¾ inch (19 mm).

C. Use machine tools to cut or drill for hardware.

D. Coordinate installation of doors with installation of frames and hardware.

3.3 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

3.4 SHEDULE - See Drawings.

END OF SECTION 08 14 16

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Hardware for doors.

1.2 RELATED SECTIONS

A. Wood doors - Section 08 14 00.

B. Metal doors and frames - Section 08 11 00.

1.3 REFERENCES

A. American National Standards Institute (ANSI) in its latest edition:

1. ANSI 156.1- Butts and hinges.
2. ANSI 156.2- Bored & preassembled locks.
3. ANSI 156.3- Exit devices.
4. ANSI 156.4- Door control (Closers).
5. ANSI 156.5- Auxiliary locks.
6. ANSI 156.6- Architectural trim.
7. ANSI 156.13- Mortise locks & latches.
8. ANSI 156.16- Auxiliary hardware.
9. ANSI 156.18- Materials & finishes.
10. ANSI 117.1- Providing accessibility and usability for physically handicapped people.

B. National Builders Hardware Association (NBHA):

1. Recommended Locations for Builders Hardware-1975.
2. Basic Builders Hardware - October 1969.

C. Builders Hardware Manufacturers Association:

1. Directory of Certified Locks & Latches.

2. Directory of Certified Door Closers.

D. National Fire Protection Association (NFPA):

1. NFPA 80 - Fire Doors and Windows.

2. NFPA 101- Life Safety Code.

E. Uniform Building Code (UBC-97).

F. Codigo para 1a Prevencion de Incendios del Cuerpo de Bomberos de Puerto Rico.

G. Americans with Disabilities Act (ADA).

1.4 QUALITY ASSURANCE

A. Hardware shall conform to the following standards:

1. Ball bearing butts shall comply with ANSI A-2112. Plain butts shall comply with ANSI A-2133.

a. Butts on outswinging exterior doors shall have non-removable pins (NRP).

b. All doors with closers shall have ball bearing butts.

2. Locksets and latches shall meet the following minimum ANSI standards:

a. Heavy duty cylindrical locks - ANSI Series 4000, Grade 1, with knob trim, except on handicapped units which shall have lever handle trim.

b. Standard duty cylindrical locks - ANSI Series 4000, Grade 2, with knob trim, except on handicapped units which shall have lever handle trim.

c. Use UL approved locks on labeled fire doors.

3. Door closers shall comply with ANSI Series CO4021, Grade 1 with cast iron case and adjustable backcheck. Closers for reverse bevel doors and all doors opening wards a hallway shall comply with ANSI Series CO2021, Grade 1 and be sized according to the manufacturer's recommendation.

4. Exit devices shall be of the modern push bar type, ANSI Grade 1. All pair openings with a combination mortise and vertical rod device shall be equipped with an openback strike. Pair openings with a combination Rim and vertical rod device and door closers on each door, shall be equipped with a type 21 door coordinator.

1.5 SUBMITTALS

A. The hardware supplier shall submit seven (7) copies of a complete hardware schedule for approval.

1. Preface sheet listing category only and manufacturers name of items being furnished, as shown on drawings.

2. For hardware locations, see drawings.

3. Open description: Single or pair, number, room locations, hand, active leaf, degree of opening, size, material, frame material, and fire rating.

4. Hardware description: Quantity, category, product number, fasteners, and finish.

5. Headings that refer to the specified Hardware Set Numbers.

6. Scheduling sequence shown in Hardware Sets.

7. Product data of each hardware item and shop drawings, where required, for special conditions and specialty hardware.

8. Vertical scheduling format only. Horizontal schedules are not acceptable.

9. Typed copy.

10. Double spacing.

11. Eight and one-half by eleven inch (8 1/2" x 11") sheets.

12. U.S. Standards finish symbols.

B. Samples: Submit sample of each type of builders hardware item proposed for project. If approved, samples may be used in project.

C. Certification: Submit notarized certification indicating that hardware furnished for labeled doors and doors requiring physically handicapped access, complies with requirements of local governing authorities and applicable regulations.

1.6 DELIVERY, STORAGE AND HANDLING

A. Package and deliver hardware items separately and mark each to correspond with heading numbers on hardware schedule.

B. Include necessary instructions, templates, drawings a fasteners for proper installation. Include 10% extra fasteners.

C. Master keys shall be delivered by the hardware supplier directly to the owner.

1.7 SUBSTITUTION

A. As per Section - 01 25 00

B. Equivalent products, as described in section 2.2 of these specifications, are acceptable substitutions. Other manufacturers with equivalent products not listed herein shall submit to the Architect, 15 days prior to Bid Opening Date, all pertinent documentation and full size samples so that the Architect can

properly evaluate the alternate. Those products approved by the Architect will be notified to all prospective bidders by an addendum to the projects specifications before Bid Opening Date.

1.8 JOB CONDITIONS

A. Furnish templates to the hollow metal and frame manufacturer as required for installing the hardware to avoid any delay in fabrication.

B. See Article 3.3 - Locations, and coordinate with templates.

C. Sub-contract the furnishing of builders hardware to a recognized local builders hardware representative for the lockset being furnished. The local hardware supplier must have been furnishing builders hardware for a period of not less than 5 years and must have 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 owner or Architect. The hardware supplier must carry a substantial inventory of the type and make of the lockset, closer, exit device, etc. being furnished. This inventory must be made available to the owner during the duration of this Contract and for maintenance purposes.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General

1. Products are listed in a brand name only to establish a standard of quality.

B. Lock and latches:

1. Corbin/Russwin

2. Best

3. Sargent

C. Door Closers:

1. Corbin/Russwin.

2. Dorma.

D. Manufacturers of other items:

1. Butts: Hager, Stanley or McKinney.

2. Exit Devices: Corbin/Russwin.

3. Floor Closers & Pivots: Dorma, Rixon, McKinney.

4. Overhead Door Holders: Corbin/Russwin, Sargent.

5. Door Pulls: Rockwood, Trimco, Hager.

6. Protective Plates: Rockwood, Trimco, Hager.

7. Bolts: Rockwood, Trimco, Hager.

8. Stops: Rockwood, Trimco, Hager.

9. Electric Strikes: Folger Adam, H.E.S.

10. Thresholds & Weatherstripping: Pemko, National Guard.

2.2 MATERIALS

A. Furnish each category with the products of only one (1) manufacturer; this requirement is mandatory whether various manufacturers are listed or not.

B. Hinges: Furnish one pair of hinges for doors up to 60 inches in height and one additional hinge for each additional 30 inches or fraction thereof. Use 3.5 inch hinges for all 1 3/8 inch thick swing doors. Use 4.5 inch hinges for all 1 3/4 inch thick swing doors up to 36 inches in width. Use 5.0 inch hinges for doors up to 42 inches and 5.0 inch heavy duty hinges for doors over 42 inches in width. Furnish nonremovable pins (NRP) at all reverse bevel doors with keysets.

Furnish wide or special throw hinges where required to clear trims at all swing doors.

Type	Hager	Stanley	McKinney	ANSI
H-1	PB191	1191	F191	T2314	A-2133
H-2	BB191	BB1191	BB191	TB2314	A-5133

C. Flush Bolts: Furnish with 12 inch rods for doors up to six feet high, and with 24 inch rods for doors higher than six feet. Provide two bolts per inactive leaf.

Type	Rockwood	Trimco	Hager
B-1	555	3917	282D
B-2	556	3916	283D

D. Locksets and Latchsets

1. Heavy Duty cylindrical series and function designations for handicapped unit are ANSI, acceptable manufacturers are:

Manufacturer	Series	Design
Corbin/Russwin	CL3300	NZD
Best	9K	15D
Sargent	10	LL

2. Heavy Duty cylindrical series and function designations are ANSI, acceptable manufacturers are:

Manufacturer	Series	Design
Corbin/Russwin	CK4200	GWC
Best	8K	4E
Sargent	9	OB

3. Standard Duty cylindrical series and function designations for handicapped unit are ANSI, acceptable manufacturers are:

Manufacturer	Series	Design

Corbin/Russwin	CL3700	NZD
Best	6K	15D
Sargent	65	LL

4. Standard Duty cylindrical series and function designations are ANSI, acceptable manufacturers are:

Manufacturer	Series	Design
Corbin/Russwin	CK4700	GWC
Best	6K	4E
Sargent	6	OB

5. Cylindrical Deadlocks series and function designations are ANSI, acceptable manufacturers are:

Manufacturer	Series
Corbin/Russwin	DL2000
Best	83T
Sargent	480

6. Padlocks shall have an extruded brass 2" case with 2 5/8" brass shackle, acceptable manufacturers are:

Manufacturer	Series
Corbin/Russwin	PD51
Best	11B772
Sargent	756H

E. Exit Devices: Series and function designations are ANSI, acceptable manufacturers are:

Manufacturer	Series	Design
Corbin/Russwin	ED5000	NZD

F. Closers:

1. Qualities: Fully hydraulic, full rack and pinion action with a high strength cast iron cylinder body. Furnish complete with full covers (when not concealed), forged steel arms, necessary brackets and fasteners. Concealed mounting on all hollow metal doors except on reverse bevel doors, where parallel mount shall be used. Furnish other scheduled accessories. Provide non-handed, non-sized closers at doors requiring handicapped access, adjustable to comply with handicapped opening force requirements. Size closers in accordance with manufacturers directions.

Type	Manufacturer	Series	Arm	ANSI
C-1	Corbin/Russwin	DC3210	Parallel	CO20 21
C-2	Corbin/Russwin	DC3200	Regular	CO20 11

G. Push and Pull Hardware:

1. Flush Pulls: Overall size 3 7/8"x 4 1/2", Base 3 3/8" x 4", depth 7/8" in stainless steel.

2. Push Plates: Plain design, with wrought plate 4"x 16"x 0.050", square corners, beveled edges.

Type	Manufacturer	Model
J300	Trimco	1001-3
J300	Hager	30S.
J303	Trimco	1820.
J303	Hager	120L.

H. Kick Plate: Furnish 10 inches x 0.050 inch x door width less 1 1/2 inches at single doors, and less 1 inch at pairs. Where glass or louver prevent this height, supply with height equal to height of bottom rail less 1 inch. On fire rated openings, height of plate shall not exceed 6 inches. Acceptable manufacturers are Hager and Trimco.

I. Armor Plates: Furnish 34 inches x 0.050 inches x door

width less 3 inches. Install prior to exit devices. Bevel top edges. Drill and countersink screw holes for oval head undercut screws. Acceptable manufacturers Rockwood,Hager and Trimco.

J. Wall Stops: ANSI LO2021. Acceptable manufacturers Rockwood, Hager and Trimco. Provide one per door leaf that has a wall at 90 degree or less of its opening path.

K. Wall Stop/Holder: ANSI LO1291 as manufactured by TRIMCO, Hager and Glynn-Johnson. Provide one per door leaf that has a wall at 90 degree or less of its opening path.

L. Weatherstripping: Apply to head and jamb stops with no cuouts for stop applied hardware.

1. Pemko S88D.

2. Pemko 322 (At sound retardant openings).

M. Thresholds: Cope at jambs. Furnish full wall opening width when frames are recessed.

1. Pemko 171.

2. Pemko 277 (At sound retardant openings).

N. Automatic Door Bottom Seals: Shall be fully mortised on door.

1. Pemko 434AR.

O. Rain Drip: Furnish wall opening width.

1. Pemko 347 x 68AR.

P. Electric Strike: Shall be H.E.S. model 5000 x 24 VAC x US28. Operated from remote reception desk by Push Button PB-7.

2.3 LABEL REQUIREMENTS

A. Furnish Underwriters Laboratories, Inc. approved

hardware items, meeting requirements of NFPA 80, at doors scheduled to be label doors.

2.4 FINISHES

A. Butts and Pivots: 626.

B. Locksets, Deadlock and Latches: 626 (Except MS1852-628).

C. Exit Devices: 630.

D. Closers: Sprayed aluminum to match;626 on Floor Type.

E. Pulls & Plates: 630.

F. Stops/Holders: 626.

G. Thresholds: 628.

H. Flush Bolts: 626.

2.5 KEYING

A. Key, masterkey and grandmaster key in accordance with owner's requirements and approved keying schedule. Furnish 2 change keys for each lock, 10 masterkeys and 2 grandmaster keys.

B. Provide cylinders of the removable core type.Core to be removed with the use of a control key that does not require the lock to be unassembled.Provide temporary construction cores to be used during the construction phase.

C. All cylinders shall be of the high security type with interlocking pins and skew-cut key bitting.

D. Furnish a complete key control system that provides tags for each individual change key and a key cabinet that will hold 150% of the key capacity of the entire project.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine door frames and related items for conditions that would prevent proper application of hardware.

B. Do not proceed until defects are corrected, with approval obtained from owner or his designated representative.

3.2 INSTALLATION

A. Install hardware according to manufacturer's printed instructions and to template dimensions. See Article 1.6 - Product Delivery and Storage regarding conversion of construction cores to final cores.

B. All hardware shall be installed by experienced workmen and left in perfect working condition. Any hardware lost or damaged shall be replaced at no additional cost to the owner.

3.3 LOCATIONS

A. Dimensions are from finish floor to center line of items.

B. This list to be included in Hardware Schedule:

Category	Dimension
Hinges	Door manufacturer stdr.
Flush Bolt Levers	72 inches and 12 inches
Knobs	Door manufacturer stdr.
Exit Device Crossbars	Manufacturer's Template
Push Plates	52inches
Pull Plates	42 inches
Wall Stops	At Head.

3.4 FINAL ADJUSTMENT

A. Provide the services of a representative to inspect material furnished and its installation and adjustment, to make final hardware adjustment, and to instruct the Owner's personnel in adjustment, care and maintenance of the hardware.

KEYING SYSTEM

PROVIDE XC PROPRAITORY CYLINDERS AND KEYS PROTECTED FROM UNAUTHORIZED MANUFACTURE AND DISTRIBUTION BY MANUFACTURER'S UNITED STATES PATENTS.

VERIFY WITH OWNER KEYING SYSTEM.

ALL LOCKS MASTER KEY & CONSTRUCTION KEY 3 KEYS PER LOCK
2 MASTERS KEYS
10 CONSTRUCTION KEYS
FINAL KEY LAY OUT AS PER ARCHITECTS AND/OR OWNER INSTRUCTIONS.
IN PLACES WERE DOORS DO NOT COME IN CONTACT WITH THE WALL
REPLACE WALL STOPS WITH FLOOR ONES, VERIFY WITH ARCHITECT.

APROVED MANUFACTURERS:

1. HINGES - MCKINNEY, HAGER.
2. LOCKS - SARGENT, CORBIN-RUSSWIN.
3. EXIT DEVICES - SARGEN, VON DUPRIN
4. CLOSERS - SARGENT, DORMA, NORTON
5. MISSELANOUS - TRIMCO, ROCKWOOD, IVES, BALDWIN
6. WEATHERSTRIPING - PEMKO, ZERO, REES, NATIONAL GUARD

OTHER MANUFACTURERS COULD BE APPROVED IF REQUEST IS SUBMITTED 15 DAYS PRIOR TO BID.

REGULATORY REQUIREMENTS:

A. CONFORM TO ALL APPLICABLE CODES FOR FIRE RATED DOORS AND FRAMES.

B. CONFORM TO THE APPLICABLE SECTIONS OF CHAPTER 5 OF NFPA 101.

C. CONFORM TO ANSI A117.1 FOR HARDWARE LOCATIONS AND REQUIREMENTS TC MEET ALL HANDICAPPED CODES AND MEET TITLE III PROVISIONS OF THE AMERICAN WITH DISABILITIES ACT.

D. QUANTITIES SHOWN ON THE SCHEDULE ARE FOR REFERENCE ONLY, FINAL COUNT IS BIDDERS RESPONSIBILITY. BIDDERS SHOULD VERIFY FLOOR PLANS AND DOORS SCHEDULE TO DETERMINE FINAL QUANTITIES.

REFERENCES:

MCK = MCKINNEY MFG COMP.	(BUTT HINGES)
SAR = SARGENT & COMP.	(LOCKSETS, EXITS, CLOSERS,)
TRI = TRIANGLE BRASS MANF.	(PUSH, PULL, BOLTS, STOPS,)
PEM = PEMKO.	(WEATHERSTRIPING)
KCS = KEY CONTROLS SYSTEM INC.	(KEY CABINETS)

END OF SECTION 08 71 00

SECTION 08520

ALUMINUM JALOUSIES WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes operable aluminum jalousies windows for exterior locations, as indicated on drawings

1.3 DEFINITIONS

A. Performance class designations shall be in accordance to AAMA/WDMA 101/I.S.2/NAFS:

1. AW: Architectural
2. HC: Heavy Commercial
3. C: Commercial
4. LC: Light Commercial
5. R: Residential

B. Performance grade number shall be in accordance to AAMA/WDMA 101/I.S.2/NAFS:

1. Design pressure number in pounds force per square foot (*pascal*) used to determine the structural test pressure and water test pressure.

C. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.

D. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of minimum test size indicated below:

1. Size indicated on drawings.

B. Structural Performance: Provide aluminum windows capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:

1. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure", based on mean roof heights above grade indicated on Drawings.

    a. Basic Wind Speed: 120 mph (53.3 m/s).

C. Windborne-Debris Resistance: Provide aluminum windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing aluminum windows identical to those specified, according to the latest ASTM code and requirements of authorities having jurisdiction.

D. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 ºF (67 ºC), ambient; 180 ºF (100 ºC) material surfaces.

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, and fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:

1. Mullion details, including reinforcement and stiffeners.
2. Joinery details.
3. Expansion provisions.
4. Flashing and drainage details.
5. Weather-stripping details.
6. Thermal-break details.
7. Window System Operators: Show locations, mounting, and details for installing operator components and controls.

C. Samples for Initial Selection: for units with factory-applied color finishes.

1. Include similar samples of hardware and accessories involving color selection.

D. Samples for Verification; for aluminum windows and components required, prepared on Samples of size indicated below.

1. Operable Window: Full-size unit with factory-applied finish.
2. Hardware: Full-size units with factory-applied finishes.
3. Weather Stripping.

E. Product Schedule: for aluminum windows. Use same designations indicated on Drawings.

F. Warranty: Special Warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1. Installer's responsibilities include providing professional engineering services needed to assume engineering responsibility.

2. Engineering Responsibility: Preparation of data for aluminum windows, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

C. Source Limitations: Obtain aluminum windows through one source form a single manufacturer.

D. Products Options: Information on Drawings and in Specifications establishes requirements for aluminum windows; aesthetic effects and performance characteristics. Aesthetic effects area indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fall in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
c. Faulty operation of movable sash and hardware.
d. Deterioration of metals, other materials, and metal finishes beyond normal weathering.

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. Valcor / Samcor
2. *Air Master* Manufacturing Corp.
3. Tamcor Corp.
4. Submit local manufacturer for approval.

2.2 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 24,000-psi (165-MPa) ultimate tensile strength, not less than 16,000-psi (110-MPa) minimum yield strength, and not less than 0.062-inch (1.6-mm) thickness at any location for the main frame and sash members.

B. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

1. Reinforcement: Where fasteners screw anchor into aluminum less than 0.125 inch (3.2 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.

2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application.

C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe serviced conditions; provide sufficient strength to withstand design pressure indicated.

E. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when aluminum window is closed.

1. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.

F. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.

G. Replaceable Weather Seals: Comply with AAAMA 701/702.

H. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

2.3 WINDOW

A. Window Type: As indicated on Construction Documents.

B. AAMA/WDMA Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS.

C. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.

D. Thermal Transmittance: Provide aluminum windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to ASTM E 1423.

E. Solar Heat-Gain Coefficient (SHGC): Provide aluminum windows with a whole-window SHGC maximum of 0.55, determined according to NFRC 200 procedures.

F. Sound Transmission Class (STC): Provide aluminum windows rated for not less than 35 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

G. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.

H. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.

I. Forced-Entry Resistance: Comply with Performance Grade 40 requirements when tested according to ASTM F 588.

2.4 BLADES

A. Louver Blades: Louver blades shall be approved equal to standard factory-installed aluminum blades system from *Titanica* window, model 600A, thickness of 0.062", manufactured by *Valcor / Samcor*. Blade system must produces weather-tight seal and complies with requirements for windborne-debris resistance and all aforementioned requirements for this project.

2.5 HARDWARE

A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals.

B. Counterbalancing Mechanism: Comply with AAMA 902.

C. Sill Cap/Track: Extruded-aluminum track with natural anodized finish, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

D. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.

E. Roller Assemblies: Low-friction design.

F. Butterfly-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.

1. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.

G. Four-or Six-Bar Friction Hinges ("projected Out-Swing" windows): Comply with AAMA 904.

1. Locking mechanism and handles for manual operation.

H. Limit Devices: Provide limit devices designed to restrict sash or ventilator opening.

I. Pole Operators (where applies): Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.

2.6 INSECT SCREENS

A. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully

integrate with window frame. Locate screens on inside of window and provide for each operable exterior sash or ventilator.

B. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Extruded-Aluminum or Aluminum Tubular Framing Sections and Cross Braces: Not less than 0.040-inch (1.0-mm) wall thickness.
2. Finish: Match aluminum window members.

C. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch-(0.28-mm-) diameter, coated aluminum wire.

2.7 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

1. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
3. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame or vent sash.

C. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.

D. Weep Holes: provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

F. Sub-frames (where applies): Provide sub-frames with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062 inch (1.6 mm) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide sub-frames capable of withstanding design loads of window units.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weather-tight window installation.

1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather-tight construction.

D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502, by applying same test pressures required to determine compliance with AAMA/WDMA 101/I.S.2/NAFS in Part 1 "Performance Requirements" Article.
2. Test Reports: Shall be prepared according to AAMA 502.

C. Remove and replace non-complying aluminum window and retest as specified above.

4.4 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and ventilators, screens, hardware, operators, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather-tight closure. Lubricate hardware and moving parts.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, dirt, and other substances.

C. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08520

SECTION 08800 - GLAZING

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 glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

E. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of

sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gains and nighttime-sky heat loss.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: For the following products, in the form of 12-inch- (300-mm-) square Samples for glass and of 12-inch- (300-mm-) long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

C. Samples: For the following products, in the form of 12-inch- (300-mm-) square Samples for glass.

1. Each color of laminated glass.
2. Each type of patterned glass.

D. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

E. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

F. Qualification Data: For installers.

G. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

H. Product Test Reports: For each of the following types of glazing products:

1. Laminated glass.
2. Coated float glass.

I. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type.

C. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
   1. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

   1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

   1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Product: Subject to compliance with requirements, provide product specified.
4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
5. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
6. Basis-of-Design Product: The design for each glazing product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 GLASS PRODUCTS

A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

1. Ultra-Clear (Low-Iron) Float Glass: Class I (clear); with a minimum 91 percent visible light transmission and a minimum solar heat gain coefficient of 0.87.

a. Products:

1) AFG Industries Inc.; Krystal Klear.
2) Pilkington Building Products North America; Optiwhite.
3) PPG Industries, Inc.; Starphire.
4) Schott Corporation; Amiran.

B. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:

1. Interlayer: Polyvinyl butyl of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lutes and installation.

a. For polyvinyl butyl interlayers, laminate lutes in autoclave with heat plus pressure.

2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.
3. Glass Products.

2.3 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. Neoprene, ASTM C 864.
2. EPDM, ASTM C 864.
3. Silicone, ASTM C 1115.
4. Thermoplastic polyolefin rubber, ASTM C 1115.
5. Any material indicated above.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:

1. Neoprene.
2. EPDM.
3. Silicone.
4. Thermoplastic polyolefin rubber.
5. Any material indicated above.

C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.4 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lutes in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lutes in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, square-ness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lutes.

G. Provide spacers for glass lutes where length plus width is larger than 50 inches (1270 mm) as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lutes from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lutes in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lutes in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lutes in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weather-tight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lutes and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 LOCK-STRIP GASKET GLAZING

A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.8 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08800

SECTION 09 29 00

GYPSUM WALLBOARD

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

1. The work included in this Section consists of furnishing all labor, materials, and equipment required for the installation of gypsum partitions and wall furring as shown on drawings and specified herein.

2. Related work described elsewhere:

    1. Unit masonry works (Section 04810)
    2. Painting (Section 09900)

1.2 SUBMITTALS

1. Contractor shall submit for the Architect's approval a complete set of shop drawings of each type of assembly.

PART 2 - PRODUCTS

2.1 PRODUCT DELIVERY, STORAGE AND HANDLING

1. All materials shall be delivered in their original unopened packages and stored in an enclosed shelter providing protection from damage and exposure to the elements. Damaged or deteriorated materials shall be removed from the premises.

2.2 PRODUCTS

1. MANUFACTURERS:

    a. US Gypsum, Co.
    b. Gold Bond
    c. Georgia Pacific

2. All materials shall be installed in strict accordance to manufacturer's recommendations. Materials specified herein as reference is from United States Gypsum Company.

    a. Gypsum panels shall be "Firecode C" Sheetrock panels ½" inch thick with square edges, 48 inches wide by 96 inches high (minimum).

    b. Corner reinforcement shall be Dura-A-Bead.

    c. Control joints shall be No. 093.

d. Casing beads shall be series 200.

e. Metal Studs shall be Style CWS, 20 gauge, 3-5/8 inches deep or as called for on drawings.

f. Metal Runners shall be Style CWS, 20 gauge, 3-5/8 inches deep or as called for on drawings.

g. Furring Channels shall be "Z" furring channels, 1-½ inches deep.

h. Joint treatment shall be Perf-A-Tape and All-Purpose Joint Compound.

i. Screws shall be type "S", length as required.

j. Insulation, where called for on drawings, shall be USG "Thermatfiber", 3 inches thick, for gypsum partitions and Owens-Corning 703 "Semi-Rigid Insulation Board", 1-½ inches thick, for gypsum wall furring.

PART 3 - EXECUTION

3.1 For Gypsum Partitions

1. Attach metal runners at floor and to structural elements above with suitable fasteners located 2 inches from each end and spaced 24 inches on center. Position studs vertically, engaging floor and ceiling runners and spaced 24" on center. When necessary, splice studs with 8 inches nested lap and one (1) positive attachment per stud flange. Place studs in direct contact with all door and window frame jambs, abutting partitions, partition corners and existing construction elements. Anchor all studs adjacent to door and window frames, partition intersections, and corners to ceiling and floor runner flanges with fastener tool. Securely anchor studs to jamb and head anchor clips of door by bold or screw attachment. Over doors and windows place horizontally a cut-to-length section of runner, with a web flange bend at each end, and secure with one (1) positive attachment per flange. Position a cut-to-length stud (extending to top runner) at vertical panel joints over door frame header.

2. Apply gypsum panels (parallel to studs). Position all edges over studs for parallel application. Use maximum practical lengths to minimize end joints. Fit ends and edges closely, but not forced together. Stagger joints on opposite sides of partition.

3. Space screws 12 inches O.C. to studs at joints and runners and 8 inches O.C. to studs in field (fire-rated fastening).

4. Power drive with an electric screwdriver so screw heads provide a slight depression below surface of gypsum panels without breaking face paper. Do not drive screws closer than 3/8 inches from edges and ends of board.

5. Apply joint treatment as per manufacturer's recommendations.

3.2 For Gypsum Wall Furring

1. Erect insulation and hold in place with 2 furring channels spaced 24 inches on centers.

2. Except at exterior corners attach narrow flanges of furring channels with concrete stub nails or power driven fasteners spaced 24 inches on centers.

3. At exterior corners attach wide flange of furring channels to wall with short flange extending beyond corner; start furring channel with a 3 inches strip of insulation followed by furring channels in the normal manner.

4. At interior corners, space second channel no more than 12 inches from corner and curt insulation to fit.

5. Hold insulation in plane until gypsum board panels are installed with 10 inches long staple field fabricated from 18 gauge tie wire and inserted through slot in channel.

6. Apply treated wood blocking around window and door openings and as required for attachment and support of fixtures and furnishings.

7. Apply gypsum panels parallel to channels, use maximum practical lengths. Fit ends closely but not forced together.

8. Space screws 16 inches O.C. in field of panels and along abutting edges.

9. Power drive with an electric screwdriver so screw heads provide a slight depression below surface of gypsum panels without breaking face paper. Do not drive screws closer than 3/8 inch from edges and ends of board.

10. Apply joint treatment as per manufacturer's recommendations.

3.3 Clean Up

1. At the completion of the work, remove all rubbish, excess material, scaffolding, tools and equipment from the building, leaving floors broom clean, and ready for the work of other trades.

END OF SECTION 09 29 00

SECTION 09 65 33

RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Provide vinyl tile flooring, vinyl bases and an underlayment for the leveling of concrete floors as required and as specified herein and shown on drawings.

B. Related work described elsewhere:

1. Cast-in-Place Concrete Section 03 33 00.

1.2 QUALITY ASSURANCE

A. Manufacturer:

Provide each type of resilient flooring and accessories as produced by a single manufacturer, including recommended primers, adhesives and leveling compounds.

B. Installer's Qualifications:

Engage Installer who is trained and experienced for the installation of this work. No allowance will be made for lack of skill on the part of the tile installer.

C. Product Specification Requirements:

Vinyl floor tile shall conform to Federal Specification SS-T-312B and NFPA 99.

1.3 SUBMITTALS

A. Product Data:

Submit manufacturer's technical data for each type of resilient flooring and accessories.

B. Samples:

Submit manufacturer's color charts in form of actual sections of resilient flooring, including accessories, showing full range of colors and patterns available, for each type of resilient flooring required.

C. Certification:

Installer shall submit certification that substrate has been properly prepared for receiving the installation of the resilient flooring.

1.4 EXTRA MATERIALS

A. Furnish not less than one box for each 25 boxes or fraction thereof, for each type, color, pattern and size installed. Materials shall be from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identifying labels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Armstrong World Industries

B. Amtico International

C. Substitutions: As per approved substitution by Architect.

2.2. VINYL COMPOSITION TILE FLOORING

A. Provide vinyl composition tile Type IV, asbestos free. Class 1 with a flame spread less than 0.75.

B. Tile Size: 1/8 inch x 12 inches x 12 inches.

C. Armstrong excelon imperial texture.

2.3 VINYL COMPOSITION TILE ACCESSORIES

A. Vinyl Wall Base:

Provide vinyl cove base with matching end stops and preformed or molded corner units. Base shall be 0.085 gauge and 4 inches in height (or as otherwise shown on the drawings). Base shall bought in 100 foot length rolls only. Color to be selected by Architect.

B. Concrete Slab Primer:

Non-staining type as recommended by flooring manufacturer.

C. Leveling and Patching Compounds:

Use fast-setting underlayment as recommended Flooring Manufacturer for leveling of concrete floors.

D. Adhesives:

Use as recommended by flooring manufacturer to suit material and substrate conditions.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer shall inspect subfloor surfaces to determine that they are satisfactory. As satisfactory subfloor surface is defined as one that is smooth, free from cracks, holes, ridges, coatings preventing adhesive bonds and other defects impairing performance or appearance. Do not allow resilient flooring work to proceed until subfloor surfaces are satisfactory. Starting of work will be construed as Installer's acceptance of subfloor surfaces within any particular area.

3.2 PREPARATION

A. Use the underlayment at the entire floor area is necessary for levelling the concrete floors. Apply in single layer and assume a minimum thickness of 1/16 inch and a maximum thickness of ¼ levelling.

B. Concrete floor surface should be clean and free of dirt, oil, grease, plaster, curing compounds and other foreign matter. Concrete floor must be sufficiently cured and free of excessive moisture or hydrostatic pressure. Dampen concrete floors with clean water. Do not leave standing puddles or water. Apply underlayment while floor is still damp with. Allow to dry before underlayment is applied.

C. Apply sufficient pressure to the underlayment with the trowel to secure adequate bonding to the cleaned, damp-mopped.

D. Apply adhesive in compliance with manufacturer's instructions.

3.3 INSTALLATION

A. Install resilient flooring in strict compliance with manufacturer's printed instructions. Extend resilient flooring into toe spaces, door reveals and into closets and similar openings.

B. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room area of equal width. Adjust as necessary to avoid use of cut widths less than ½ tile at room perimeters. Lay tile with grain running in one direction and square to room axis, unless otherwise indicated.

C. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged if so numbered.

D. Cut tile neatly around all fixtures. Broken, cracked, chipped, or deformed tiles are not acceptable.

E. Adhere tile flooring to substrate using full spread of adhesive applied in compliance with flooring manufacturer's instructions.

3.4 INSTALLATION OF ACCESSORIES

A. Apply wall base to walls, columns, casework and other permanent fixtures in rooms or areas where base is required.

B. When possible install base of same length as wall so as to minimize joints with preformed corner units.

C. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.

3.5 CLEANING AND PROTECTION

A. Clean floors using appropriate cleaner recommended by manufacturer.

B. Do not wash or wax floor until time period recommended by resilient flooring manufacturer has elapsed to allow resilient flooring to become well-sealed in adhesive.

C. Remove any excess adhesive or other surface blemishes, using appropriate cleaner recommended by resilient flooring manufacturers.

D. Protect flooring against damage during construction period.

E. Clean and wax resilient flooring.

END OF SECTION 09 65 33

SECTION 09180 – CEMENT PLASTER

1. RELATED DOCUMENTS:

   The general provisions of the contract including General and Special Conditions, apply to the work specified in this section.

2. DESCRIPTION OF WORK:

   The extent of the Portland cement plaster work is shown on the drawings.

3. GENERAL:

   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.

   Warm Weather Requirements:

   Protect plaster against uneven and excessive evaporation and from strong blasts of dry air, both natural and artificial. Apply and cure plaster as require 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.

   Ventilation Requirements:

   Provide natural or mechanical means of ventilation to properly dry interior plaster during and after application.

   Sample Installation:

   Prior to installation of plaster work, plaster sample section of each type of plaster required for approval of the P.B.A. Demonstrate the proposed range of texture, workmanship, and color if required, to be expected in the complete work.

SECTION 09180 – CEMENT PLASTER

4. MATERIALS:

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.

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. 16 Sieve – 10 to 40%, No. 30 Sieve – 30 to 65%, No. Sieve – 95 to 100%.

Portland Cement:

ASTM C 150, Type I color gray unless otherwise called for by the finish schedule.

5. INSTALLATION:

General Requirements:

Contractor must examine all surfaces which are to receive plaster and all grounds and other accessories which act as grounds or screeds, and shall notify the P.B.A. in writing, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the plaster work until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor.

Protect continuous work from rusting or soiling as a result of plastering operations.

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 form impurities which might impair the plaster work.

Hand apply plaster to the specified thickness. Machine application of plaster will not be allowed, except where sprayed-on plaster is specified.

SECTION 09180 – CEMENT PLASTER

INSTALLATION: (CONT.)

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.

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.

Wherever a masonry wall abuts or adjoins the concrete framework, tool plaster to produce a "V" joint.

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, discoloration, projections, 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.

Plaster Proportions: (By volume)

Sand	5 ¾	parts
Lime	1	part
Cement	1 1/3	parts

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 cementitious material. Use goat, cattle or deer hair or pure manila fiber, ½"to 2" long, free from grease, oil, dirt and other impurities.

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.

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.

SECTION 09180 – CEMENT PLASTER

INSTALLATION: (CONT.)

Plaster over Metal Lath:

Apply 3 – coat plaster over all metal lath, with or without solid backing. Apply first (scratch) coat not less than ½" thick and second (brown) basecoat not less than ¼" thick.

Measure thickness of plaster from backplane of metal lath (exclusive of ribs of dimples), except if metal lath is applied over solid base, and measure from face of solid backing.

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.

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.

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 san float finish.

Plaster over Concrete or Masonry:

Surfaces shall be free of loose or deteriorated areas, clean and free of dust, loose particles, and foreign matter.

Apply bonding agent to concrete surfaces prior to application of plaster, in accordance with manufacturer's instructions.

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.

Moisture Retention Requirements:

Dampen bases, if required, for proper suction. Do not saturate bases and do not apply plaster until visible surface water disappears.

SECTION 09180 – CEMENT PLASTER

INSTALLATION: (CONT.)

Moisture Retention Requirements: (Cont.)

Dampen previous plaster coats which have dried out prior to time for applications of next coat. Dampen with water as required for uniform suction.

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:

Cut, parch, repair, and point-up plaster as required and as directed by the P.B.A. Repair cracks and indented surfaces by moistening plaster and filling with new material, troweled or tamped flush with adjoining surfaces. Point-up finish plaster surfaces around items which are built into or penetrate plaster surfaces.

7. CLEANING AND PROTECTION:

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.

Contractor shall be aware of requirements for protection of plaster from deterioration and damage until time of acceptance of the work.

END OF SECTION

SECTION 09900

PAINTING

1. RELATED DOCUMENTS

The general provisions of the contract, including General and Special Conditions apply to the work specified in this section.

2. DESCRIPTION OF WORK

This work includes the painting and finishing of all interior and exterior exposed items and surfaces throughout the project, expect as herein specified. Surface preparation, priming and coats of paint specified are in addition to shop priming and surface treatment specified under other sections, except as otherwise specified.

The work includes the field painting of all bare and covered pipes (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under the mechanical and electrical work, except as otherwise specified.

The "paint" as used herein means all coating systems materials which includes primers, emulsions, enamels, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

Paint all exposed surfaces no matter which colors are designated in any "schedule", except where the natural finish of the material is obviously intended and specifically noted as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint these same as adjacent similar materials or areas. If color or finish is not designated, the Architect will select these from standard colors available.

3. PAINTING NOT INCLUDED

The following categories of work are not included as part of the painter-applied finish work, or are included in other sections of these specifications, unless otherwise shown or specified.

a. Shop Priming

Unless otherwise specified, shop priming of ferrous metal items is included under the various sections for structural steel, miscellaneous metal items, hollow metal work, and similar items, as well as fabricated components, such as architectural woodwork, wood casework, and shop fabricated, or factory built mechanical and electrical equipment or accessories.

b. Pre-Finished Items

Unless otherwise indicated, do not include painting when factory finishing is specified for such items as (but not limited to) metal toilet enclosure, acoustic materials, architectural woodwork, and casework, finished mechanical and electrical equipment including light fixtures, switchgear and distribution cabinets, doors, and equipment.

c. Concealed Surfaces

Unless otherwise indicated, painting is not required or wall or ceiling surfaces in concealed areas and inaccessible areas, such as foundation spaces, furred areas, pipe spaces, duct shafts, as applicable to this project. Do not paint copper pipe, zinc-coated pipe, and zinc-coated ducts under insulation. Do not paint zinc-coated and copper pipe in concealed spaces.

d. Finished Metal Surfaces

Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze, and similar finished materials will not require finish painting, except as otherwise specified.

e. Operating Parts and Labels

Do not paint any moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sink-ages, sensing devices, motor, and fan shafts, unless otherwise indicated. Do not paint over any code-required labels, such as Underwriters Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

4. GENERAL

a. Site Conditions

Starting of painting work will be construed as the Applicator's acceptance of the surfaces within any area. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film.

b. Atmospheric Conditions

Exterior paint shall not be applied when the temperature of the surface is below 45 degrees Fahrenheit or above 95 degrees Fahrenheit unless otherwise directed. Interior paint may be applied at any time, provided the surfaces to be painted are dry and the temperature can be kept above 45 degrees Fahrenheit during the application of ordinary paints, and between 65 degrees Fahrenheit and 95 degrees Fahrenheit during the application of enamels and varnishes. Paint shall not be applied during foggy or rainy weather or when, in the opinion of the PBA, the surfaces are not in proper condition for painting.

c. Delivery and Storage

Deliver all materials to the job site in original, new, and unopened packages and containers bearing manufacturer's name and label, and application instructions thereon.

d. Protection

Protect work of other trades, whether to be painted or not, against damage by the painting and finishing work. Leave all such work undamaged. Correct any damages by cleaning, repairing, or replacing, and repainting, as directed by the PBA. Provide “Wet Paint” signs as required to protect newly painted finishes. Remove temporary protective wrappings after completion of painting operations.

e. Clean Up

During the progress of the work, remove from the project all discarded paint materials, rubbish, cans, and rags. Upon completion of painting work, clean all paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

f. Colors

Prior to beginning work, the PBA will furnish a color schedule to the Contractor.

5. MATERIAL – PAINT TECHNICAL DATA:

All proposed paint products and its respective complements (primers, sealers, etc.) to be applied on all project's exposed surfaces (interior and exterior) must be submitted by Contractor for PBA approval. Such products must comply with the following characteristics and parameters:

PRODUCT No.	PRODUCT	SPECIFICATIONS
1	100% Acrylic Flat Exterior Paint	• Product Type: 100% Acrylic • Percent of Solid by Weight: 54% ± 2% • Percent of Solid by Volume: 36% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal. • Recommended Film Dry Thickness: 1.5 mils • Viscosity (KU): ≥ 105 Krebs Units (KU) • Drying Time to Touch (Hr.); No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 4 Hours • Percent of Pigments by Weight: 38% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: <1 g/L
2	100% Acrylic Flat Interior Paint	• Product Type: 100% Acrylic • Percent of Solid by Weight: 56% ± 2% • Percent of Solid by Volume: 38% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal. • Recommended Film Dry Thickness: 1.5 mils • Viscosity (KU): ≥ 110 Krebs Units (KU) • Drying Time to Touch (Hr.); No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 4 Hours • Percent of Pigments by Weight: 41% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: <1 g/L

• MATERIAL - PAINT TECHNICAL DATA (Cont.'):		
PRODUCT No.	**PRODUCT**	**SPECIFICATIONS**
3	Satin Acrylic Paint	• Product Type: Acrylic Resin • Percent of Solid by Weight: 52% ± 2% • Percent of Solid by Volume: 38% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal. • Recommended Film Dry Thickness: 1.5 mils • Viscosity (KU): ≥ 105 Krebs Units (KU) • Drying Time to Touch (Hr.); No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 4 Hours • Percent of Pigments by Weight: 29% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: <100 g/L
4	Acrylic Semi-Gloss Interior Paint	• Product Type: 100% Acrylic • Percent of Solid by Weight: 49% ± 2% • Percent of Solid by Volume: 36% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal. • Recommended Film Dry Thickness: 1.4 mils • Viscosity (KU): ≥ 110 Krebs Units (KU) • Drying Time to Touch (Hr.); No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 4 Hours • Percent of Pigments by Weight: 25.9% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: <50 g/L

• **MATERIAL - PAINT TECHNICAL DATA (Cont.'):**		
PRODUCT No.	**PRODUCT**	**SPECIFICATIONS**
5	**Enamel Paint for Metals**	• **Product Type: Alkyd Oil Resin** • **Percent of Solid by Weight: 67% ± 2%** • **Percent of Solid by Volume: 51% ± 2%** • **Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 450–500 sq. ft./gal.** • **Recommended Film Dry Thickness: 1.4 mils** • **Viscosity (KU): ≥ 70 Krebs Units (KU)** • **Drying Time to Touch (Hr.); No more than 1.5 Hours** • **Drying Time to Recoat (Hr.): No more than 8 Hours** • **Percent of Pigments by Weight: 28% ± 2%** • **Volatile Organic Compounds (VOC) - Grams/Liters: <400 g/L**
6	**Traffic Paint**	• **Product Type: Alkyd Resin** • **Percent of Solid by Weight: 67% ± 2%** • **Percent of Solid by Volume: 41% ± 2%** • **Coverage per Gallon at Recommended Film Thickness (Range – Ln. Ft.): 350 linear feet (4")** • **Recommended Film Dry Thickness: ≥3.0 mils** • **Viscosity (KU): ≥ 70 Krebs Units (KU)** • **Drying Time to Touch (Hr.): No more than 15 minutes** • **Drying Time to Recoat (Hr.): No more than 1 Hour** • **Percent of Pigments by Weight: 54% ± 2%** • **Volatile Organic Compounds (VOC) - Grams/Liters: ≤500 g/L**

• **MATERIAL - PAINT TECHNICAL DATA (Cont.'):**

PRODUCT No.	PRODUCT	SPECIFICATIONS
7	100% Acrylic Floor Paint	• Product Type: 100% Acrylic • Percent of Solid by Weight: 48% ± 2% • Percent of Solid by Volume: 33% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal. • Recommended Film Dry Thickness: 1.3 mils • Viscosity (KU): ≥ 70 Krebs Units (KU) • Drying Time to Touch (Hr.); No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 4 Hours • Percent of Pigments by Weight: 29% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: ≤200 g/L
8	Primer Change on Base Coat from Oil to Satin or Flat	• Product Type: 100% Acrylic • Percent of Solid by Weight: 53% ± 2% • Percent of Solid by Volume: 36% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal • Recommended Film Dry Thickness: 1.4 mils • Viscosity (KU): ≥ 95 Krebs Units (KU) • Drying Time to Touch (Hr.): No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 2 Hours • Percent of Pigments by Weight: 35% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: ≤100 g/L

• MATERIAL - PAINT TECHNICAL DATA (Cont.'):		
PRODUCT No.	**PRODUCT**	**SPECIFICATIONS**
9	**Primer** Keeping Existing Base Coat (Flat to Flat)	• Product Type: 100% Acrylic • Percent of Solid by Weight: 49% ± 2% • Percent of Solid by Volume: 37% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 400–450 sq. ft./gal • Recommended Film Dry Thickness: 1.3 mils • Viscosity (KU): ≥ 85 Krebs Units (KU) • Drying Time to Touch (Hr.): No more than 1 Hour • Drying Time to Recoat (Hr.): No more than 2 Hours • Percent of Pigments by Weight: 24% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: ≤50 g/L
10	Primer for Galvanized Metals	• Product Type: Alkyd Resin • Percent of Solid by Weight: 60% ± 2% • Percent of Solid by Volume: 45% ± 2% • Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 500–550 sq. ft./gal. • Recommended Film Dry Thickness: 1.4 mils • Viscosity (KU): ≥ 68 Krebs Units (KU) • Drying Time to Touch (Hr.); No more than 15 minutes • Drying Time to Recoat (Hr.): No more than 6 Hours • Percent of Pigments by Weight: 45% ± 2% • Volatile Organic Compounds (VOC) - Grams/Liters: <500 g/L

• **MATERIAL - PAINT TECHNICAL DATA (Cont.'):**		
PRODUCT No.	**PRODUCT**	**SPECIFICATIONS**
11	**Paint for Metals (Acrylic Waterborne)**	• **Product Type: Acrylic** • **Percent of Solid by Weight: 51% ± 2%** • **Percent of Solid by Volume: 40% ± 2%** • **Coverage per Gallon at Recommended Film Thickness (Range – Sq. Ft.): 640 sq. ft./gal.@ 1 mil** • **Recommended Film Dry Thickness: 1.4 mils** • **Viscosity (KU): 85–90 Krebs Units (KU)** • **Drying Time to Touch (Hr.): 12–15 minutes** • **Drying Time to Recoat (Hr.): 2–4 Hours** • **Percent of Pigments by Weight: 22% ± 2%** • **Volatile Organic Compounds (VOC) - Grams/Liters: <200 g/L**

6. MATERIAL TESTING

The right is reserved by the PBA to engage the services of a testing laboratory to perform all necessary test to verify that the paint submitted for approval by the Contractor complies with the requirements of this specifications.

7. SURFACE PREPARATION

a. General

Perform all preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified.
Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish painted or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.

Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Provide cleaning solvents of low toxicity and a flash point more than 100º F. Program the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.

b. Cementitious Materials

Prepare cementitious surfaces of concrete, concrete block, cement plaster and cement-asbestos board to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze.

Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition by sponging the affected surfaces with a zinc sulphate solution of 2 lbs. zinc sulphate per gal. of water, or other acceptable method, before application of paint. Do not paint over surfaces where the moisture content exceeds 8% unless otherwise permitted in the manufacturer's printed directions.

c. Wood

Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooths those finished surfaces exposed to view, and dust off.

Prime, stain, or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, face, undersides, and backsides of such wood, including cabinets, counters, cases, paneling, etc. Seal tops and bottoms of wood doors with a heavy coat of varnish or equivalent sealer immediately upon delivery to job.

Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other approved sealer, before application of the priming coat.

After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sandpaper smooth when dried.

d. Ferrous Metals

Clean non-galvanized, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with SSPC recommendations.

Touch-up all shop-applied prime coats which have damaged, or bare areas, where required by other sections of these specifications. Wire-brush, solvent clean, and touch up with the same primer as the shop coat.

8. MATERIALS PREPARATION:

Mix and prepare painting materials in strict accordance with the manufacturer's directions.

Store materials (not in actual use) in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.

Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film which may form on the surfaces of materials into the material. Remove the film and, if necessary, strain the material before using.

9. APPLICATION:

"Exposed surfaces" shall mean areas visible when permanent of built-in fixtures, grilles, etc., area in place in areas scheduled to be painted.

Apply paint by brush, roller, or spray in accordance with the manufacturer's directions. Spray paint uniformly with suitable equipment.

The number of coats and paint film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has completely dried.

Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color, and appearance.

a. Prime Coats

Before application of finish coats, apply a prime coat to material which is required to be painted or finished, and which has not been prime coated by others. Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn through or other defects due to insufficient sealing.

b. Mechanical Applications

Apply each roller coat to provide the equivalent hiding as brush-applied coats. Use spray application (generally) on wire mesh and similar surfaces where hand brush work would be inferior.

Wherever spray applications are used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double back with spray equipment for the purpose of building up film thickness of two (2) coats in one pass.

c. Completed Work

Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

Paint the back sides of access panels, removable or hinged covers to match the exposed surfaces. Finish exterior doors on tops, bottoms, and side edges the same as the exterior faces, unless otherwise indicated. Sand lightly between each succeeding enamel or varnish coat.

10. SUBMITTALS

a. Manufacturer's Data

1. Submit two (2) copies of manufacturer's specifications, including paint label analysis and application instructions for each material specified.

2. List each material and cross reference to the specific paint and finish system and application. Identify by manufacturer's catalog number and general classification. No painting work shall be done until this schedule has been finally approved.

b. Samples

1. On 12" x 12" hardboard, provide two (2) samples of each color and material, with texture to simulate actual conditions. Resubmit each sample as requested until required sheen, color, and texture is achieved.

2. On actual wood surfaces, provide two (2), 4" x 8" samples of each finish as required. Label and identify each as to location and application.

11. SURFACES TO BE PAINTED

The exact locations and limits of the surfaces requiring the various types of finishes shall be as established in the Color Schedule. The paint required for the various types of surfaces shall be as follows:

a. Interior concrete, masonry, or plastered surfaces, except were indicated to receive and enamel finish: Two (2) coats exterior concrete and masonry paint.

b. Interior concrete, masonry, or plastered surfaces, indicated to received enamel finish:

First coat – enamel under coater as recommended by manufacturer

Second and third coats – Semi-gloss enamel

c. Interior woodwork (enamel finish):

First coat – enamel under coater as recommended by the manufacturer

Second and third coats – Semi-gloss enamel

d. Interior woodwork (natural finish):

First coat – Stain if required

Second coat – Filler tinted to match stain if required by species of wood

Third and fourth coats – Semi-gloss varnish

e. Miscellaneous metal items which are specified under other sections to receive finishes as specified under this section or for which finishes are not specified under other sections:

First coat – shop primed; or one (1) coat of primer for galvanized or non-galvanized metal as the case may be

Second and third coats – gloss enamel

f. Wainscots indicated to receive polyurethane finish: Two (2) coats polyurethane paint

12. <u>GUARANTEE</u>:

a. The Contractor shall perform all items of paint work included under this Contract as specified on this section and/ or as recommended by manufacturer's paint products, and shall, without additional charges, replace any paint work or paint products/materials which develop defects, except because of vandalism or acts of God, within five (5) years from the date of final certificate of approval issued by the Public Buildings Authority (PBA).

b. The Contractor shall also be responsible for any or all damages resulting from inadequate surface preparation, improper application procedures or any other work performed without PBA or manufacturer's representative approval. In addition, the Contractor shall, without additional charges, repair all injuries to existing work caused by such conditions to the satisfaction of the PBA.

c. The Contractor shall submit to the PBA an official certification forms by paint products' manufacturer (to be acquired and applied on project's interior/exterior exposed surfaces included on contract) which guarantee that such products are free of defects occur due to faulty manufacture for a period of five (5) years from the date of final certificate of approval issued by the PBA. Also, the manufacturer shall guarantee that they will provide, without additional charges, all paint products, or materials necessary to replace all defective ones during such period.

WHITEBOARDS

(*Pizarra Blanca Para Marcadores*)

a. Whiteboards:

Whiteboards shall be of the composition type, four feet (4') width x eight feet (8') long, having the base made of temper treated ¼" thick hardboard. Panels are tempered on both sides resulting in hardboard impervious to moisture and warping. This panel shall comply with applicable Federal Specifications for similar kind of product.

b. Board Frame & Marker-Trough:

One (1) inch faced heavy-duty wrap-around aluminum frame is affixed to the board, rounded at the corner for maximum strength and safety. A heavy gauge etched marker-trough is provided the full width of the whiteboard. All trim and marker-trough are neat extruded aluminum, etched and anodized with a satin finish.

c. Trim and Accessories:

Fabricate frames and trim of not less than 0.062" thick aluminum alloy, rectangular (four feet (4') long x eight feet (8') width), to suit type of installation. Provide straight, single-length units wherever possible and keep joints to a minimum trim, accessories and fasteners with satin anodized finish AA-M31A31.

d. Fabrication & Assembly:

Provide factory-built whiteboard units. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Public Buildings Authority (PBA).

SECTION 10161

LAMINATED PLASTIC TOILET PARTITIONS AND URINAL SCREENS

1. RELATED DOCUMENTS

   The general provisions of the contract, including General and Special Conditions apply to the work specified in this section.

2. DESCRIPTION OF WORK

   The extent of the toilet partition work is shown on the drawings.

3. QUALITY ASSURANCE

   Field Measurements

   Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work.

   Shop Assembly

   Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for transportation and handling limitations. Clearly mark units for reassembly and coordinated installation.

4. SUBMITTALS

   Manufacturer's Data

   Submit 2 copies of catalog cuts of hardware anchors, fastenings and other data as required.

   Shop Drawings

   Submit for approval of PBA shop drawings for the fabrication and erection of toilet partition assemblies. Show all anchorage and accessory items, and finish.

   Samples

   Submit sample of hardware and accessories for approval. Submit 3 samples 6" x 6" of laminated plastic.

5. MATERIALS

Laminated Plastic

NEMA Standard LD-1, minimum 1/16" thick.

Contact Cement

As recommended by laminated plastic manufacturer.

Hardware and Accessories

See details on drawings. All bolts and screws shall be Monel bronze or chromium plated brass with theft – resistant (one-way) type heads and nuts.

Plywood

1" thick Douglas fir, Ext. – DFPA-A-A, immersion treated

6. FABRICATION

Provide doors, panels, screens and pilaster fabricated for the partition system in accordance with details shown on drawings and this specifications. Use one-piece laminated plastic with no splices or joints. Cover all edges with laminated plastic.

7. INSTALLATION

Install partitions rigid, straight, plumb and level, with the panels laid out as shown. Secure panels to supporting walls with not less than 3 angles, attached near top and bottom and at mid height at each face of the panel. Secure pilasters to the floor with ¼" x 2" bolts and expansion shield. Fasten the overhead brace to each pilaster with 2 bolts. Set tops of doors parallel with the overhead brace when doors are in the closed position.

Adjust and lubricate hardware for proper operation after installation. Set hinges on out-swing doors to return to the fully-closed position.

Wall-mounted Screens

Attach in the same way as panels. Set units so as to provide full support and to resist lateral impact.

Protection, Cleaning and Final Adjustments

Protect units during delivery, storage, and after erection so that there will be no indication of use or damage at the time of acceptance. Replace damaged work as directed.

Perform all final adjustments to door hardware of the partition assembly just prior to final inspection. Clean exposed surfaces of partitions, hardware, fittings and accessories.

END OF SECTION 10161

SECTION 10522

EXTINGUISHERS AND CABINETS

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 fire extinguishers and cabinets is indicated on architectural drawings.

B. Definition: "Fire extinguishers" as used in this section refers to units which can be hand-carried as opposed to those which are equipped with wheels or to fixed *fire* extinguishing systems.

C. Types of products required include:

1. Fire extinguishers.
2. Fire extinguisher cabinets.
3. Mounting brackets

D. Fixed fire protection systems are specified in Section 15310.

1.3 QUALITY ASSURANCE:

A. Single Source Responsibility: Obtain products in this section form one manufacturer.

B. Coordination: Verify that fire extinguisher cabinets are sized o accommodate fire extinguishers of type and capacity specified herein.

C. UL-Listed Products: Provide new portable fire extinguishers which are UL listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher specified herein.

1.4 SUBMITTALS:

A. Product Data: Submit product data for each type of product included in this section. For fire extinguisher cabinets include roughing-in dimensions and details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style and door construction, and panel style and materials.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. J.L. Industries
2. *Larsen's* Mfg. Co.
3. Johnson-Lee, Division of W.F. Lee Corp.
4. *Muckle* Manufacturing, Division of *Technico*, Inc.
5. *Watrous*, Inc.

2.2 FIRE EXTINGUISHERS:

A. General: Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by Architect from manufacturer's standard which comply with requirements of governing authorities.

B. Abbreviations indicated below to identify extinguisher types related to UL classification and rating system and not, necessarily to type and amount of extinguishing material contained in extinguisher.

C. Carbon Dioxide Type: UL-rated 5-B:C, 5 lb. nominal capacity, in manufacturer's standard enameled metal container for Class B and Class C fires.

D. Carbon Dioxide Type: UL-rated 10-B:C, 10 lb nominal capacity, in manufacturer's standard enameled metal container, for Class B and Class C fires.

E. Multi-Purpose Dry Chemical Type: UL-rated 2A:10B:C, 5 lb. nominal capacity, in enameled steel container, for Class at Class B and Class C fires.

2.3 MOUNTING BRACKETS:

A. Provide manufacturer's standard brackets designed to prevent accidental dislodgement of extinguisher, of sizes required for type and capacity of extinguisher specified herein, in manufacturer's standard plated finish.

1. Provide brackets for extinguishers not located in cabinets.

2.4 FIRE EXTINGUISHER CABINETS:

A. General: Provide fire extinguisher cabinets where indicated on architectural drawings, or suitable size for housing fire extinguishers, of types and capacities indicated.

B. Construction: Manufacturer's standard enameled steel box, with trim, frame, door and hardware to suite cabinet type, trim.

Painted Finish: Apply painted fin concealed surfaces of cabinet components except other than a painted finish is indicated.

1. Color: Provide colors as selected by Architect manufacturer's standard colors.

2. Preparation: Clean surfaces of dirt, grease, and rust or mill scale.

3. Baked Enamel Finish: Immediately after clean pretreatment, apply cabinet manufacturer's standard enamel finish system to the following surfaces:

   a. Interior of cabinet.
   b. Stainless Steel Finish: AISI No. 4 polished finish, with paper masking to protect finish.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Install items included in this section in locations mounting heights indicated, or if not indicated, at height to comply with applicable regulations of government authorities.

1. Prepare recesses in walls for fire extinguisher cabinet, as required by type, size and style of cabinet and in accordance with manufacturer's instructions.

2. Securely fasten mounting brackets and fire extinguishers cabinets to structure, square and plumb, to comply manufacturer's instructions.

END OF SECTION 10522

SECTION 10800

TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Toilet, bath, shower and washroom accessories.

B. Grab bars.

C. Attachment hardware.

1.2 RELATED SECTIONS

A. Section 09300 - Tile: Ceramic accessories.

1.3 REFERENCES

A. ANSI A117.1 - Safety Standards for the Handicapped.

B. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

C. ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.

C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI A117.1 and ADA code for access for the handicapped.

B. Accessories which conform to U.S. Federal Specifications following is a list of current Federal Specifications for Soap Dispenser, mirrors, washrooms accessories and wall urns and other accessories models which shall be meet or exceed performance criteria established by each Specifications. Selections from this guide should be made by consulting the reference Federal Specification that describes each item listed.

1. Soap Dispensers - Federal Specifications, FF - D - 00396 G (GSA - FSS), February 11, 1972 and prior editions, Soap Dispensers, Type I

2. Mirrors: Federal Specifications, DD - M 00411b (GSA-GSS), April 5, 1968 & Amendment - 1, April 7, 1970, mirrors - class 2, style E metal frame, stainless steel - grade 1 type 304 stainless steel - grade 1 type 304 stainless steel.
3. Wash room accessories : Federal Specifications, WW-P-541/8A (GSA - FSS), October 12, 1971 & Amendment - 1, June 17, 1974, Plumbing Fixtures (Accessories, land use).
   a. Type 1, class I, dispenser toilet tissue mounting R - Recessed style K single roller mounted.
   b. Type 1, class I, dispensers toilet tissue mounting P - Partitions mounted.
4. Federal Specification, WW-P-541b, interim amendment - 6, November 5, 1963, Plumbing Fixtures, land use.
   a. Type 541 : Tumber & toothbrush holder.
   b. Type 452 : Turin Robe Hook
   c. Type 457 : Toilet Paper Holder, Recessed
   d. Type 458 : Grab bar vertical
   e. Type 460 : Soap dish & bar, surfaced mounted
   f. Type 461 : Medicine cabinet, Recessed
5. Federal Specification, WW-P-541b, September 20, 1954, Plumbing fixtures, land use.
   a. Type 416 : Tumbler & tooth brush holder
   b. Type 421 : Double Coat Hook
   c. Type 431 & 431m : metal towel bar
   d. Type I : Class 3, dispensers, paper towel mounting, R -Recessed- Kind e.
   e. Type II : Waste Receptacle mounting R - Recessed.
   f. Type III : Class 2, Medicine cabinets swinging door, mounting R - Recessed
   g. Type IV : Class 1, towel bars surface mounted, concealed.
   h. Type IV : Class 3, Soap dish & bar surfaced mounted, concealed.
   i. Type IV : Class 3, Soap dish & bar surfaced mounted
   j. Type VI : Class 4, Holders, Toothbrush & tumbler surfaced mounted
   k. Type VI : Class 2, Holders Soap Recessed

1.6 PRODUCT, DELIVERY, STORAGE AND HANDLING

A. Delivery items in manufacturer's original unopened protective packing.

B. Store material in original protective packaging to prevent soiling, physical damage, or wetting.

C. Handle so as to prevent damage to finished surfaces.

D. Protection
   1. Maintain protective covers on all units until installation is complete.
   2. Remove protective covers at final clean-up of installation.
   3. Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the work and materials of all other trades.

E. Replacements

In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner at no additional cost.

1.7 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on product data.

1.8 COORDINATION

A. Coordinate work under provisions of Section 01300.

B. Coordinate the work with the placement of internal wall reinforcement to receive anchor attachments.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bobrick Washroom Equipment Inc.

B. Other acceptable manufacturers offering equivalent products.
1. Bradley Plumbing Fixtures.
2. American Dispenser Co., Inc.

2.2 MATERIALS

A. Stainless Steel Sheet: ASTM A167, Type 304.

B. Tubing: ASTM A269, stainless steel.

C. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, and Security type.

D. Expansion Shields: Fiber, lead, or rudder as recommended by accessory manufacturer for component and substrate.

2.3 FABRICATION

A. Weld and grind joints of fabricated components, smooth.

B. Form exposed surfaces from single sheet of stock, free of joints. Form surfaces flat without distortion. Maintain surfaces without scratches or dents.

C. Fabricate grab bars of tubing, free of visible joints, return to wall with end attachment flanges. Form bar with 1-1/2 inches (39 mm) clear of wall surface. Knurl grip surfaces.

D. Shop assemble components and package complete with anchors and fittings.

E. Provide steel anchor plates, adapters, and anchor components for installation.

F. Anchors and Fasteners

Provide anchors and fasteners capable of developing a retaining force commensurate with the strength of the accessory to be mounted, and well suited for use with the supporting construction. Where exposed use fasteners with finish matching the accessory.

G. Finish: All accessory items shall be stainless steel with satin finish.

H. Design is based on use of products manufactured by several Manufacturer's and catalog numbers of that manufacturer are given as an indication of the quality and style required. Equal products by other manufacturer's approved by the Owner will be acceptable in accordance with the General Conditions and Section 01300.

2.4 KEYING

A. Supply 2 keys for each accessory to Owner.

2.5 FINISHES

A. Stainless Steel: No. 4 satin luster finish.

B. Back paint components where contact is made with building finishes to prevent electrolysis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions under provisions of Section 01400.

B. Verify that site conditions are ready to receive work and dimensions are as indicated on shop drawings and instructed by the manufacturer.

C. Verify exact location of accessories for installation.

D. Check opening scheduled to receive recessed units for correct dimensions, plumpness of blocking or frames, preparation that would affect installation of accessories.

E. Check areas to receive surface mounted units for conditions that affect installation of accessories.

F. Verify spacing of plumbing fixtures and toilet partitions that affect installation of accessories.

G. Do not begin installation of washroom accessories until openings and surfaces are acceptable.

H. Examine the area and conditions under which work of this section will be installed. Correct conditions detrimental to proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

C. Throughout construction of substrate surfaces, use all means necessary to ensure proper and adequate provision for concealed support devices, and for finished openings, to receive the work of this Section.

3.3 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions and ANSI A117.1.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Drill holes to correct size and application that is concealed by item, with 1/4 in. tolerance.

D. Mount recessed accessories into wall openings with screws through cabinet side into wood blocking, or sheet metal screws into metal frames or expansion bolts for concrete and blocks.

E. Mount surface mounted accessories to back up with toggle bolts, plumb and align.

F. Install the work of this Section in strict accordance with the manufacturer's recommendations as approved by the Owner. Anchoring all components plumb, level, square, and firmly into position for long life under hard use.

3.4 Adjust and clean

A. Adjust accessories for proper operation.

B. After completion of installation, clean and polish all exposed surfaces.

C. Deliver keys and instruction sheets to Owner.

3.5 SCHEDULE

Bathroom accessories shall be furnished and installed in accordance with the Equipment and Accessories Schedule shown on Drawings and the following list.

A. Dwelling units and handicapped dwelling units.
   1. Medicine Cabinet
      a. 16" x 22" Recess mounted with two plastic shelves medicine cabinet.
      b. Polystyrene body material
      c. Reversible
      d. Stainless steel 304 door frame and back door
      e. ¼ float plate mirror
      f. Piano hinge, tire 304 stainless steel (17 long)
      g. Magnetic catch
      h. Type III, class 2 designation

i. Five year guarantee

2. Tooth Brush Holder (See specification 09300)
3. Soap Holder and Grab Bar (See Specification 09300)
4. Curtain Rod
   a. Rod of 18 gauge type 304 satin finish stainless steel
   b. 1¼" O.D.
   c. Flanges of 20 gauge type 305 satin finish stainless steel, 3 1/8" O.D.
   d. Escutcheons snap over flanges to provide permanent vandal - resistant mounting
   e. Concealed mounting
5. Toilet Paper Holders (See Specification 09300)
6. Towel Bar
7. Double Robe Hook
   a. Surface mounted
   b. Project 2" from wall
   c. Satin finish stainless steel
   d. Type 304 stainless steel heavy gauge 18 No. 4
   e. Vandal - resistant escutcheons

B. Handicapped Dwelling Units
1. Grab bars
   a. 1 1/4" dia, heavy duty
   b. Concealed mounting
   c. Heavy duty 18 gauge 304 stainless steel tubing
   d. Welded 11 - gauge 304 stainless steel mounting flanges
   e. Sustain loads over 1300 pounds (Designed and test), double FHA, VA, HEW requirements
   f. Satin finish
   g. For grab bar configuration, and/or length and installation of position see construction drawings.
   h. Supply
   i. Grab bar mounting kits for masonry walls and partition walls (stainless steel machine screws, cap nuts, backing plate, corrosion resistant zinc plating drop in anchors, etc.).
2. Folding Corner Shower Seat
   a. Type 304 stainless steel
   b. Satin finish
   c. 3/4 return edges
   d. Folds to vertical position when not in use

C. Administration Building
1. Toilet Paper Holders : Public Toilets
   a. Single roll toilet tissue dispensers
   b. Theft resistant service
   c. 1/8" thick anodized aluminum
   d. One piece construction with hinged arm and snap lock.
   e. Tumbler lock secures spindles in place
   f. Surface mounted and hold one standard toilet tissue roll
   g. 6 1/2" W x 2" H x 4 7/8" D. Overall dimensions
2. Mirror
   a. Fixed angle tilt mirror w/shelf

b. Type 304 stainless steel polished to No. 8 architectural bright finish
c. 16" w x 24 h @ 40" A.F.F

3. Paper towel dispenser
   a. Surface mounted
   b. 400 multi - fold or 300 c - fold towels capacity
   c. Type 304 stainless steel
   d. Satin finish
   e. Welded construction - seamless
   f. Corners and burr - free edges
   g. Non flexing double panel construction door with full length piano hinges
   h. Tumber locks keyed alike to others units
   i. Rough wall opening 15 5/8" h x 11 1/4" w x 4" d
   j. Top of wall openings 51" from finish floor

4. Liquid Soap Dispenser
   a. Horizontal surface mounted
   b. Push in type value of chrome plated brass with neoprene "O" ring packings
   c. Secured with lock
   d. 40 oz. liquid soap capacity
   e. Heavy gauge type 304 stainless steel
   f. Satin finish
   g. Unit Measures 8 3/16" W x 4 7/8" H x 2 7/8" D Valve Projects 2 1/2"
   h. Top of wall opening in relation to lavatory mounting height

5. Waste Receptacle
   a. Surface mounted
   b. 16.5 gal. capacity
   c. Removable leak proof heavy duty vinyl liner
   d. Hinge Cover
   e. Type 304 stainless steel
   f. Satin finish exposed surfaces
   g. Welded construction with seamless corners
   h. Burr free edges
   i. Unit measures 18" W x 23" H x 9" D
   j. Top of wall opening 45" from finished floor

6. Grab Bars
   a. Horizontal 1 1/4" (32mm) Dia. Stainless Steel
   b. Concealed Mounting
   c. Satin Finish
   d. 36" (914 mm) and 42" (1067 mm) lenghts

2.3 Washrooms accessories

A. Dwelling Units
1. Medicine Cabinet
2. Tooth Brush Holder
3. Soap Holder and Grab Bar
4. Curtain Rod
5. Toilet Paper Holder
6. Towel Bar
7. Double Robe Hook

B. Handicapped Dwelling Units
1. Medicine Cabinet

2. Tooth Brush Holder
3. Soap Holder and Grab Bar
4. Curtain Rod
5. Toilet Paper Holder
6. Towel Bar
7. Double Robe Hook
8. Grab Bar : 84" Length @ 36" AFF - Horizontal
9. Grab Bar : 24" Length @ 36" AFF - Horizontal
10. Grab Bar : 60" Length @ 32" AFF - Horizontal
11. Grab Bar : 24" Length @ 40" AFF - Vertical
12. Grab Bar : 30" Length @ 33" AFF - Horizontal and Vertical
13. Grab Bar : 24" Length @ 40" AFF - Vertical
14. Grab Bar : 33" Length @ 36" AFF - Horizontal
15. Grab Bar : 24" Length @ 36" AFF - Horizontal
16. Folding Corner Shower Seat
17. All grab bars shall be 1 1/4" (32 mm) dia., 18 ga. and stainless steel
18. All Grab Bars, will be concealed Mounting Kits on Vandal Proof Screws
19. All grab bars shall be safely grip finish

C. Administration Building Toilets
1. Mirrors (16" x 24")
2. Paper Towel Dispenser
3. Liquid Soap Dispenser
4. Waste Receptacle
5. Sanitary Paper Holders
6. 48 length Handicapped Grab Bar with center post; only one end return
7. Grab Bar 36" and 42" length

END OF SECTION

SECTION 15000

General Specifications for HVAC system Cleaning
(Include special provisions to insulation upgrade)

Part 1 -- Special Provisions

1.01 Qualification of the HVAC System Cleaning Contractor

(A) Membership:

1. The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.

(B) Certification:

1. The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

(C) Supervisor Qualifications:

1. A person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.

(D) Experience:

1. The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning as requested by the **owner**. Bids shall only be considered from firms which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

(E) Equipment, Materials and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.

1. The contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., contractors should comply with applicable national safety codes and standards.
2. The contractor shall be responsible for the safety equipment of employees.
3. The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all

other site documentation requirements of applicable OSHA programs and this specification

4. Contractor shall submit to the PBA representative all Material Safety Data Sheets (MSDS) for all chemical products proposed to be used in the cleaning process.
5. The contractor shall submit the name and experience of the safety manager of the company or present project for PBA approval.
6. The contractor shall submit the name and experience of the Environmental Manager of the company or present project for PBA approval.
7. The contractor shall submit a safety and environmental plan to PBA representative for approval before start any kind of cleaning activity.

(F) Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in this state. Contractor shall comply with all Federal, state and local rules, regulations, and licensing requirements.

1.02 Standards

(A) NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).

1. All terms in this specification shall have their meaning defined as stated in the NADCA Standards.
2. NADCA Standards must be followed with no modifications or deviations being allowed.

1.03 Documents

(A) Mechanical Drawings: Public Buildings Authority (PBA) shall provide the HVAC system cleaning contractor with one copy of the following documents:

1. Project drawings and specifications.
2. Approved construction revisions pertaining to the HVAC system.
3. Any existing indoor air quality (IAQ) assessments or environmental reports prepared for the facility.

(B) It is not permitted to contractor to photocopy any part of mechanical drawings, specifications or IAQ assessment without previous authorization of PBA.

(C) It is not permitted to contractor to move outside of building mechanical drawings, specifications or any IAQ assessment without previous authorization of PBA.

Part 2 -- HVAC System Cleaning Specifications and Requirements

2.01. Scope of Work

(A) Scope: This section defines the requirements necessary to render HVAC components clean, and to verify the cleanliness through inspection and/or testing

in accordance with items specified herein and applicable NADCA Standards.

(B) The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

(C) The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. Parts of the HVAC system include (not limited)

a. return air grilles
b. return air ducts to the air handling unit (AHU)
c. the interior surfaces of the AHU
d. mixing box
e. coil compartment
f. condensate drain pans
g. humidifiers and dehumidifiers
h. supply air ducts
i. fans
j. fan housing
k. fan blades
l. air wash systems
m. spray eliminators
n. turning vanes
o. filters
p. filter housings
q. reheat coils
r. supply diffusers
s. exhaust and ventilation components
t. make-up air systems.
u. Plenums (as design).
v. Carpets (special condition)
w. Others as indicated by Engineer.

2.02. HVAC System Component Inspections and Site Preparations

(A) HVAC System Component Inspections:

1. Prior to the commencement of any cleaning work, the HVAC system cleaning contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project.
2. The cleanliness inspection should include air handling units and representative areas of the HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of the units should be inspected.

(B) The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented

1. Damaged system components found during the inspection shall be documented and brought to the attention of the PBA representative or Engineer.

(C) Site Evaluation and Preparations: Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.

(D) Inspector Qualifications: Qualified personnel should perform the HVAC cleanliness inspection to determine the need for cleaning. At minimum, such personnel should have an understanding of HVAC system design, and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

2.03 General HVAC System Cleaning Requirements:

(A) Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.

(B) Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.

(C) Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.

1. If while cleaning process is in progress and any tenant employee or

representative of tenant is uncomfortable with any kind of odor, contractor have to stop the cleaning process until find out the odor source and correct it.

(D) Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.

(E) Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.

(F) Service Openings: The contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.

1. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.
2. Other openings shall be created where needed and they must be created so they can be sealed in accordance with industry codes and standards.
3. Closures must not significantly hinder, restrict, or alter the airflow within the system.
4. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.
5. Openings must not compromise the structural integrity of the system.
6. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.
7. Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.
8. Rigid fiber glass duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiber glass duct system closures.
9. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the PBA representative or Engineer in project report documents.

(G) Ceiling sections (tile): The contractor may remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.

(H) Air distribution devices (registers, grilles & diffusers): The contractor shall clean all air distribution devices.

(I) Air handling units, terminal units (VAV, Dual duct boxes, etc.), blowers and exhaust fans: The contractor shall insure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas to be cleaned include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. All visible surface contamination deposits shall be removed in accordance with NADCA Standards. Contractor shall:

1. Clean all air handling units (AHU) internal surfaces, components and condensate collectors and drains.
2. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.
3. Clean all coils and related components, including evaporator fins.

(J) Duct Systems: Contractor shall:

1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
2. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests (see NADCA Standards).

2.04 Health and Safety

(A) Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.

(B) Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

(C) Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with **EPA and Puerto Rico Environmental Quality Board requirements.**

2.05 Mechanical Cleaning Methodology

(A) Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility.

(B) It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods (See applicable NADCA Standards) and other specified tests, in accordance with all general requirements.

(C) No cleaning method, or combination of methods, shall be used which could

potentially damage components of the HVAC system or negatively alter the integrity of the system.

1. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
2. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters, including hand-held vacuums and wet-vacuums.
3. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.
4. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

(D) Methods of Cleaning Fibrous Glass Insulated Components

1. Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be removed by using mechanical methods.

(E) Replaced Fibrous Glass Material

1. Replacement: As requested, Contractor must be capable of remove exposed fibrous glass insulation in air handlers and/or ductwork requiring replacement.
2. Replacement material: all replaced materials shall conform to applicable industry codes and standards, including those of UL and SMACNA.
    i. Replace fiber glass insulation with 1" thick, non compressed fiber glass insulation.
    ii. The new insulation material shall have 0.24 Btu-in/ft^2- °f.
    iii. The new insulation material shall have a noise reduction of 0.7/in thick.
    iv. The new insulation material shall have 3 lb/ft^3 or less density.
    v. The new insulation material shall have a fire rating of 25/50 (as ASTM-84 and UL 723).

vi. All insulation edges shall be encapsulated within the panel.

(F) Cleaning of coils

1. Any cleaning method may be used which will render the Coil Visibly Clean and capable of passing Coil Cleaning Verification (see applicable NADCA Standards).
2. Coil drain pans shall be subject to Non-Porous Surfaces Cleaning Verification. The drain for the condensate drain pan shall be operational. Cleaning methods shall not cause any appreciable damage to, displacement of, inhibit heat transfer, or erosion of the coil surface or fins, and shall conform to coil manufacturer recommendations when available.
3. Coils shall be thoroughly rinsed with clean water to remove any latent residues.

(G) Biocidal Agents and Coatings:

1. Biocidal agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.
2. Application of any biocidal agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris and before of installation of new insulation.
3. When used, chemical biocides and coatings shall be applied in strict accordance with manufacturer recommendations and EPA registration listing.
4. Biocidal coatings shall be applied according to manufacturer's instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces. A continuous film must be achieved on the surface to be treated by the coating application.
5. Application of any biocidal coatings shall be in strict accordance with manufacturer's minimum millage surface application rate standards for effectiveness.

2.06 Cleanliness Verification

(A) General:

1. Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents and coatings.

(B) Visual Inspection: The HVAC system shall be inspected visually to ensure that no visible contaminants are present.

1. If no contaminants are evident through visual inspection, the HVAC

system shall be considered clean; however, the PBA reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards.

2. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
3. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.
4. Cleanliness verification shall be performed immediately after mechanical cleaning and before the HVAC system is restored to normal operation.

(C) Verification of Coil Cleaning:

1. Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA Standards).

2.07 Pre-existing System Damage:

(A) Contractor is not responsible for problems resulting from prior inappropriate or careless cleaning techniques of others.

2.08 Post-project Report:

(A) At the conclusion of the project, the Contractor shall provide a report to the PBA representative or Engineer indicating the following:

1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
2. Areas of the system found to be damaged and/or in need of repair.

2.09 Applicable Standards and Publications: The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by any reference thereto:

(A) National Air Duct Cleaners Association (NADCA): "ACR-2002, Assessment, Cleaning & Restoration of HVAC Systems," 2001.

(B) National Air Duct Cleaners Association (NADCA): "Understanding Microbial Contamination in HVAC Systems," 1996.

(C) National Air Duct Cleaners Association (NADCA): "Introduction to HVAC System Cleaning Services," 2002.

(D) National Air Duct Cleaners Association (NADCA): Standard 05 "Requirements for the Installation of Service Openings in HVAC Systems," 1997.

(E) Underwriters' Laboratories (UL): UL Standard 181.

(F) American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89, "Ventilation for Acceptable Indoor Air Quality".

(G) Environmental Protection Agency (EPA): "Building Air Quality," December 1991.

(H) Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): "HVAC Duct Construction Standards - Metal and Flexible," 1985.

(I) North American Insulation Manufacturers Association (NAIMA): "Cleaning Fibrous Glass Insulated Air Duct Systems," 1993.

SECTION 15010

BASIC MECHANICAL REQUIREMENTS

A. GENERAL

1. RELATED DOCUMENTS

1.1 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 Sections, and the other sections of Division 15.

2. SUMMARY

2.1 This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

2.1.1 Submittals. Coordination drawings. Record documents. Maintenance manuals. Rough-in. Mechanical installations. Cutting and patching.

2.2 Related Sections: The following sections contain requirements that relate to this section:

2.2.1 Division 15 Section "ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT", for factory-installed motors, controllers, accessories, and connections.

2.2.2 Division 15 Section "BASIC MECHANICAL MATERIALS AND METHODS", for materials and methods common to the remainder of Division 15, plus general related specifications, including:

a. Access to mechanical installations.

b. Excavation for mechanical installations within the building boundaries, and from building to utilities connections.

3. SUBMITTALS

3.1 General: Follow the procedures specified in Division 1 Section "SUBMITTALS".

3.2 Increase, by the quantity listed below, the number of mechanical related shop drawings, product data, and samples submitted, to allow for required distribution plus two copies of each submittal required, which will be retained by the Mechanical Consulting Engineer.

3.2.1 Shop Drawings – Initial Submittal: 1 additional blue- or black-line prints.

• SUBMITTALS (Cont.'):

3.2.2 Shop Drawings – Final Submittal: 1 additional blue- or black-line prints.

3.2.3 Product Data: 1 additional copy of each item.

3.2.4 Samples: 1 additional as set.

3.3 Additional copies may be required by individual sections of these Specifications.

4. COORDINATION DRAWINGS

4.1 Prepared coordination drawings in accordance with Division 1 Section "PROJECT COORDINATION", to a scale of ¼" = 1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where the space is limited for installation of access and where sequencing and coordination of the Work, including (but not necessarily limited to) the following:

4.1.1 Indicate the proposed locations of piping, ductwork, equipment, and materials. Include the following:

a. Clearances for installing and maintaining insulation.

b. Clearances for servicing and maintaining equipment, including tube removal, filters removal, and space for equipment disassembly required for periodic maintenance, as recommended by equipment manufacturers.

c. Equipment connections and support details.

d. Exterior wall and foundation penetrations.

e. Fire-rated wall and floor penetrations.

f. Sizes and locations of required concrete pads and bases.

g. Valve stem movement.

4.1.2 Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

4.1.3 Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings, and their relationship to other penetrations and installations.

4.1.4 Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted items.

5. RECORD DOCUMENTS

5.1 Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSE-OUT". In addition to the requirements specified in Division 1, indicate the following installed conditions:

5.1.1 Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 15 Section "MECHANICAL IDENTIFICATION". Indicate actual inverts and horizontal locations of underground piping.

5.1.2 Equipment locations (exposed and concealed), dimensioned from prominent building lines.

5.1.3 Approved substitutions, Contracts Modifications, and actual equipment and materials installed.

5.1.4 Contract Modifications, actual equipment and materials installed.

5.2 Engaged the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified in Division 1 Section "FIELD ENGINEERING" to record and verify the locations and invert elevations or underground installations.

6. MAINTENANCE MANUALS

6.1 Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSE-OUT". In addition to the requirements specified in Division 1, include the following information for equipment items:

6.1.1 Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

6.1.2 Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

6.1.3 Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassemble; aligning and adjusting instructions.

6.1.4 Servicing instructions and lubrication charts and schedules.

7. DELIVERY, STORAGE, AND HANDLING

7.1 Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. PRODUCTS

1. NOT APPLICABLE

C. EXECUTION

1. ROUGH-IN:

1.1 Verify final locations for rough-in with field measurements and with the requirements of the actual equipment to be connected.

1.2 Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

2. MECHANICAL INSTALLATIONS

2.1 General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

2.1.1 Coordinate mechanical systems, equipment, and materials installation with other building components.

2.1.2 Verify all dimensions by field measurements.

2.1.3 Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

2.1.4 Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

2.1.5 Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

2.1.6 Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

• MECHANICAL INSTALLATIONS (Cont.'):

2.1.7 Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

2.1.8 Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirement's conflict with individual system requirements, refer conflict to the Architect.

2.1.9 Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

2.1.10 Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practicable, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

2.1.11 Install access panel or doors where are concealed behind finished surfaces. Access panels and doors where are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "ACCESS DOORS" and Division 15 Section "BASIC MECHANICAL MATERIALS AND METHODS".

2.1.12 Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at specified slope.

3. CUTTING AND PATCHING

3.1 General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 1, the following requirements apply:

3.1.1 Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

3.2 Perform cutting, fitting, and patching of mechanical equipment and materials required to:

3.2.1 Uncover Work to provide for installation of ill-timed Work.

3.2.2 Remove and replace defective Work.

• CUTTING AND PATCHING (Cont.'):

3.2.3 Remove and replace Work not conforming to requirements of the Contract Documents.

3.2.4 Remove samples of installed Work as specified for testing.

3.2.5 Install equipment and materials in existing structures.

END OF SECTION 15010

SECTION 15030

ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

A. GENERAL

1. RELATED DOCUMENTS

1.1 Drawings and general provisions of the Contract, including the General Conditions, the Supplementary Special Conditions and all Division-1 Specifications sections, apply to the Work of this Section, and the other sections of Division 15.

1.2 Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 16.

2. SUMMARY

2.1 This sections specifies the basic requirements for electrical components that are integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

2.2 Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections.

2.3 Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the drawings.

3. REFERENCES

3.1 NEMA Standards MG 1: Motors and Generators.

3.2 NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies.

3.3 NEMA Standard 250: Enclosures for Electrical Equipment.

3.4 NEMA Standard KS 1: Enclosed Switches.

3.5 Comply with National Electrical Code (NFPA 70). (Last Edition)

4. SUBMITTALS

4.1 No separate submittal is required. Submit product data for motor, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

5. QUALITY ASSURANCE ELECT. REQUIREMENTS FOR MECH. EQUIP

5.1 Electrical components and materials shall be UL labeled.

B. PRODUCTS

1. MOTORS

1.1 The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1.1.1 Torque characteristic shall be sufficient to satisfactory accelerate the driven loads.

1.1.2 Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

1.1.3 Two speed motors shall have two separate windings on poly-phase motors.

1.1.4 Temperature Rating: Rate for 40ºC environment with maximum 50ºC temperature rise for continuous duty at full load (Class A Insulation).

1.1.5 Starting capability: Frequency of starts as indicated by automatic control system and not less than five (5) evenly time spaced starts per hours for manually controlled motors.

1.1.6 Service Factor: 1.15 for poly-phase motors and 1.35 for single-phase motors.

1.1.7 Motor construction: NEMA Standard MG 1, general purpose, continuous duty, " Design "B" except "C" where required for high starting torque.

a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.

b. Bearings:

1) Ball or roller bearings with inner and outer shaft seals.

2) Re-greased, except permanently sealed where motor is normally inaccessible for regular maintenance.

• MOTORS (Art. 1.1.7) – Cont.'

3) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.

c. Enclosure Type:

1) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.

2) Guarded drip-proof motor where exposed to contact by employees or building occupants.

3) Weather protected Type 1 for outdoor use, Type II where not housed.

d. Noise rating: "Quiet".

e. Noise rating: "Quiet", rating on motors located in occupied spaces of building.

f. Efficiency: "Energy Efficient" motors shall have a minimum efficiency as schedule in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "Average Standard Industry Motors", in accordance with IEEE Standard 112, test method B.

g. Nameplate: Indicate the full identification of manufacturer, rating, characteristics, construction, special features and similar information.

2. STARTERS, ELECTRICAL DEVICES, AND WIRING

2.1 MOTOR STARTER CHARACTERISTIC

2.1.1 Enclosure: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have proper class and division.

2.1.2 Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and startup conditions.

2.2 MANUAL SWITCHES SHALL HAVE

2.2.1 Pilot lights and extra positions for multi-speed motors.

2.2.2 Overload protection: Melting alloy type thermal overload relays.

2.3 MAGNETIC STARTERS

2.3.1 Maintained contact push buttons and pilot lights properly arranged for single speed or multi-speed operation as indicated.

2.3.2 Trip-free thermal overload relays, each phase.

2.3.3 Interlocks, pneumatic switches and similar devices as required for coordination with control requirements or Division 15 Controls Sections. 7.1.8 Failure by the Contractor to submit shop drawings in sample time for checking, shall no claim for extension by reason of such default will be allowed.

2.3.4 Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.

2.3.5 Externally operated manual reset.

2.3.6 Under-voltage release or protection.

3. CAPACITORS

3.1 FEATURES

3.1.1 Individual unit cells all welded steel housing each capacitor internally fused non-flammable synthetic liquid impregnate craft tissue insulation aluminum foil electrodes.

3.1.2 KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

3.2 DISCONNECT SWITCHES

3.2.1 Fusible switches: Fused, each phase; general duty; horsepower rated; non-teased quick-make, quick-break mechanism; dead front line side shield; solder-less lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “Open” position; are quenchers; capacity and characteristics as indicated.

3.2.2 Non-fusible switches: For equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poled and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

C. EXECUTION (Not Applicable)

END OF SECTION OF 15030

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

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. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Mechanical demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. 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.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with 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 to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless 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. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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 for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: **CPVC and PVC** one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturer:

a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturer:

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

1. Manufacturers:

    a. Capitol Manufacturing Co.
    b. Central Plastics Company.
    c. Epco Sales, Inc.
    d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

    a. Calpico, Inc.
    b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

    a. Perfection Corp.
    b. Precision Plumbing Products, Inc.
    c. Sioux Chief Manufacturing Co., Inc.
    d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Metraflex Co. and d: Pipeline Seal and Insulator, Inc.

2. Sealing Elements: **EPDM** and **NBR** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: **Stainless steel**. Include two for each sealing element.
4. Connecting Bolts and Nuts: **Stainless steel** of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: **Polished chrome-plated and rough brass**.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: **Polished chrome-plated and rough brass**.

E. One-Piece, Stamped-Steel Type: With **set screw or spring clips** and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With **concealed-rivet** hinge, **set screw or spring clips**, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawing 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 unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    f. Bare Piping at Ceiling Penetrations in Finished Spaces: **One-piece** cast-brass type with polished chrome-plated finish.
    g. Bare Piping at Ceiling Penetrations in Finished Spaces: **One-piece, stamped-steel type with concealed hinge** and set screw.
    h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with **polished chrome-plated** finish.
    i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with **concealed** hinge and **set screw or spring clips**.
    j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
    k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with [**set screw**] [**spring clips**] [**set screw or spring clips**].

1. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

   a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with **[concealed]** [**exposed-rivet**] [**concealed or exposed-rivet**] hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
   g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with **polished chrome-plated** finish.
   h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with **concealed** hinge and set screw or spring clips.
   i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
   j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
   k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

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 (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. **Steel** Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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 ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section **"Painting (Professional Line Products)."**

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use [3000-psi (20.7-MPa) 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section " Cast-in-Place Concrete (Limited Applications)]."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 15050

SECTION 15060

HANGERS AND SUPPORTS

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 hangers and supports for mechanical system piping and equipment.

B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
2. Division 13 Sections on fire-suppression piping for fire-suppression pipe hangers.
3. Division 15 Section "Mechanical Vibration Controls and Seismic Restraints" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports".

1.4 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

C. Design seismic restraint hangers and supports for piping and equipment.

D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping support and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

C. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where 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 hangers and supports that are similar to those indicated for this Project in material, design, and extent.

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. Pipe Hangers:

a. AAA Technology and Specialties Co., Inc.
b. B-Line Systems, Inc.
c. Carpenter & Patterson, Inc.
d. Empire Tool & Manufacturing Co., Inc.
e. Globe Pipe Hanger Products, Inc.
f. Grinnell Corp.
g. GS Metals Corp.

• Article 2.1, B.1: Pipe Hangers (Cont.'):

h. Michigan Hanger Co., Inc.
i. National Pipe Hanger Corp.
j. PHD Manufacturing, Inc.
k. PHS Industries, Inc.
l. Piping Technology & Products, Inc.

2. Channel Support Systems:

a. B-Line Systems, Inc.
b. Grinnell Corp.; Power-Strut Unit
c. GS Metals Corp.
d. Michigan Hanger Co., Inc.; O-Strut Div.
e. National Pipe Hanger Corp.
f. Thomas & Betts Corp.
g. *Unistrut* Corp.
h. *Wesanco*, Inc.

3. Thermal-Hanger Shield Inserts:

a. Carpenter & Patterson, Inc.
b. Michigan Hanger Co., Inc.
c. PHS Industries, Inc.
d. Pipe Shields, Inc.
e. *Rilco* Manufacturing Co., Inc.
f. Value Engineered Products, Inc.

4. Powder-Actuated Fastener Systems:

a. *Gunnebo* Fastening Corp.
b. Hilti, Inc.
c. ITW Ramset/Red Head
d. *Masterset* Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized, Metallic Coatings: for piping and equipment that will not have field-applied finish.
2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.

1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

• Article 2.2B (Cont.'):

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi (690-KPa) minimum compressive-strength insulation, encased in sheet metal shield.

1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
3. Material for Cold Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
6. Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate.
7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
8. For Clevis or Band Hanger: insert and shield cover lower 180 degrees of pipe.
9. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

A. 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.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

D. Grout: ASTM C 1107, Grade B, factory-mixed and packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Non-staining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi (34.5-MPa), 28 day compressive strength.

PART 3 – EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in Sections specifying equipment and systems.

• ARTICLE 3.1: HANGER AND SUPPORT APPLICATIONS (Cont.')

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type I): For suspension of non-insulated or insulated stationary pipes, NPS ½ to NPS 30 (DN15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.
3. Carbon or Alloy-Steel, Double-bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS ¾ to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS ½ to NPS 24 (DN15 to DN600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): for suspension of pipes, NPS ½ to NPS 4 (DN15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): for suspension of non-insulated stationary pipes, NPS ¾ to NPS 8 (DN20 to DN200).
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS ½ to NPS 8 (DN15 to DN200).
8. Adjustable Band Hangers (MSS Type 9): for suspension of non-insulated stationary pipes, NPS ½ to NPS 8 (DN15 to DN200).
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS ½ to NPS 2 (DN15 to DN50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS ⅜ to NPS 8 (DN10 to DN200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS type 12): For suspension of non-insulated stationary pipes, NPS ⅜ to NPS 8 (DN10 to DN80).
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS ½ to NPS 30 (DN15 to DN750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast-iron floor flange and with U-Bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-½ to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): for suspension of pipes, NPS 2-½ to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.

• ARTICLE 3.1C (Cont.'):

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS ¾ to NPS 20 (DN20 to DN500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS ¾ to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.

E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weld-less Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installation with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): for attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

• ARTICLE 3.1F (Cont.'):

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (675 kg).
    c. Heavy (MSS Type 33): 300 lib (1350 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.

G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-¼ inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

• ARTICLE 3.1H (Cont.'):

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

1. Field assemble and install according to manufacturer's written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange form grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Install building attachments within concrete slabs or attach 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, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

E. 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.

• ARTICLE 3.2: HANGER AND SUPPORT INSTALLATION (Cont.')

F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," are not exceeded.

K. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits according to ASME B31.9.

2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span are of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS ¼ to NPS 3-½ (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0/06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN200 to DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN400 to DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

• ARTICLE 3.1K (Cont.'):

5. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

A. Cut, drill and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 shielded metal are welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and 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. Paint exposed areas immediately after erecting 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 paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

• ARTICLE 3.6: PAINTING (Cont.')

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are 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.

END OF SECTION 15060

SECTION 15081

DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes semi-rigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 7 Section "Fire-stopping" for fire-stopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 15 Section "Equipment Insulation" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
3. Division 15 Section "Pipe Insulation" for insulation for piping systems.
4. Division 15 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for the following:

1. Removable insulation sections at access panels.
2. Application of field-applied jackets.
3. Applications at linkages for control devices.

C. Samples: For each type of insulation and field-applied jacket. Identify each Sample, describing product and intended use. Submit 12-inch (300 mm) square sections of each sample material.

1. Manufacturer's Color Charts: Show the full range of colors available for each type of field-applied finish material indicated.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include date of tests.

1.3 SUBMITTALS (Cont.'):

E. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors. Flame-spread rating of 75 or less and smoke-developed rating of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups according to the following requirements, using materials indicated for the completed Work:

1. Include the following mockups:

    a. One 10-foot (3-m) section of rectangular straight duct.
    b. One 90-degree square elbow and one 90-degree radius elbow.
    c. One branch takeoff.
    d. One transition fitting.
    e. Four support hangers.

2. Build mockups with cutaway sections to allow observation of application details for insulation materials, mastics, attachments, and jackets.
3. Build mockups in the location indicated or, if not indicated, as directed by Architect.
4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Obtain Architect's approval of mockups before starting insulation application.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate clearance requirements with duct Installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

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. Mineral-Fiber Insulation:

   a. Certainteed Manson.
   b. *Knauf* Fiberglass GmbH.
   c. Owens-Corning Fiberglas Corp.
   d. Schuller International, Inc.

2. Flexible Elastomeric Thermal Insulation:

   a. *Armstrong World Industries, Inc.*
   b. *Rubatex Corp.*
   c. *Armaflex, Inc.*

3. Closed-Cell Phenolic-Foam Insulation:

   a. *Kooltherm Insulation Products, Ltd*.

4. Calcium Silicate Insulation:

   a. *Owens-Corning Fiberglas Corp.*
   b. *Pabco.*
   c. *Schuller International, Inc*.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from Kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from Kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

D. Closed-Cell Phenolic-Foam Insulation: Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.

E. Calcium Silicate Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: White or gray.
3. PVC Jacket Color: Custom color selected

D. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209 (ASTM B 209M), and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.

1. Finish: Smooth finish.
2. Finish: Cross-crimp corrugated finish.
3. Finish: Stucco-embossed finish.
4. Finish: Factory-painted finish.
5. Moisture Barrier: 1-mil (0.025-mm) thick, heat-bonded polyethylene and Kraft paper.

2.3 FIELD-APPLIED JACKETS (Cont.'):

E. Stainless-Steel Jacket: Deep corrugated sheets of stainless steel complying with ASTM A666, Type 304 or 316; 0.10 inch (2.5 mm) thick; and roll stock ready for shop or field cutting and forming to indicate sizes.

1. Moisture Barrier: 1 mil (0.025 mm) thick, heat-bonded polyethylene and Kraft paper.
2. Moisture Barrier: 3 mil (0.075 mm) thick, heat-bonded polyethylene and Kraft paper.
3. Jacket Bands: Stainless steel, Type 304, ¾ inch (19 mm) wide.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized a minimum of 8 oz. /sq. yd. (270 g/sq.mt.).

1. Tape Width: 4 inches (100 mm).

B. Bands: ¾ inch (19 mm) wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
3. Aluminum: 0.007 inch (0.18 mm) thick.
4. Brass: 0.010 inch (0.25 mm) thick.
5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.

C. Wire: 0.080 inch (2.0 mm), nickel-copper alloy; 0.062 inch (1.6 mm), soft-annealed, stainless steel; or 0.062 inch (1.6 mm), soft annealed, galvanized steel.

D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

1. Welded Pin Holding Capacity: 100 pd. (45 kg.) for direct pull perpendicular to the attached surface.

E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 pd. (45 kg) fir direct pull perpendicular to the adhered surface.

F. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions, with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

3.3 GENERAL APPLICATION REQUIREMENTS (Cont.'):

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1. Seal penetrations with vapor-retarder mastic.
2. Apply insulation for exterior applications tightly joined to interior insulation ends.
3. Seal insulation to roof flashing with vapor-retarder mastic.

P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over compress insulation during installation.

4. Impale insulation over anchors and attach speed washers.
5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with ½-inch (13 mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
7. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches (450 mm) o.c.
8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch (150 mm) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.
10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:

a. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
b. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over-compress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with ½-inch (13 mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch (150 mm) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150mm) o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to ducts and plenums as follows:

1. Follow the manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.6 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION

A. Apply insulation as follows:

1. Secure each layer of insulation to duct with stainless-steel bands at 12-inch (300 mm) intervals and tighten without deforming the insulation materials.
2. Apply two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6 mm), soft-annealed, stainless-steel wire spaced at 12-inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300 mm) intervals.
3. On exposed applications, finish insulation with a skim coat of mineral-fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging

adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.

3.7 CALCIUM SILICATE INSULATION APPLICATION

A. Apply insulation according to the manufacturer's written instructions and as follows:

1. Secure single layer of insulation to duct with stainless-steel bands. Tighten bands without deforming the insulation material.
2. Apply two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6 mm), soft-annealed, stainless-steel wire. Secure outer layer with stainless-steel bands.
3. On exposed applications, without metal jacket, finish insulation with a skim coat of mineral-fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.

3.8 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch (50 mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch (1.6 mm) thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.9 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting".

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.10 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

3.10 DUCT SYSTEM APPLICATIONS (Cont.'):

C. Insulate the following plenums and duct systems:

1. Indoor concealed supply, return, and outside air ductwork.
2. Indoor exposed supply, return, and outside air ductwork.
3. Outdoor exposed supply and return ductwork.
4. Indoor exposed range-hood exhaust ductwork.
5. Indoor concealed range-hood exhaust ductwork.
6. Indoor exposed oven and dishwasher exhaust ductwork.
7. Indoor concealed oven and dishwasher ductwork.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation in the following systems, materials, and equipment:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
5. Flexible connectors.
6. Vibration control devices.
7. Testing agency labels and stamps.
8. Nameplates and data plates.
9. Access panels and doors in air-distribution systems.

3.11 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: round or Rectangular supply and return air ducts, concealed and exposed

1. Material: **Mineral-fiber blanket** 0.75 pounds density.
2. Thickness: **2 inches** (50 mm).
3. Number of Layers: **One**.
4. Field-Applied Jacket: **Foil and paper**.
5. Vapor Retarder Required: **Yes**.

B. Service: Round or Rectangular cold outside-air ducts, concealed and exposed.

1. Material: **Mineral-fiber blanket** 0.75 pounds density.
2. Thickness: **2 inches** (50 mm).
3. Number of Layers: **One**.
4. Field-Applied Jacket: **Foil and paper.**
5. Vapor Retarder Required: **Yes**.

C. Service: Round or Rectangular, range-hood & dishwasher exhaust ducts, concealed & exposed.

1. Material: **Calcium silicate**.
2. Thickness: **2 inches** (50 mm).
3. Number of Layers: **Two**.
4. Field-Applied Jacket: **Glass cloth**.

3.11 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE (Cont.'):

5. Vapor Retarder Required: **Yes**.

3.12 OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Round or Rectangular supply, return & cold outside-air ducts.

1. Material: **Mineral-fiber board** 3 lbs, density.
2. Thickness: **2 inches** (50 mm).
3. Number of Layers: **Two**.
4. Field-Applied Jacket: Glass cloth.
5. Field-Applied Jacket: Foil and paper.
6. Field-Applied Jacket: PVC.
7. Vapor Retarder Required: **Yes**.
8. Field-Applied Jacket: Aluminum.

    a. Aluminum Thickness: 0.032 inch (0.8 mm).
    b. Corrugation Dimension: **2-½ by 5/8 inch (64 by 16 mm).**

END OF SECTION 15081

SECTION 15083

PIPE INSULATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 2 Section “Hydronic Distribution” for loose-fill pipe insulation in underground piping outside the building.
2. Division 2 Section “Steam Distribution” for loose-fill pipe insulation in underground piping outside the building.
3. Division 7 Section “Fire-stopping” for fire-stopping materials and requirements for penetrations through fire and smoke barriers.
4. Division 15 Section “Duct Insulation” for insulation for ducts and plenums.
5. Division 15 Section “Equipment Insulation” for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
6. Division 15 Section “Hangers and Supports” for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for the following:

1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
2. Attachment and covering of heat trace inside insulation.
3. Insulation application at pipe expansion joints for each type of insulation.
4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Removable insulation at piping specialties and equipment connections.
6. Application of field-applied jackets.

C. Samples: For each type of insulation and jacket. Identify each Sample, describing product and intended use. Submit Samples in the following sizes:

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN50).
2. Sheet Form Insulation Materials: 12 inches (300 mm) square.
3. Jacket Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
4. Manufacturer's Color Charts: Show the full range of colors available for each type of field-applied finish material indicated.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

E. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups according to the following requirements, using materials indicated for the completed Work:

1. Include the following mockups:

a. One 10-foot (3 m) section of NPS 2 (DN 50) straight pipe.
b. One 90-degree elbow.
c. One tee fitting.
d. One NPS 2 (DN50) valve.
e. Four support hangers, including hanger shield and insert.
f. One strainer with removable portion of insulation.
g. One reducer.

1.4 QUALITY ASSURANCE (Cont.'):

2. Build mockups with cutaway sections to allow observation of application details for insulation materials, mastics, attachments, and jackets.
3. Build mockups in the location indicated or, if not indicted, as directed by Architect.
4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Obtain Architect's approval of mockups before starting insulation application.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports".

B. Coordinate clearance requirements with piping Installer for insulation application.

C. Coordinate installation and testing of steam or electric heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

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. Mineral-Fiber Insulation:

    a. *CertainTeed Manson.*
    b. *Knouf Fiber Glass GmbH.*
    c. *Owens-Corning Fiberglass Corp.*
    d. *Schuller International, Inc*.

2. Cellular-Glass Insulation:

    a. *Pittsburgh-Corning Corp*.

3. Flexible Elastomeric Thermal Insulation:

    a. *Armstrong World Industries, Inc.*
    b. *Rubatex Corp*.

4. Polyolefin Insulation:

    a. *Armstrong World Industries, Inc.*
    b. *IMCOA*.

5. Closed-Cell Phenolic-Foam Insulation:

    a. *Kooltherm Insulation Products, Ltd*.

6. Calcium Silicate Insulation:

    a. *Owens-Corning Fiberglass Corp.*
    b. *Pabco.*
    c. *Schuller International, Inc*.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all purpose, vapor-retarder jacket.
2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

    a. Class 1, Grade A for bonding glass cloth and tape to un-faced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to un-faced glass-fiber insulation.
    b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

4. Vapor-Retarder Mastics: Fire-and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.

2.2 INSULATION MATERIALS (Cont.'):

7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

B. Cellular- Glass Insulation: Inorganic, foamed or cellulosed glass, annealed, rigid, hermetically sealed cells, incombustible.

1. Preformed Pipe Insulation, without Jacket: Comply with ASTM C 552, Type II, Class 1.
2. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.

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

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

D. Polyolefin Insulation: Unicellular polyethylene thermal plastic, preformed pipe insulation. Comply with ASTM C 534, Type I, except for density.

1. Adhesive: As recommended by insulation material manufacturer.

E. Closed-Cell Phenolic-Foam Insulation: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade I.

F. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

G. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: White or gray.
3. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.

D. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil (0.75-mm) thick, high-impact, ultraviolet-resistant PVC.

2.3 FIELD-APPLIED JACKETS (Cont.'):

1. Shapes: 45 and 90 degree, short and long radius elbows, tees, valves, flanges, reducers, end caps, soil pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

E. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil (0.5-mm) thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45 and 90 degree, short and long radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

F. Aluminum Jacket: Factory cut and rolled to indicate sizes. Comply with ASTM B 209 (ASTM B 209M), 3003 alloy, H-14 temper.

G. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicate sizes. Comply with ASTM B 209 (ASTM B 209M), 3003 alloy, H-14 temper.

1. Finish and Thickness: Smooth finish, 0.010 inch (0.25 mm) thick.
2. Moisture Barrier: 1-mil-(0.025 mm) thick, heat-bonded polyethylene and Kraft paper.
3. Elbows: Preformed, 45 and 90 degree, short and long-radius elbows; same material, finish, and thickness as jacket.

H. Stainless-Steel Jacket: ASTM A666, Type 304 or 316; 0.10 inch (2.5 mm) thick; and factory cut and rolled to indicate sizes.

I. Stainless-Steel Jacket: ASTM A666, Type 304 or 316; 0.10 inch (2.5 mm) thick; and roll stock ready for shop or field cutting and forming to indicate sizes.

1. Moisture Barrier: 3-mil (0.075 mm) thick, heat-bonded polyethylene and Kraft paper.
2. Elbows: Gore type, for 45 and 90 degree elbows in same material, finish, and thickness as jacket.
3. Jacket Bands: Stainless steel, Type 304, ¾ inch (19 mm) wide.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized a minimum of 8 oz. /sq. yd. (270 g/sq.mt.).

1. Tape Width: 4 inches (100 mm).

B. Bands: ¾ inch (19 mm) wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A666, Type 304; 0.020 inch (0.5 mm) thick.
2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
3. Aluminum: 0.007 inch (0.18 mm) thick.

4. Brass: 0.010 inch (0.25 mm) thick.
5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.

C. Wire: 0.080-inch (2.0 mm), nickel-copper alloy; 0.062 inch (1.6 mm), soft-annealed, stainless steel; or 0.062 inch (1.6 mm), soft-annealed, galvanized steel.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

3.3 GENERAL APPLICATION REQUIREMENTS (Cont.'):

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-½ inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

    a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

3.3 GENERAL APPLICATION REQUIREMENTS (Cont.'):

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1. Seal penetrations with vapor-retarder mastic.
2. Apply insulation for exterior application tightly joined to interior insulation ends.
3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal metal jacket to roof flashing with vapor-retarder mastic.

Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Fire-stopping and fire-resistive joint sealers are specified in Division 7 Section "Fire-stopping".

T. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6m) to form a vapor retarder between pipe insulation segments.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION (Cont.'):

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve size where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 CELLULAR-GLASS INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.

3.5 CELLULAR-GLASS INSULATION APPLICATION (Cont.'):

3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply pre-molded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.6 FLEXIBLE ELASTOMERIC THERMAL, INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.7 POLYOLEFIN INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. For split tubes, seal longitudinal seams and end joints with manufacturer's recommended adhesive.
3. For self-adhesive insulation, staple longitudinal seams after sealing. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3.7 POLYOLEFIN INSULATION APPLICATION (Cont.'):

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of polyolefin pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.8 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

3.8 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION (Cont.'):

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered sections of phenolic-foam insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered segments of phenolic-foam insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.9 CALCIUM SILICATE INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with stainless-steel bands at 12 inch (300 mm) intervals and tighten without deforming insulation materials.
2. Apply two layer insulation with joints tightly-butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062 inch (1.6 mm), soft-annealed, stainless steel wire spaced at 12 inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12 inch (300 mm) intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-settings cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.

3.9 CALCIUM SILICATE INSULATION APPLICATION (Cont.'):

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
4. Finish flange insulation the same as pipe insulation.

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.
3. Finish insulation of fittings the same as pipe insulation.

D. Apply insulation to valves and specialties as follows:

1. Apply mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation the same as pipe insulation.

3.10 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch (50mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062 inch (1.6 mm) thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.

1. Draw jacket material smooth and tight.
2. Apply lap or joints strips with the same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-½ inch (40 mm) laps at longitudinal seams and 3 inch (75 mm) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

3.10 FIELD-APPLIED JACKET APPLICATION (Cont.'):

C. Apply PVC jacket where indicated, with 1 inch (25 mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

D. Apply metal jacket where indicated, with 2 inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.11 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass cloth jacket as specified in Division 9 Section "Painting".

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.12 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Drainage piping located in crawl spaces, unless otherwise indicated.
5. Below-grade piping, unless otherwise indicated.
6. Chrome-plated pipes and fittings, unless potential for personnel injury.
7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.13 FIELD QUALITY CONTROL

A. Inspection: Owner will engage a qualified inspection agency to perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements.

B. Inspection: Engage a qualified inspection agency to perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements.

C. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1. Inspect fittings and valves randomly selected by Architect.
2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.

D. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

E. Reinstall insulation and covers on fitting s and valves uncovered for inspection according to these Specifications.

3.14 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.15 INTERIOR INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot and recirculated hot water.

1. Operating Temperature: 60 to 140 degrees F (15 to 60 degrees C).
2. Insulation Material: **Flexible elastomeric closed cell phenolic foam**.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Copper Pipe, ½" to 2½": 1".
    b. Copper Pipe, 3" and Up: 1½".

4. Field-Applied Jacket: **None**.
5. Vapor Retarder Required: **No**.
6. Finish: **None**.

B. Service: Domestic chilled water.

1. Operating Temperature: 35 to 60 degrees F (2 to 15 degrees g C).
2. Insulation Material: **Flexible elastomeric closed-cell phenolic foam**.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Copper Pipe, ½" to 2½": 1 INCH.
    b. Copper Pipe, 3" and Up: 1½ INCHES.

4. Field-Applied Jacket: **Aluminum**.
5. Vapor Retarder Required: **Yes**.
6. Finish: **None**.

C. Service: Condensate drain piping.

1. Operating Temperature: 35 to 75 degrees F (2 to 24 degrees C).
2. Insulation Material: **Flexible elastomeric**.
3. Insulation Thickness: **1 inch**.
4. Field-Applied Jacket: **None**.
5. Vapor Retarder Required: **Yes**.
6. Finish: **None**.

D. Service: Chilled-water supply and return.

1. Operating Temperature: 35 to 75 degrees F (2 to 24 degrees C).
2. Insulation Material: **Flexible elastomeric Closed-cell phenolic foam.**
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Black Steel Pipe: **½" to 2½": 1 INCH.**
    b. Black Steel Pipe: **3" and Up: 1½ INCHES.**

4. Field-Applied Jacket: **Aluminum**.
5. Vapor Retarder Required: **Yes**.
6. Finish: **None**.

E. Service: Refrigerant suction and hot-gas piping.

1. Operating Temperature: 35 to 50 degrees F (2 to 10 degrees C).
2. Insulation Material: **Flexible elastomeric Closed-cell phenolic foam**.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Copper Pipe, ½" and Up: 1 INCH

4. Field-Applied Jacket: **Aluminum**.
5. Vapor Retarder Required: **Yes**.
6. Finish: **No**.

F. Service: Heating hot-water supply and return.

1. Operating Temperature: 100 to 200 degrees F (38 to 93 degrees C).
2. Insulation Material: **Cellular glass, with jacket**.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Black Steel and/or Copper Pipe, ½" to 2½": **1½ INCHES**
    b. Black Steel and/or Copper Pipe, 3" and Up: **2 INCHES**

4. Field-Applied Jacket: **Aluminum**.
5. Vapor Retarder Required: **No**.
6. Finish: **None**.

3.16 EXTERIOR INSULATION APPLICATION SCHEDULE

A. This application schedule is for aboveground insulation outside the building. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.

B. Service: Refrigerant suction.

1. Operating Temperature: 35 to 50 degrees F (2 to 10 degrees C).
2. Insulation Material: **Flexible elastomeric Closed-cell phenolic foam**, such as *Arma-Flex*.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Copper Pipe, ½" and Up: **1 INCH**.

4. Field-Applied Jacket: **Aluminum None**.
5. Vapor Retarder Required: **Yes**.
6. Finish: **None**.

C. Service: Chilled-water supply and return.

1. Operating Temperature: 35 to 75 degrees F (2 to 24 degrees C).
2. Insulation Material: **Flexible elastomeric Closed-cell phenolic foam**.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Black Steel and/or Copper Pipe, ½" to 2½": **1 INCH**.
    b. Black Steel and/or Copper Pipe, 3" and Up: **1½ INCHES**.

4. Field-Applied Jacket: **Aluminum**.
5. Vapor Retarder Required: **Yes**.
6. Finish: **None**.

D. Service: Heating hot-water supply and return.

1. Operating Temperature: 100 to 200 degrees F (38 to 104 degrees C).
2. Insulation Material: **Flexible elastomeric Closed-cell phenolic foam**.
3. Insulation Thickness: Apply the following insulation thicknesses:

    a. Copper Pipe, ½" to 2½: **1 INCH**.
    b. Copper Pipe, 3" and Up: **1½ INCHES**.

4. Field-Applied Jacket: **Aluminum**.
5. Vapor Retarder Required: **No**.
6. Finish: **None**.

END OF SECTION 15083

SECTION 15110

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 the following general-duty valves:

1. Bronze angle valves.
2. Cast-iron angle valves.
3. Copper-alloy ball valves.
4. Ferrous-alloy ball valves.
5. Ferrous-alloy butterfly valves.
6. High-pressure butterfly valves.
7. Bronze check valves.
8. Gray-iron swing check valves.
9. Ferrous-alloy wafer check valves.
10. Spring-loaded, lift-disc check valves.
11. Bronze gate valves.
12. Cast-iron gate valves.
13. Bronze globe valves.
14. Cast-iron globe valves.
15. Cast-iron plug valves.
16. Resilient-seated, cast-iron, eccentric plug valves.
17. Chain-wheel actuators.

B. Related Sections include the following:

1. Division 2 piping Sections for general-duty and specialty valves for site construction piping.
2. Division 13 fire-suppression piping and fire pump Sections for fire-protection valves.
3. Division 15 Section “Mechanical Identification” for valve tags and charts.
4. Division 15 Section “HVAC Instrumentation and Controls” for control valves and actuators.
5. Division 15 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.

1.3 DEFINITIONS (Cont.'):

2. EPDM: Ethylene-propylene-dyne ter-polymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Poly-tetra-fluoro-ethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetra-fluoro-ethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot and cold-water, **sanitary waste, and storm drainage** piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 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 angle, gate, and globe 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 valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand-wheels or stems as lifting or rigging points.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 (DN 50) and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-½ (DN 65) and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chain-wheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive: For quarter-turn valves NPS 8 (DN 200) and larger.
3. Hand-wheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 (DN 150) and smaller, except plug valves.
5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Solder Joint: With sockets according to ASME B16.18.

a. Caution: Use solder with melting point below 840 deg F (454 deg C) for angle, check, gate, and globe valves; below 421 deg F (216 deg C) for ball valves.

• 2.2 VALVES, GENERAL (Cont.'):

2. Threaded: With threads according to ASME B1.20.1.

J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE ANGLE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Bronze Angle Valves with Metal Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; *Stockham* Div.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Red-White Valve Corp.

2. Type 2, Bronze Angle Valves with Nonmetallic Disc:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; *Stockham* Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. NIBCO INC.
i. Powell, WM. Co.

3. Type 3, Bronze Angle Valves with Metal Disc and Renewable Seat:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; *Stockham* Div.
e. Grinnell Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.

C. Bronze Angle Valves, General: MSS SP-80, with ferrous-alloy hand-wheel.

D. Type 1, Class 125, 150 & 200 Bronze Angle Valves: Bronze body with bronze disc **and union-ring bonnet.**

• 2.3 BRONZE ANGLE VALVES (Cont.'):

E. Type 2, Class 125, 150 & 200 Bronze Angle Valves: Bronze body with **PTFE** or **TFE** disc **and union-ring bonnet.**

F. Type 3, Class 125, 150 & 200 Bronze Angle Valves: Bronze body with bronze disc and renewable seat. **Include union-ring bonnet**.

2.4 CAST-IRON ANGLE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type II, Cast-Iron Angle Valves with Metal Seats:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; *Stockham* Div.
d. NIBCO INC.

C. Cast-Iron Angle Valves, General: MSS SP-85, Type II.

D. Class 125, Cast-Iron Angle Valves: Bronze mounted with gray-iron body and bronze seats.

E. Class 250, Cast-Iron Angle Valves: Bronze mounted with gray-iron body and bronze seats.

2.5 COPPER-ALLOY BALL VALVES

A. Available Manufacturers:

B. Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Div.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. DynaQuip Controls.
f. Grinnell Corporation.
g. Jamesbury, Inc.
h. Kitz Corporation of America.
i. Legend Valve & Fitting
j. NIBCO INC.
k. Watts Industries, Inc.; Water Products Div.

2. Two-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves;
d. Crane Co.; Crane Valve Group; Stockham Div.
e. DynaQuip Controls.
f. Flow-Tek, Inc.
g. Grinnell Corporation.
h. Hammond Valve.
i. Honeywell Braukmann.
j. Jamesbury, Inc.
k. Jomar International, LTD.
l. Kitz Corporation of America.
m. Legend Valve & Fitting, Inc.
n. Milwaukee Valve Company.
o. Nexus Valve Specialties.
p. NIBCO INC.
q. R & M Energy Systems (Borger, TX).
r. Red-White Valve Corp.
s. Richards Industries; Marwin Ball Valves.
t. Watts Industries, Inc.; Water Products Div.

3. Three-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. DynaQuip Controls.
c. Grinnell Corporation.
d. Hammond Valve.
e. Jamesbury, Inc.
f. Kitz Corporation of America.
g. NIBCO Inc.
h. PBM, Inc.
i. Red-White Valve Corp.
j. Worcester Controls.

4. Safety-Exhaust, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. DynaQuip Controls.
c. Grinnell Corporation.
d. Hammond Valve.
e. Jamesbury, Inc.
f. Milwaukee Valve Company.
g. NIBCO INC.

C. Copper-Alloy Ball Valves, General: MSS SP-110.

D. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 400-psig (2760-kPa) minimum CWP rating.

• 2.5 COPPER-ALLOY BALL VALVES (Cont.'):

E. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.

F. Three-Piece, Copper-Alloy Ball Valves: Brass or bronze Forged body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.

G. Safety-Exhaust, Copper-Alloy Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating **for compressed air of at least 125 psig (860 KPa) or of 400-psig (2760-kPa) CWP**.

2.6 FERROUS-ALLOY BALL VALVES

A. Available Manufacturers:

B. Manufacturers:

1. American Valve, Inc.
2. Conbraco Industries, Inc.; Apollo Div.
3. Cooper Cameron Corp.; Copper Cameron Valves Div.
4. Crane Co.; Crane Valve Group; Stockham Div.
5. Flow-Tek, Inc.
6. Foster Valve Co.
7. Hammond Valve.
8. Jamesbury, Inc.
9. Jomar International, LTD.
10. Kitz Corporation of America.
11. KTM Products, Inc.
12. McCANNA, Incorporated.
13. Milwaukee Valve Company.
14. NIBCO INC.
15. PBM, Inc.
16. Richards Industries; Marwin Ball Valves.
17. Worcester Controls.

C. Ferrous-Alloy Ball Valves: General: MSS SP-72, with flanged ends.

D. Ferrous-Alloy Ball Valves: Class 150, full port.

E. Ferrous-Alloy Ball Valves: Class 300, full port.

2.7 FERROUS-ALLOY BUTTERFLY VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Flangeless, Ferrous-Alloy Butterfly Valves:

    a. American Valve, Inc.
    b. Bray International, Inc.
    c. Cooper Cameron Corp.; Copper Cameron Valves Div.
    d. Crane Co.; Crane Valve Group; Center Line.
    e. Crane Co.; Crane Valve Group; Stockham Div.
    f. Dover Corp.; Dover Resources Company; Norriseal Div.
    g. General Signal; DeZurik Unit.
    h. Grinnell Corporation.
    i. Hammond Valve.
    j. Kitz Corporation of America.
    k. Legend Valve & Fitting, Inc.
    l. Metraflex Co.
    m. Milwaukee Valve Company.
    n. Mueller Steam Specialty.
    o. NIBCO INC.
    p. Process Development & Control.
    q. Red-White Valve Corp.
    r. Techno Corp.
    s. Tyco International, Ltd.; Tyco Valves & Controls.
    t. Watts Industries, Inc.; Water Products Div.

2. Single-Flange, Ferrous-Alloy Butterfly Valves:

    a. American Valve, Inc.
    b. Bray International, Inc.
    c. Cooper Cameron Corp.; Cooper Cameron Valves Div.
    d. Crane Co.; Crane Valve Group; Center Line.
    e. Crane Co.; Crane Valve Group; Jenkins Valves.
    f. Crane Co.; Crane Valve Group; Stockham Div.
    g. Dover Corp.; dover Resources Company; Norriseal Div.
    h. General Signal; DeZurik Unit.
    i. Grinnell Corporation.
    j. Hammond Valve.
    k. Kitz Corporation of America.
    l. Legend Valve & Fitting, Inc.
    m. Metraflex Co.
    n. Milwaukee Valve Company.
    o. Mueller Steam Specialty.
    p. NIBCO INC.
    q. Process Development & Control.
    r. Red-White Valve Corp.
    s. Techno Corp.
    t. Tyco International, Ltd.; Tyco Valves & Controls.
    u. Watts Industries, Inc.; Water Products Div.

3. Flanged, Ferrous-Alloy Butterfly Valves:

    a. Bray International, Inc.
    b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
    c. Grinnell Corporation.
    d. Mueller Steam Specialty.
    e. Tyco International, Ltd.; Tyco Valves & Controls.

4. Grooved-End, Ductile-Iron Butterfly Valves:

    a. Central Sprinkler Co.; Central Grooved Piping Products.
    b. Grinnell Corporation.
    c. Hammond Valve.
    d. McWane, Inc.; Kennedy Valve Div.
    e. Milwaukee Valve Company.
    f. Mueller Steam Specialty.
    g. NIBCO INC.
    h. Victaulic Co. of America.

C. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.

D. Flangeless, 200-psig (1380-kPa) CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer type with one-piece stem.

E. Single-Flange, 200-psig (1380-kPa) CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with one-piece stem.

F. Flanged, 200-psig (1380-kPa) CWP Rating, Ferrous-Alloy Butterfly Valves: Flanged-end type with one-piece stem.

G. Grooved-End, 175-psig (1207-kPa) CWP Rating, Ferrous-Alloy Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends.

2.8 BRONZE CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type I, Bronze, Horizontal Lift Check Valves with Metal Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Stockham Div.
    d. Red-White Valve Corp.
    e. Walworth co.

• 2.8 BRONZE CHECK VALVES (Cont.'):

2. Type 2, Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; *Stockham* Div.
    e. Walworth Co.

3. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Red-White Valve Corp.

4. Type 2, Bronze, Vertical Lift Check Valves with Nonmetallic Disc:

    a. Grinnell Corporation.
    b. Kitz Corporation of America.
    c. Milwaukee Valve Company.

5. Type 3, Bronze, Swing Check Valves with Metal Disc:

    a. American Valve, Inc.
    b. Cincinnati Valve Co.
    c. Crane Co.; Crane Valve Group; Crane Valves.
    d. Crane Co.; Crane Valve Group; Jenkins Valves.
    e. Crane Co.; Crane Valve Group; Stockham Div.
    f. Grinnell Corporation.
    g. Hammond Valve.
    h. Kitz Corporation of America.
    i. Legend Valve & Fitting, Inc.
    j. Milwaukee Valve Company.
    k. NIBCO INC.
    l. Powell, Wm. Co.
    m. Red-White Valve Corp.
    n. Walworth Co.
    o. Watts Industries, Inc.; Water Products Div.

6. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. Grinnell Corporation.
    f. Hammond Valve.
    g. McWane, Inc.; Kennedy Valve Div.
    h. Milwaukee Valve Company.

• 2.8 BRONZE CHECK VALVES (Cont.'):

i. NIBCO INC.
j. Red-White Valve Corp.
k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.

C. Bronze Check Valves, General: MSS SP-80.

D. Type 1, Class 200, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

E. Type 1, Class 200, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

F. Type 2, Class 200, Bronze, and Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

G. Type 2, Class 200, Bronze, and Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

H. Type 3, Class 200, Bronze, and Swing Check Valves: Bronze body with bronze disc and seat.

I. Type 4, Class 200, Bronze, and Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.9 GRAY-IRON SWING CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Gray-Iron Swing Check Valves with Metal Seats:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Flomatic Valves.
f. Grinnell Corporation.
g. Hammond Valve.
h. Kitz Corporation of America.
i. Legend Valve & Fitting, Inc.
j. Milwaukee Valve Company.
k. Mueller Co.
l. NIBCO INC.
m. Powell, Wm. Co.
n. Red-White Valve Corp.
o. Walworth Co.
p. Watts Industries, Inc.; Water Products Div.

• 2.9 GRAY-IRON SWING CHECK VALVES (Cont.'):

2. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; *Stockham* Div.
c. Mueller Co.
d. Watts Industries, Inc.; Water Products Div.

3. Grooved-End, ductile-Iron Swing Check Valves:

a. Grinnell Corporation.
b. Mueller Co.
c. Victaulic Co. of America.

C. Gray-Iron Swing Check Valves, General: MSS SP-71.

D. Type I, Class 250, gray-iron, swing check valves with metal seats.

E. Type II, Class 250, gray-iron, swing check valves with composition to metal seats.

F. 175-psig (1207-kPa) CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends.

2.10 FERROUS-ALLOY WAFER CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Single-Plate, Ferrous-Alloy, Wafer Check Valves:

a. Gestra, Inc.
b. McWane, Inc.; Kennedy Valve Div.
c. Mueller Co.
d. Techno Corp.
e. Tyco International, Ltd.; Tyco Valves & Controls.
f. Wheatley Gaso, Inc.

2. Dual-Plate, Ferrous-Alloy, Wafer Check Valves:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; *Stockham* Div.
c. Flomatic Valves.
d. Gestra, Inc.
e. Grinnell Corporation.
f. Gulf Valve Co.
g. Metraflex Co.
h. Mueller Steam Specialty.

• 2.10 FERROUS-ALLOY WAFER CHECK VALVES (Cont.'):

i. NIBCO INC.
j. Red-White Valve Corp.
k. SSI Equipment, Inc.
l. Techno Corp.
m. Val-Matic Valve & Mfg. Corp.
n. Valve and Primer Corp.
o. Watts Industries, Inc.; Water Products Div.

3. Dual-Plate, Ferrous-Alloy, Wafer-Lug Check Valves:

a. Crane Co.; Crane Valve Group; Crane Vales.
b. Gulf Valve Co.
c. Valve and Primer Corp.

4. Dual-Plate, Ferrous-Alloy, Double-flanged-Type Check Valves:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Gulf Valve Co.
c. Techno Corp.

C. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.

D. Single-Plate, Class 125 or 150, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

E. Single-Plate, Class 125 or 150, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

F. Single-Plate, Class 125 or 150, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

G. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

H. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

I. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

2.11 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type I, Wafer Lift-Disc Check Valves:

a. Mueller Steam Specialty.

• 2.11 SPRING-LOADED, LIFT-DISC CHECK VALVES (Cont.'):

2. Type II, compact-Wafer, Lift-Disc Check Valves:

    a. Durabla Fluid Technology, Inc.
    b. Flomatic Valves.
    c. GA Industries, Inc.
    d. Grinnell Corporation.
    e. Hammond Valve.
    f. Metraflex Co.
    g. Milwaukee Valve Company.
    h. Mueller Steam Specialty.
    i. Multiplex Manufacturing Co.
    j. NIBCO INC.
    k. SSI Equipment, Inc.
    l. Val-Matic Valve & Mfg. Corp.
    m. Valve and Primer Corp.

3. Type III, Globe Lift-Disc Check Valves:

    a. Durabla Fluid Technology, Inc.
    b. Flomatic Valves.
    c. GA Industries, Inc.
    d. Grinnell Corporation.
    e. Hammond Valve.
    f. Metraflex Co.
    g. Milwaukee Valve Company.
    h. Multiplex Manufacturing Co.
    i. NIBCO INC.
    j. SSI Equipment, Inc.
    k. Val-Matic Valve & Mfg. Corp.
    l. Valve and Primer Corp.

4. Type IV, Threaded Lift-Disc Check Valves:

    a. Check-All Valve Mfg. Co.
    b. Durable Fluid Technology, Inc.
    c. Grinnell Corporation.
    d. Legend Valve & Fitting, Inc.
    e. Metraflex Co.
    f. Milwaukee Valve Company.
    g. Mueller Steam Specialty.
    h. NIBCO INC.
    i. Watts Industries, Inc.; Water Products Div.

C. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

D. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

• 2.11 SPRING-LOADED, LIFT-DISC CHECK VALVES (Cont.'):

E. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

F. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

G. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

2.12 BRONZE GATE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Bronze, Non-Rising Stem Gate Valves:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; *Stockham* Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Kitz Corporation of America.
i. Legend Valve & Fitting, Inc.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Powell, Wm. Co.
m. Red-White Valve Corp.
n. Walworth Co.
o. Watts Industries, Inc.; Water Products Div.

2. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; *Stockham* Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Kitz Corporation of America.
i. Milwaukee Valve Company.
j. NIBCO INC.
k. Powell, Wm. Co.
l. Red-Whire Valve Corp.
m. Walworth Co.

• 2.12 BRONZE GATE VALVES (Cont.'):

3. Type 3, Bronze, Rising-Stem, Split-Wedge Gate Valves:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Grinnell Corporation.
    d. NIBCO INC.

C. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy hand-wheel.

D. Type 1, Class 200, Bronze Gate Valves: Bronze body with non-rising stem and bronze solid wedge **and union-ring bonnet**.

E. Type 2, Class 200, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge **and union-ring bonnet**.

F. Type 3, Class 200, Bronze Gate Valves: Bronze body with rising stem and bronze split wedge **and union-ring bonnet**.

2.13 CAST-IRON GATE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Cast-Iron, Non-Rising Stem Gate Valves:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; *Stockham* Div.
    e. Grinnell Corporation.
    f. Hammond Valve.
    g. Kitz Corporation of America.
    h. Legend Valve & Fitting, Inc.
    i. Milwaukee Valve Company.
    j. NIBCO INC.
    k. Powell, Wm. Co.
    l. Red-White Valve Corp.
    m. Walworth Co.
    n. Watts Industries, Inc.; Water Products Div.

2. Type 1, Cast-Iron, Rising –Stem Gate Valves:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.

• 2.13 CAST-IRON GATE VALVES (Cont.'):

d. Crane Co.; Crane Valve Group; *Stockham* Div.
e. Grinnell Corporation.
f. Hammond Valve.
g. Kitz Corporation of America.
h. Legend Valve & Fitting, Inc.
i. Milwaukee Valve Company.
j. NIBCO INC.
k. Powell, Wm. Co.
l. Red-White Valve Corp.
m. Walworth Co.
n. Watts Industries, Inc.; Water Products Div.

C. Cast-Iron Gate Valves, General: MSS SP-70, Type 1.

D. Class 125, NRS, Bronze-Mounted, and Cast-Iron Gate Valves: Cast-iron body with bronze trim, non-rising stem, and solid-wedge disc.

E. Class 125, OS&Y, Bronze-Mounted, and Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

F. Class 250, NRS, Bronze-Mounted, and Cast-Iron Gate Valves: Cast-iron body with bronze trim, non-rising stem, and solid-wedge disc.

G. Class 250, OS&Y, Bronze-Mounted, and Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.14 BRONZE GLOBE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; *Stockham* Div.
e. Grinnell Corporation.
f. Hammond Valve.
g. Kitz Corporation of America.
h. Legend Valve & Fitting, Inc.
i. Milwaukee Valve Company.
j. NIBCO INC.
k. Powell Wm. Co.
l. Red-White Valve Corp.
m. Walworth Co.

• 2.14 BRONZE GLOBE VALVES (Cont.'):

2. Type 2, Bronze Globe Valves with Nonmetallic Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. Grinnell Corporation.
    f. Hammond Valve.
    g. Kitz Corporation of America.
    h. McWane, Inc.; Kennedy Valve Div.
    i. Milwaukee Valve Company.
    j. NIBCO INC.
    k. Powell, Wm. Co.
    l. Red-White Valve Corp.
    m. Walworth Co.

3. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; *Stockham* Div.
    e. Grinnell Corporation.
    f. Hammond Valve.
    g. Milwaukee Valve Company.
    h. NIBCO INC.
    i. Walworth Co.

C. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy hand-wheel.

D. Type 1, Class 200, Bronze Globe Valves: Bronze body with bronze disc **and union-ring bonnet**.

E. Type 2, Class 200, Bronze Globe Valves: Bronze body with **PTFE or TFE disc and union-ring bonnet**.

F. Type 3, Class 200, Bronze Globe Valves: Bronze body with bronze disc and renewable seat. **Include union-ring bonnet**.

2.15 CAST-IRON GLOBE VALVES

A. Available Manufacturers.

B. Manufacturers:

1. Type 1, Cast-Iron Globe Valves with Metal Seats:

    a. Cincinnati Valve Co.

• 2.15 CAST-IRON GLOBE VALVES (Cont.'):

b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; *Stockham* Div.
e. Grinnell Corporation.
f. Hammond Valve.
g. Kitz Corporation of America.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell, Wm. Co.
k. Red-White Valve Corp.
l. Walworth Co.

C. Cast-Iron Globe Valves, General: MSS SP-85.

D. Type I, Class 125, Cast-Iron Globe Valves: Gray-Iron body with bronze seats.

E. Type 1, Class 250, Cast-Iron Globe Valves: Gray-Iron body with bronze seats.

2.16 CAST-IRON PLUG VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Lubricated-Type, Cast-Iron Plug Valves:

a. Milliken Valve Co.; Inc.
b. Nordstrom Valves, Inc.
c. Olson Technologies; Homestead Div.
d. R & M Energy systems (Tomball, TX).
e. Walworth Co.

2. Non-Lubricated-Type, Cast-Iron Plug Valves:

a. General signal; DeZurik Unit.
b. Grinnell Corporation.
c. Mueller Flow Technologies.
d. Tyco International, Ltd.; Tyco Valves & Controls.
e. Wheatley Gaso, Inc.
f. Xomox Corporation.

C. Cast-Iron Plug Valves, General: MSS SP-78.

D. Class 125 or 150, lubricated-type, cast-iron plug valves.

2.17 RESILENT-SEATED, CAST-IRON, ECCENTRIC PLUG VALVES

A. Available Manufacturers:

B. Manufacturers:

1. General Signal; DeZurik Unit.
2. Milliken Valve Company.
3. Olson Technologies; Homestead Div.
4. Pratt, Henry Company.
5. Val-Matic Valve & Mfg. Corp.

C. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 2-½ (DN 65) and Smaller: Design similar to MSS SP-108, and rated for 175-psig (1207-kPa) minimum CWP.

D. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 3 (DN 80) and Larger: MSS SP-108, and rated for 175-psig (1207-kPa) minimum CWP.

1. Resilient Seating Material: Suitable for potable-water service, unless otherwise indicated.

2.18 CHAINWHEEL ACTUATORS

A. Available Manufacturers:

B. Manufacturers:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries, Inc.

C. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Sprocket Rim with Chain Guides: **Ductile iron**, of type and size required for valve. **Include zinc coating**.
2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
3. Chain: **Hot-dip, galvanized steel**, of size required to fit sprocket rim.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

• 3.1 EXAMINATION (Cont.'):

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 in positions from fully open to fully close. Examine guides and seats made accessible by such operations.

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. Verify that gasket in of proper size that its material composition is suitable for service, and that it is free form defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, **or gate, gate, or plug** valves.
2. Throttling Service: Angle, ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of vales with higher SWP class or CWP ratings may be substituted.

C. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-½ to NPS 4 (DN 65 to DN 100): Flanged or threaded ends.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-½ to NPS 4 (DN 65 to DN 100): Flanged ends.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End, **Copper Tubing and Steel Piping:** Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

• 3.3 VALVE INSTALLATION (Cont.'):

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chain-wheel operators on valves **NPS 4 (DN 100)** and larger and more than 96 inches (2400 mm) above floor. Extend chains to **60 inches (1520 mm)** above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: in horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15110

SECTION 15121

PIPE EXPANSION FITTINGS AND LOOPS

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 Sections includes the following pipe expansion joints and expansion compensation devices for mechanical piping systems:

1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Rubber expansion joints.
4. Flexible-hose expansion joints.
5. Packed slip expansion joints.
6. Flexible ball joints.
7. Pipe bends and loops.
8. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chloro-sulfonated polyethylene synthetic rubber.

D. CSM: Chloro-sulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-dyne ter-polymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressure, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

A. Product Data: for each type of pipe expansion joint and alignment guide indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculation: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

D. Welding certificates.

E. Operation and Maintenance Data: For pipe expansion joints to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code – Steel".
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirement, provide products by one of the manufacturers specified.

2.2 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

1. Manufacturers:

    a. Adsco Manufacturing, LLC.
    b. Anamet, Inc.
    c. Badger Industries.
    d. Expansion Joint Systems, Inc.
    e. Flex-Hose Co., Inc.
    f. Flexicraft Industries.
    g. Flex-Pression, Ltd.
    h. Flex-Weld, Inc.
    i. Hyspan Precision Products, Inc.
    j. Metraflex, Inc.
    k. Piping Technology & Products, Inc.
    l. Proco Products, Inc.
    m. Senior Flexonics, Inc.; Pathway Division.
    n. Tozen America Corp.
    o. Unaflex Inc.
    p. WahlcoMetroflex.

2. Metal-Bellows Expansion Joints for Copper Piping: **Multiple**-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
3. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
4. Metal-Bellows Expansion Joints for Steel Piping: **Multiple**-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
5. Minimum Pressure Rating: 175 psig (1200 kPa), unless otherwise indicated.
6. Configuration: **Double**-bellows type **with base**, unless otherwise indicated.
7. End Connections: **Flanged or weld**.

B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, anti-torque device, and removable end clip for positioning.

1. Manufacturers:

    a. Adsco Manufacturing, LLC.
    b. Flexicraft Industries.
    c. Flex-Pression, Ltd.
    d. Flex-Weld, Inc.
    e. Hyspan Precision Products, Inc.
    f. Metraflex, Inc.
    g. Senior Flexonics, Inc.; Pathway Division.
    h. Unaflex Inc.

2. Minimum Pressure Rating: 175 psig (1200 kPa), unless otherwise indicated.

• ARTICLE 2.2A (Cont.):

3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
4. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
5. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: **Solder joint or threaded**.
6. End Connections for Copper Tubing NPS 2-½ to NPS 4 (DN 65 to DN 100): **Solder joint or threaded**.
7. End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
8. End Connections for Steel Pipe NPS 2-½ to NPS 4 (DN 65 to DN 100): **Flanged or Welded**.

C. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors".

1. Manufacturers:

   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Flex-Weld, Inc.
   d. Garlock Sealing Technologies.
   e. General Rubber Corp.
   f. Mason Industries, Inc.; Mercer Rubber Co.
   g. Metraflex, Inc.
   h. MG Piping Products Co.
   i. Proco Products, Inc.
   j. Red Valve Company, Inc.
   k. Senior Flexonics, Inc.; Pathway Division.
   l. Tozen America Corp.
   m. Unaflex Inc.
   n. Vibration Mountings & Controls, Inc.

2. Arch Type: Multiple arches.

3. Spherical Type: Multiple spheres.

   a. Minimum Pressure and Temperature Ratings for NPS 1-½ to NPS 4 (DN 40 to DN 100): [150 psig (1035 kPa) at 220 deg F (104 deg C).
   b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6 (DN 125 and DN 150): [140 psig (966 kPa) at 200 deg F (93 deg C).
   c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12 (DN 200 to DN 300): [140 psig (966 kPA) at 180 deg F (82 deg C).

4. Material: Buna-N

5. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

D. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers:

    a. Flex-Hose Co., Inc.
    b. Flexicraft Industries.
    c. Flex-Pression, Ltd.
    d. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder joint end connections.

    a. NPS 2 (DN 50) and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
    b. NPS 2-½ to NPS 4 (DN 65 to DN 100): Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
    c. NPS 2 (DN 50) and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.
    d. NPS 2-½ to NPSW 4 (DN 65 to DN 100): Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.

3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 (DN 50) and smaller and flanged or welded end connections for NPS 2-½ (DN 65) and larger.

    a. NPS 2 (DN 50) and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
    b. NPS 2-½ to NPS 6 (DN 65 to DN 150): Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
    c. NPS 8 to NPS 12 (DN 200 to DN 300): Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.
    d. NPS 2 (DN 50) and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.
    e. NPS 2-½ to NPS 6 (DN 65 to DN 150): Stainless-steel hoses and double-braid, stainless-steel sheaths with sheaths with 275 psig at 70 deg F (1900 kPa at 21 deg C) and 200 psig at 600 deg F (1380 kPa at 315 deg C) ratings.
    f. NPS 8 (DN 200) and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

E. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F (1725 kPa at 204 deg C) minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.

1. Manufacturers:

    a. Adsco Manufacturing, LLC.
    b. Advanced Thermal Systems, Inc.
    c. Hyspan Precision Products, Inc.

2. Configuration: Double-joint class with base, unless otherwise indicated.
3. End Connections: Flanged or weld ends to match piping system.

F. Flexible Ball Joints: Carbon-steel assembly with asbestos-free composition packing, designed for 360-degree rotation and angular deflection, and 250 psig at 400 deg F (1725 kPa at 204 deg C) minimum pressure rating; complying with ASME Boiler and Pressure Vessel Code: Section II, "Materials", and with ASME B31.9, "Building Services Piping", for materials and design of pressure-containing parts and bolting.

1. Angular Deflection for NPS 6 (DN 150) and Smaller: 30-degree minimum.
2. Angular Deflection for NPS 8 (DN 200) and Larger: 15-degree minimum.
3. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
4. End Connections for NPS 2-½ (DN 65) and Larger: Flanged.
5. Manufacturers:

    a. Advanced Thermal Systems, Inc.
    b. Hyspan Precision Products, Inc.

2.3 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:

    a. Adsco Manufacturing, LLC.
    b. Advanced Thermal Systems, Inc.
    c. Flex-Hose Co., Ing.
    d. Flexicraft Industries.
    e. Flex-Weld, Inc.
    f. Hyspan Precision Products, Inc.
    g. Metraflex, Inc.
    h. Piping Technology & Products, Inc.
    i. Senior Flexonics, Inc.; Pathway Division.

2.4 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F844, steel, pain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: zinc-coated steel.
3. Washer and Nut: zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-componet epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland Cement Mix, 3000 psi (20.7 MPa) minimum. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink, nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 – EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, non-metallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors".

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion joints and bends and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION

SECTION 15180

HEATING AND COOLING PIPING

PART 1 – GENERAL

1.01 SUMMARY

A. This section provides the general requirements for heating and/or cooling piping and related equipment or materials to be installed at aforementioned project.

1.02 SCOPE OF WORK

A. Furnish and install heating and cooling pipes, conforming in all aspects to the specifications, schedules and plans or drawings or as indicated by Engineer or PBA representative.

B. Furnish and install any accessories required by heat and cooling pipes for proper operation of the equipment's as recommended by manufacturer or distributors and is not specific in drawings. Check with Engineer or PBA representative for approval.

C. Pipes in this section include:

1. Heating water.
2. Cooling (Chilled) water.
3. Condensate
4. Refrigerant
5. Piping Specialties
    i. Flow measuring devices – Venturi Type.
6. Refrigeration Specialties
    i. Water Treatment Equipment & Materials.
    ii. Glycol makeup units.
    iii. Filter Feeder – Heating and cooling water systems.
    iv. Chemical feed system – Condenser water.
    v. System cleaning.

1.03 RELATED WORKS

A. Section 15050 – Basic Mechanical Materials and Methods.

B. Section 15075 – Mechanical Identification.

C. Section 15083 – Pipe Insulation.

D. Section 15950 – Testing, Adjusting and Balancing.

1.04 RELATED STANDARDS

A. ARI – Air Conditioning and Refrigeration Institute.

B. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.

C. ASTM – American Society of Testing Materials.

D. NEC – National Electrical Code.

E. NFPA – National Fire Protection Association.

F. NEMA – National Electric Manufacturers Association.

G. UL – United Laboratories.

H. OSHA – Office of Safety and Health Act

I. EPA – Environmental Protection Agency

1.05 SUBMITTALS

A. Submit three (3) copies of data for any kind of pipe expected to be used or indicated in drawing or as specified for any applicable code.

B. Submittal shall include manufacturer data:

1. Weight, physical properties, thermal properties, electrical properties.

2. Drawing showing pipe configuration, connection size, overall dimension and field clearances and pipe requirements.

3. Chemical analysis or material composition.

4. Installation recommendations.

1.06 QUALITY ASSURANCE

A. Inspect pipes delivered to site for damages.

B. Store with minimum handling and comply with manufacturer's instruction for rigging, loading-unloading and transportation.

C. Store and protect as indicated by manufacturer against weather or vandalism.

D. Keep materials and equipment free of debris and dirt.

PART 2 – PRODUCTS

2.01 STEEL PIPE

A. Heating, Cooling and Condenser water pipe allowed for all sizes.

1. ASTM A53, Grade B, seamless Schedule 40.

2. ASTM A106, Schedule 40 (for high temperature).

3. ASTM A120, Not permitted in any service.

2.02 COPPER PIPE & TUBING

1. Heating, Cooling piping allowed on sizes 2½" and smaller only.

2. ASTM B88 Type L hard drawn.

3. Drains and Condensate piping: Type DWV per ASTM-B306 or Type L hard ASTM B88.

4. Refrigerant: Type ACR per ASTM-B280.

5. Size pipe at 5'/100' max. pressure drop.

2.03 FITTINGS

A. For steel pipe: flanged or butt weld for larger sizes, ASTM B31.

B. For copper water or drain: wrought copper or cast bronze. Lead free solder.

C. Refrigerant:

1. Brazed joint or flared.

2. Brazed joints: long radius wrought-copper or forged-brass sweat fittings. Do not use cast sweat-type fittings. Cadmium free filler metal.

3. Flare joints: standard SAE forged brass short-shank.

D. Make all connections between ferrous and non-ferrous material through dielectric unions, fittings or flanges. Install isolation valve upstream of dielectric.

2.05 PRESSURE GAUGES

A. Four and One-half inch minimum face diameter, ¼" NPT brass bottom mount, steel case, adjustable steel pointer, accuracy 1% of full scale or better.

B. Stainless steel case, phosphorous bronze Bourdon tube and corrosion resistant movement.

C. Maximum range: approximately double the expected working pressure of the service.

D. Install with an isolation valve and a drain valve between the gauge and the isolation valve.

E. Install a pressure snubber in services with rapid pressure pulses.

F. White face with black lettering.

G. Calibration adjustment by screwdriver.

H. Acceptable manufacturers:

1. Ashcroft
2. Dwyer
3. Foxboro
4. Honeywell
5. U.S. Gauge
6. Johnson Controls
7. Weiss
8. Duro
9. Other as Engineer approved

2.06 THERMOMETERS

A. Painted vertical metal case with 8" long (min) reading scale, glass or Lucite face, adjustable multi-angle housing and brass separable socket.

B. Bottom or back pipe thread connection.

C. Use thermal wells with heat transfer enhancement compound in piping services.

D. Range (s):

1. Heating Water: 50ºF to 300ºF with 2ºF scale divisions.

2. Cooling Water: 20ºF to 100ºF with 2 ºF scale divisions.

E. Accuracy: 1% of full scale or better.

F. Acceptable manufacturers:

1. Cooper
2. Davis
3. Duro
4. Weiss
5. Foxboro
6. Taylor
7. Other as Engineer approved

2.07 PIPING SPECIALTIES

A. ¼" or ½" MPT pressure temperature taps: Stainless steel for condensate services, brass or bronze for water and air service, extended stem for insulated pipes.

B. Acceptable manufacturers:

1. Universal Lancaster
2. Sisco
3. Peterson Equipment Co.

C. Basket Strainers: Cast iron body with flanged connections and stainless steel easily removable basket, ⅛"" staggered perforations, Hayward Model 72 or similar Kinney, Elliot or Zum.

D. Backflow Preventer:

1. Air gap fittings are the preferred method of preventing backflow. If a preventer is required discuss with the Engineer.

2. Fire Protection entry – Double check assembly.

3. Irrigation service – Vacuum breaker.

E. Automatic Air Vents: High capacity float-type with brass or semi-steel body, copper float and removable top for cleaning.

F. Expansion Tanks: Closed hydro-pneumatic diaphragm or bladder type, welded steel, rated for 125 psig, cleaned, prime coated, steel support saddles.

1. Acceptable expansion tank manufacturers:

i. Amtrol
ii. Armstrong
iii. Bell & Gossett
iv. Taco
v. Other as Engineer approved

G. Air Purger: Line size with automatic vent. Acceptable manufacturer: Amtrol.

H. Air Separators: Tangential type; fabricated, tested and stamped in accordance with the ASME code; cast iron or steel tank, removable galvanized steel strainer, perforated stainless steel all collector tube, 125 psig working pressure.

1. Acceptable manufacturers:

i. Taco
ii. Amtrol
iii. Bell & Gossett
iv. Other as Engineer approved

I. Relief Valves: Bronze or iron body, bronze trim, bronze lifting gear, ASME rated direct spring loaded type, lever operated, non-adjustable factory set discharge pressure.

1. Acceptable Manufacturers:

i. McDonnell-Miller
ii. Bell & Gossett.
iii. Watts
iv. Other as Engineer approved.

J. Combination Check and Shut-off Valves: cast iron body, contoured disc, calibrated balancing adjustment, back-seating valve stem. Install on discharge side of pump with stem up, suitable for 175 psig working pressure and 300 F operating temperature.

K. Pressure Reducing Valve: all bronze, adjustable spring and diaphragm; integral strainer, female thread connections.

1. Acceptable manufacturers of pressure reducing valves:

i. Armstrong
ii. Bell & Gossett
iii. Fisher
iv. Taco
v. Other as Engineer approved.

2.08 REFRIGERATION SPECIALTIES

A. Filter-dryers:

1. Conform to ARI Standard 710.

2. Full flow replaceable core in sizes ½" and larger.

3. Sealed type in sizes smaller than ½".

4. Use desiccant cores that will not plug, cake, channel, or break down, but remove water, acid, and foreign material from the refrigerant.

5. Construct so that no desiccant can pass into the refrigerant lines.

6. Minimum bursting pressure, 1,500 psi.

7. Provide in liquid line to each evaporator.

B. Strainers:

1. Brass or cast iron body.

2. Not less than 60-mesh non-corrodible screen of a free area not less than ten times the pipe diameter.

C. Sight Glass:

1. Provide in the liquid line preceding each expansion valve.

D. Discharge-line oil separator:

1. Rated capacity equal to or greater than that of the compressor.

2. Provide with an oil-float valve assembly or needle valve and orifice assembly, drain-line shutoff valve, and sight glass.

3. Connect oil-return line to the compressor.

E. Charging valves:

1. General purpose type with brass body, flared or solder ends, and removable valve core. Provide quick coupling connection at valve inlet.

F. Flow Measuring Devices:

1. Flow measuring devices 2" and smaller may be a combination measuring device and balancing/shut off valve assembly or a separate venture with a remote balancing valve.

   i. Device shall be non-ferrous pressure die-cast construction with sweat or threaded ends, 300 psi WSP at 250ºF.
   ii. Venturi/ball valve with integral flow measuring tops, adjustable memory set, and full size locking indicating handle.

iii. Orifice-type balancing devices are not acceptable.
iv. Minimum accuracy +/-3%.
v. Acceptable manufacturers:

a) Barco
b) Gerand
c) Preso
d) Flow Design

2. Flow measuring devices 2½" and larger shall consist of a venture unit and separate balancing valve.

i. Cast steel with weld ends or machined steel for butt welding, 150 psi WSP at 250ºF.
ii. Venturi unit shall include manual shut-off valves and quick-disconnect fittings at meter taps and shall be furnished with tags marked with Venturi size, station designations, GPM, and meter reading for GPM.
iii. Orifice-type balancing devices are not acceptable.
iv. Bore sizes shall be selected so that meter read-out at specified flow rate is between 7" and 27" w.g.
v. Minimum accuracy +/-3%.
vi. Acceptable manufacturers:

a) Barco
b) Gerand
c) Preso

3. Meter in High impact case to match Venturi output values.

2.09 WATER TREATMENT EQUIPMENT (**if applies, in accordance to plans**)

A. Chemical Feed System – Condenser Water:

1. Water treatment Subcontractor shall have been in business and providing water treatment services in the geographical area for a minimum of 5 years.

2. System shall be a Total-Dissolved-Solids Bleed and Pulse Feed Treatment System for automatic injection of Biocides and Inhibitors determined by the subcontractor. System shall include but not be limited to: Makeup water meter, Dual Biocide feed with timer control and two positive displacements pumps, Bleed solenoid valve, conductivity controller (bleed or blow-down control by Beta Hydac, Pulsa Feeder or approved equal and automatic blow-down valve.

3. Chemicals shall include but not be limited to: Inhibitor – 360 PPM organophosphate (Aqua Chem. 8031) and Biocide – Level determined by subcontractor (Aqua Chem A576 or approved equal) Clean, Flush and provide complete service for one full cooling season.

• ARTICLE 2.9A (Cont.'):

4. Contractor to furnish for inclusion the O&M manual:

   i. Water test data on chemical concentrations.
   ii. MSDS sheets and manufacturer and supplier of all chemicals used.

PART 3 – INSTALLATION

3.01 WORK PREPARATION

A. Contractor shall remove the existing pipes as indicated by Engineer.

1. Removing includes plumbing connections not necessary for futures works of new equipment's. Consult Engineer or PBA representative for complete scope of removing scope.

2. Final disposition of removed equipment and material shall complaint with Puerto Rico environmental standards and regulations, and EPA.

B. Contractor shall to coordinate any work with PBA representative or Engineer.

C. Contractor shall coordinate any work to be executing out of regular offices hours.

D. Contractor shall be responsible by all necessary permissions and taxes in the transportation from distributor or fabrication facilities to installation site.

E. Contractor shall be responsible for handling and disposal of any kind of hazardous material find it in the pre-bid visit or in the installation process.

3.02 GENERAL

A. Automatic Air Vents shall be installed with ball type isolation valves upstream and unions on vent discharge pipe.

B. Wye type strainers shall be installed upstream of control valves.

C. Coil valves and drains – All heating and cooling coils shall have ball type isolation valves and drain valves with GHT, cap and chain.

D. Test refrigerant pipe in accordance with ARI standards. Pressure test only, Vacuum Testing is not acceptable.

3.03 REFRIGERANT PIPE INSTALLATION

A. Pitch suction lines 1" in 15' toward the compressor, install oil traps, consisting of short radius fittings, at the bases of vertical suction lines.

B. Shop drawings: refrigerant piping sizing, layout and accessories.

3.04 SPECIAL DEVICES (**if applies, in accordance to plans**)

A. Install a pressure-temperature tap on each side of each of equipment as (pump, chillers, cooling towers, AHU, heat transfer device, coils, radiators, radiant panels and others.

B. Install one hydronic balancing valve as defined above in series with each air handling unit coil, heat exchanger, each section of fin tube radiators or radiant panels. A section is defined as that assembly controlled by one stat/temperature control valve combination.

C. Expansion tanks, air separators and other devices heavier than 200 pounds may not be suspended from overhead without written permission from the Structural Engineer.

D. Flow (paddle) Switches are not recommended. They may be used if required by equipment manufacturer. The Engineer shall carefully and fully detail flow switch installation if used.

3.05 VALVES

Provide valves on lines before they enter and after they leave a relatively inaccessible basement, crawl space or trench.

3.06 GAUGES AND THERMOMETERS

Calibrate all gauges and thermometers in the presence of the Engineer prior to installation.

3.07 DIELECTRIC UNIONS

Install dielectric fittings at connections between dissimilar metals. Install an isolation valve upstream of dielectric.

3.08 FILTER FEEDERS

Provide filter feeders in the heating and cooling systems.

3.09 PRE-OPERATIONAL FLUSH AND CLEANING

A. Notify the Engineer five (5) work days in advance of starting the cleaning. Cleaning and flushing of all systems shall take place in the presence of the District Project Manager or his designated representative. "Certification of Work Certificate" documents the cleaning procedure and personnel involved. The designated representative observing the cleaning shall sign the certification. School personnel or custodial staffs are not authorized to witness the procedure.

• ARTICLE 3.09 (Cont.'):

B. Closed piping systems, heating water and chilled water, shall be cleaned using a cold alkaline cleaning solution at normal system pumping pressures. At the Contractors option he may use chemicals furnished by the Owner (at no additional cost to the contractor) or he may use commercially available chemicals furnished by the contractor (at no additional cost to the School District).

1. Owner furnished Cleaning Solution

i. Oz per 100 gal. of system volume

a) Tri-sodium phosphate (alkaline) 16 oz
b) Sodium Hydroxide (alkaline) 1 oz
c) Dawn dishwashing soap (surfactant) 1 oz
d) Sodium Sulfite (oxygen scavenger) 1 oz

C. Contractor Furnished Cleaning Solution

1. Alkaline cleaner supplied by one of the listed water treatment vendors. Submit the cleaner formulation and complete manufacturer instructions on use of the cleaner. The alkaline cleaner shall include sodium hydroxide and tri-sodium phosphate with surfactants and corrosion inhibitors. Follow the manufacturer's recommended concentrations for the system volumes.

D. The cleaning solution must begin with a **minimum pH of 12.0**.

E. Procedure to clean an entire hydronic system (**if applies, in accordance to plans**):

1. Isolate the expansion tank from all cleaning solutions.

2. Fill system with the alkaline cleaning solution. Make sure that the cleaning solution circulates through all piping and heat transfer components in the hydronic system.

3. Circulate the alkaline cleaning solution in any heating water or chilled water system for 48 hours. Repair any leaks while circulating.

4. Drain the alkaline cleaning solution and fill the system with domestic cold water. Circulate and flush as necessary until the circulated rinse water reaches a pH of 8.5 maximum at all end points of the hydronic system.

5. When the rise water has reached 8.5 pH, remove and clean all piping strainers throughout the system. Do not drain the rinse water from the piping system until the propylene glycol is ready to be installed. The District Project Manager or representative must verify and approve the cleanliness of the system. A minimum of three samples will be taken of each hydronic system. The Contractor and the Owner will each retain one sample and one sample will be sent for chemical analysis.

• ARTICLE 3.09 (Cont.'):

6. Drain and partially fill the hydronic system with clean domestic cold water. Install the uninhibited propylene glycol to a concentration of 30%. The Owner will sample and install the water treatment chemicals after the glycol is charged into the system – pH buffer, oxygen scavenger, and corrosion inhibiting surfactant.

7. Before using the glycol feeder, thoroughly clean the tank of dirt, oil, grease, and solids. Fill the tank completely full with domestic cold water and one gallon of chlorine bleach. Allow to stand overnight. Rinse the tank free of chlorine.

8. Fill the glycol feeder with a solution of water and propylene glycol, 30% minimum or +9ºF or lower freeze point. Maintain a full glycol tank (30% minimum) until the system have been thoroughly vented of air and all of the leaks have been repaired. Leave a full tank of 30% PG upon project completion.

9. Submit the "Certification of Work" and the quantity of propylene glycol that was charged into the piping system. Transmit the information to the District Project Manager. Include a copy of the "Certification of Work", the propylene glycol quantity, the MSDS sheets, and the name of the chemical supplier in the O&M Manuals.

10. Glycol feed system(s) – leave tanks filled with a 30% solution Uninhibited Polypropylene Glycol.

11. Provide one (1) hour training on condenser water chemical system.

12. Deliver Venturi flow meter to Project Manager prior to installation of meter.

END OF SECTION

SECTION 15400

PLUMBING

1. SCOPE

All plumbing work and related items necessary to complete the work shown on drawings or specified, or both, are a part of the contract.

2. IMPORTANT NOTES

It shall be the direct responsibility of the Contractor to become acquainted with all the requirements of this project; and such requirements shall be as much a part of this contract as though written herein.

3. RECORD DRAWINGS

The Contractor shall maintain a complete accurate record of any variations or changes to the contract drawings during construction which may be necessary due to field conditions.

4. WORK INCLUDED

All plumbing work (inside and outside the buildings) including all exterior sanitary and water piping. Also the complete gas storage and supply system; and solar water heating systems, if shown in Contract Drawings.

All provisions for metering, as required or shown in the Contract, all sewage treatment facilities and water pumping system, if shown in Contract Drawings.

All waste branches, soil stacks, soil branches, and vent lines within the buildings.

All work in connection with the water installation within buildings, and extending out to, and Drawings. All fixtures specified on drawings as well as excavating and backfilling required for pipe trenches, etc.

All roof flashing required for plumbing work. All work, materials, parts and piping for roof drainage. Everything necessary for the completion and successful operation of the work, whether or not herein definitely specified, or indicated on the drawings, shall be furnished and installed as well and as faithfully as if so specified or so indicated.

SECTION 15400 – PLUMBING (Cont.')

5. COMPLIANCE WITH MUNICIPAL AND COMMONWEALTH REGULATIONS

All work under this Division shall conform in every respect to Rules and Regulations of the Department of Health of Puerto Rico, the P.R. Aqueduct and Sewer Authority and Puerto Rico Environmental Quality Board, if applicable.

6. DRAWINGS

The drawings and specifications are intended to supplement each other so that any detail shown on the drawings & not mentioned in the specifications or vice versa, shall be executed the same as if mentioned in the specifications and shown on the drawings.

Everything necessary for the completions and successful operation of the work, whether or not herein definitely specified or indicated on the drawings, shall be furnished and installed as well and as faithfully as if specified or so indicated.

The Contractor, before installing any of this work, shall see that it does not interfere with the clearances required for finished partitions, walls, etc., as shown in the drawings.

Work installed by the Contractor which interferes with or modifies the architectural or the structural design as shown on the Contract Drawings shall be changed as directed by the Authority and all costs incident to such changes shall be paid by the Contractor.

7. PRIOR TESTS

All concealed work must remain uncovered until required tests have been completed, but in the event that the project constructions schedule requires it, the Contractor shall make arrangement for prior test on the portion of the plumbing work involved. The Authority shall be notified in advance of all prior tests and shall be represented at such tests. The cost of these tests shall be paid by the Contractor.

8. EXCAVATION AND BACKFILL

Trenches for all underground pipe lines shall be excavated to the required depths, and bell holes provided as necessary to insure uniform bearing. Excavations below required depth shall be refilled with sand or gravel firmly compacted. Where rock is encountered, it shall be excavated to a depth 3 inches below the lowermost part of the pipe and the space shall be refilled to grade with sand or gravel and well tamped. After pipe lines have been tested, inspected and approved by the Engineer, the trenches shall be filled with approved fill, which shall be thoroughly tamped, and firmly compacted.

SECTION 15400 – PLUMBING (Cont.')

9. MATERIALS

All inside soil, waste and vent piping and fittings for the building/s sanitary drainage system/s shall be PVC, Schedule 40DWV (Drain, Waste & Vent) pipe and fittings in accordance with latest edition of ASTM Standards D-2665 and D-2466 respectively.

All exterior building sewer piping and fittings (*cloaca exterior*) shall be PVC SDR-35 ASTM 3034 including connections required to the existing sanitary sewer facilities unless otherwise specified in the plumbing site plan approved by the P.R.A.S.A. Joints shall be in accordance with Federal Specifications WW-T-799a (L).

All galvanized piping shall be Schedule 40.

10. SUPPLY PIPING

All water supply pipes within the building shall be embedded in the chases, walls and/or in the floor slabs. When embedded in the floor slabs the pipe lines shall be placed on top of the reinforcing steel. Where copper tubing connects to steel or iron pipe the connections shall be made with dielectric couplings. Sizes for all water distributing piping and connection to fixtures shall be as shown on drawings.

11. SOIL, WASTE AND VENT PIPING

Soil, waste and vent stacks of sizes shown shall be run as indicated on the drawings and shall extend a minimum of six (6) inches above the roof. All offset shall be made at an angle of not more than 45º and all horizontal runs shall have a pitch of not less than 1/8" to the foot unless otherwise approved by the Authority.

Branch, soil, waste and vent connections shall be run to the soil stack, waste stacks or vent stacks as shown or required. Soil, waste, and vent piping shall be run as indicated on the plans.

Changes in directions in drainage or waste piping shall be made by the appropriate use of 45º wye (Y), long or short sweep quarter bends, fifth, sixth, eight or sixteenth bends or by a combination of these or equivalent fittings. Sanitary tees and short quarter bends may be used in drainage or waste lines only where the direction of flow is from the horizontal to the vertical. Long turn fittings shall be used whenever conditions permit. All horizontal ventilation piping shall pitch toward the main.

SECTION 15400 – PLUMBING (Cont.)

12. ROOF DRAINAGE SYSTEM AND INSTALLATION

Materials and parts for roof drains shall be as specified in contract drawings. Interior piping shall be DWV PVC schedule 40 with DWV fittings of PVC 1 type L.

12A. CLEANOUTS

All cleanouts shall be so located and installed so that they may be readily accessible and removable for cleaning the lines, and the plugs shall have their threads well greased to facilitate removal. Cleanouts are specified in Contract Drawings or herein.

13. HOSE BIBBS

Hose bibs are specified in Contract Drawings or herein.

14. GASKETS

Gasket material shall be Full-Faced for Cast Iron Flanges and Raised-Face for Steel Flanges. Select materials to suit the service of the piping system and in accordance to their respective ANSI standard (A 21.11, B16.20 or B16.21). Material chosen will not be detrimentally affected by the chemical and thermal properties of the fluid being carried. Materials containing asbestos are not acceptable.

15. HANGERS, ANCHORS AND GUIDES

All exposed piping shall be supported from the building structure, etc., by means of approved hangers or brackets. Piping shall be supported to maintain required grading and pitch of lines, to prevent vibrations and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

Pipe hanger shall be secured to construction by approved iron inserts of adjustable type, where hanger locations are determined; after concrete is poured, expansion shields and bolts shall be used. These shall be of approved type.

16. OPEN ENDS

The Contractor shall keep all end of pipes, including those extending above roof, drains, and fixtures closed with caps or plugs so as to prevent dirt of building materials from

SECTION 15400 – PLUMBING (Cont.)

• OPEN ENDS (Cont.')

getting into pipe and traps. All temporary plugs or caps shall be removed at the completion of the work.

17. BRONZE BALL VALVE

At each building service connections and where shown on the drawings the contractor shall furnish properly placed water pipe, three-piece design ball valves, conforming to Federal Specifications WW-V-35, Type II, Class A, Style 1, rated for 400 WOG pressure.

Bronze Ball Valves shall be equal to Nibco three-piece ball valve 595 series for full flow, solder connections. The valves shall be furnished with type 316 stainless steel ball and stem, and with Buna-N Seat.

Sizes for all water distributing piping and connections to fixture shall be as shown on drawings.

All horizontal runs shall pitch toward the main.

18. LOCATION OF PLUMBING IN SLABS, WALLS AND CHASE

No parts of the plumbing shall be permitted to be exposed below the floor slabs, walls or chases. Water closet elbows, shower drain traps and any other part of plumbing shall be of such construction as to permit them to be completely embedded in the floor slabs, walls or chases.

19. TESTS OF PLUMBING SYSTEM

Sanitary Drainage System: The entire piping of sanitary system in each building shall be tested with water and proved tight to the satisfaction of the Engineer before trenches area backfilled, piping covered, or fixtures connected.

For water tests, the connections to yard sewers and the piping of the sanitary system below floors on ground shall be filled with water to the top of a vertical section of pipe ten feet high and the water allowed to stand for at least 30 minutes for inspection, after which, if the lines prove tight, the water shall be drawn off and the fixtures connected. Each vertical stack of the sanitary system, with its branch waste and vent pipes, shall be tested separately.

SECTION 15400 – PLUMBING (Cont.)

• TESTS OF PLUMBING SYSTEM (Cont.')

Water Supply System: The entire water supply system shall be tested to a hydrostatic pressure of 125 pounds per square inch and proved tight at this pressure before trenches area backfilled and before fixtures area installed. Water supply piping, if in any way concealed by structural work, shall be tested to the aforesaid pressure and proved tight before pipes are concealed.

All repairs to piping system shall be made with new material. No caulking on screwed joints, cracks, or holes will be acceptable. Where it becomes necessary to replace pieces of pipe, such replacement shall be the same length as the defective parts.

20. GENERAL REQUIREMENTS

All parts of the plumbing system and associated equipment shall be tested and adjusted to work properly and be left in good operating condition.

All testing instruments, gauges, pumps, and other equipment required or necessary for tests shall be provided by the Contractor.

The Authority shall be notified in advance of all tests, and shall have a representative present. Tests shall be conducted to his entire satisfaction.

All defects disclosed in the work by tests or otherwise shall be made good or the work replaced without additional cost to the Authority.

Tests shall be repeated after any defects disclosed thereby have been made good or the work replaced, if the Authority deems necessary.

21. GENERAL TEST FOR WATER SUPPLY AND PLUMBING SYSTEM

Prior to Requesting Final Inspection, the Contractor shall have the project water distribution system connected to its indicated source of supply and in operation, with all valves fully open. He shall also have installed temporary connections thru the meter box so as to supply running water thru all interior and exterior pipe lines. A complete test shall be made by the Engineer of all bibs, compression stops, shower valves, lawn faucets and other fittings of the plumbing system.

All defective work discovered by this test shall be satisfactorily corrected by the Contractor, before final acceptance of work. All the water consumed during the test shall be at the Contractor's expense.

SECTION 15400 – PLUMBING (Cont.)

22. PLUMBING FIXTURES

General Requirements:

The Contractor shall furnish and install fixtures in accordance with the fixture schedule shown in Contract Drawings. Plumbing fixtures shall be of the best quality.

All material specified to be brass shall be thoroughly cleaned and polished.

Each fixture shall be separately trapped, using the type and size of trap called for under the heading of "Fixture" of the type required by the plumbing code. The traps shall be of approved type.

The Contractor shall erect the roughing-in of the soil, waste and water supply piping strictly in accordance with the sanitary fixtures roughing-in measurements furnished in advance by the designer.

Roughing-in shall include water supply, drainage, and necessary work required for the installation of the fixtures. Floor drains shall be provided at all toilet rooms.

23. FIXTURE CONNECTIONS

All floor connections must comply with the requirements of the local plumbing regulations except where herein otherwise specified. Connections between fixture with a floor outlet and flange shall be made with non-asbestos composition filler which must be a germicide, absolutely gas and fume proof, watertight, stain-proof, which does not harden or dry under any extreme of climatic change, and must adhere to wet surfaces.

24. GUARANTEE

a. The Contractor shall leave the entire plumbing installation included under this Contract in proper working conditions, and shall, without additional charge, replace any work, materials and/or equipment or any of its component parts which develop defects, except from ordinary use, within one (1) year from the date of final certificate of approval issued by the Puerto Rico Aqueduct & Sewer Authority, the P.B.A. and other applicable agencies.

b. The Contractor shall also be responsible for any or all damages resulting from defective materials, and/or equipment, and shall, without additional charge, repair or replace all injuries to existing work caused by such defects or replacements to the satisfaction of the Authority.

SECTION 15400 – PLUMBING (Cont.)

c. The Contractor shall furnish certificates or guarantee from the manufacturers of specialties to the effect that they will furnish new parts, fixtures, materials or equipment where defects occur due to faulty manufacture for a period of one, (1) year from the date of final certificate of approval issued by the Authority.

25. PLUMBING FIXTURES AND BATHROOM ACCESSORIES SCHEDULE

The Contractor shall furnish and install, at proposed male and/or female's restrooms (whichever applies), the plumbing fixtures and bathroom accessories indicated on plans, in accordance to description shown on the following schedule:

NUMBER	DESCRIPTION	HEIGHT	LOCATION	COMMENTS
1	WATER CLOSET	1'-5" top	Toilets	Approved equal or similar to American Standard *Afwall*, 1.128 GPF, manual flush valve, elongated wall mounted.
2	WATER CLOSET FOR THE HANDICAPPED	1'-7" top	Toilets	Same as Number 1 but shall be installed at 19" from top of rim to floor.
3	WATER CLOSET FOR KINDERGARTEN	0'-10" top	Toilets	Approved equal or similar to American Standard *Baby Devoro*, round front flush valve toilet, less seat, 10" rough-in. Rim height at 10".
4	LAVATORY SINK	2'-5" top	Toilets	Approved equal or similar to American Standard *Declyn* wall mount sink, 0.5 GPM, Model 1340.119, pillar tap metering faucet w/ extended spout.
5	LAVATORY SINK FOR THE HANDICAPPED	2'-10" top	Toilets	Same as Number 4 but shall be installed at 34" from floor with automatic closing faucet.

• **PLUMBING FIXTURES & BATHROOM ACCESSORIES SCHEDULE (Cont.'):**

NUMBER	DESCRIPTION	HEIGHT	LOCATION	COMMENTS
6	LAVATORY SINK FOR KINDERGARTEN	1'-10" top	Toilets	Approved equal or similar to American Standard *Lucerne* wall hung lavatory w/ single center faucet hole, Model 0356.421, pillar tap metering faucet w/ extended spout.
7	SINGLE BOWL KITCHEN SINK	As Indicated on Drawings	Office Kitchenette	Approved equal or similar to American Standard Model 145B.301900, 18gauge, 30⅛" x 19⅛"x 9". Strainers shall be American Standard Model 4331013, Brass Body, 3½" outlet, 1½" tail-place.
8	URINAL	1'-0" base	Toilets	Approved equal or similar to American Stand. *Trimbrook.* 0.85-1.0 GPF, Model 6561.017, white vitreous china, blow-out urinal with two (2) wall hanger, ¾" inlet spud.
9	URINAL FOR THE HANDICAPPED	1'-0" base	Toilets	Same as Number 8
10	WATER HEATER	According to Shower Head	Toilets	Tank-less electric water heater, approved equal or similar to *Power Pak Plus* (220v.) manufactured by *Marey*. **To be connected to nearest available electric panel-board.**
11	HAND DRYER	As Indicated on Drawings	Toilets	Approved equal or similar to recessed hand dryer Bobrick Model B-750 w/ auto pilot no-touch sensor. **To be connected to the nearest available electric utility or panel-board.**

• **PLUMBING FIXTURES & BATHROOM ACCESSORIES SCHEDULE (Cont.'):**

NUMBER	DESCRIPTION	HEIGHT	LOCATION	COMMENTS
12	GRAB BAR (24")	3'-0" center	Toilet for Disabled	1¼" diameter, stainless steel, surface mounted with snap flange. Approved equal or similar to Bobrick Model B-5806 series.
13	GRAB BAR (36")	3'-0" center	Toilet for Disabled	1¼" diameter, stainless steel, surface mounted with snap flange. Approved equal or similar to Bobrick Model B-5806 series.
14	MIRROR	3'-4" base	Toilets	Approved equal or similar to Bobrick Model B-165-1824, 18" x 24".
15	TILTED MIRROR FOR THE HANDICAPPED	Complied with ADA	Toilets	Approved equal or similar to Bobrick Model B-293, stainless steel, 18" x 30".
16	MEDICINE CABINET	Complied with ADA	Toilets	Approved equal or similar to Bobrick Model B-297, surface-mounted, heavy-gauge steel w/ mirror and fixed shelves.
17	LAVATORY WATER FAUCET	2'-5" base	Toilets	One-handle, 4" center set, approved equal or similar to American Standard Model Colony-Soft No. 2275.509 (Polished Chrome).
18	KITCHEN SINK FAUCET	As Indicated on Plans	Office Kitchenette	One-metal lever handle, 8-½" spout length, approved equal or similar to American Standard Model Colony-Soft No. 417560.

• **PLUMBING FIXTURES & BATHROOM ACCESSORIES SCHEDULE (Cont.'):**

NUMBER	DESCRIPTION	HEIGHT	LOCATION	COMMENTS
19	SHOWER STALL (Shower Head)	Complied with ADA	Toilets	Soft hand system kit, Approved Equal or Similar to American Standard Model 1662.600.002, ½" pipe conn., 30° spray adjustment, 4-arm handle w/ vandal-proof screws, ½" pipe size.
20	SHOWER SEAT (Folding Corner)	Complied with ADA	Toilets	Approved equal or similar to Bobrick Model B-5193 w/ solidly fused plastic surface and stainless steel frame. Folds to vertical position when not in use.
21	SHOWER CURTAIN ROD	6'-0" top	Toilets	Approved equal or similar to Bobrick Model B-6107 (heavy duty).
22	TOILET PAPER HOLDER	As Indicated on Plans	Toilets	Approved equal or similar to Bobrick Model B-288 (surface mounted).
23	PAPER TOWEL DISPENSER & WASTE RECEPTACLE	Wall Opening at 51" from Finish Floor	Toilets	Approved equal or similar to Bobrick Model B-3944 (recessed mounted).
24	SOAP DISH (For Shower)	As Indicated on Plans	Toilets	Approved equal or similar to Bobrick Model B-4390, stainless steel, heavy duty recessed mounted with bar.
25	LIQUID SOAP DISPENSER	As Indicated on Plans	Toilets	Approved equal or similar to Bobrick Model B-2112 (surface mounted).

• **PLUMBING FIXTURES & BATHROOM ACCESSORIES SCHEDULE (Cont.'):**

NUMBER	DESCRIPTION	HEIGHT	LOCATION	COMMENTS
26	HOSE BIBB	As Indicated on Drawings	Outside Building (On-Site)	Approved equal or similar to Central Brass Model 576, ½"–14 PS, female, lock-shield type with loose key handle.
27	FLOOR DRAIN	N/A	Toilets	Approved equal or similar to J.R. Smith 2010-A, cast iron body with 5" Ø round grate strainer, polished bronze with vandal-proof screws.
28	CLEAN-OUT (Flush with Floor)	N/A	Floor	PVC type body with bronze countersunk plug and access cover approved equal or similar to J.R. Smith series 4810, round frame with scoriated cover, nickel bronze, furnished with vandal-proof screws.
29	WALL TILE	As Indicated on Plans	Toilets	8" x 8" ceramic wall tiles (ivory color), as specified on Sections 09310 and 09311.
30	FLOOR TILE	As Indicated on Plans	Toilets	12" x 12" non-slip ceramic floor tiles (ivory color), as specified on Sections 09310 and 09311.

SECTION 15420

DRAINAGE AND VENT 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 sanitary drainage and vent piping, and storm drainage piping inside building and to locations indicated.

1.3 DEFINITIONS

A. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewage from building.

B. Drainage Piping: Building sewer piping outside building that conveys storm drainage from building.

C. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping.

D. Drainage and Vent Piping: Piping inside building that conveys waste water and vapors from fixtures and equipment throughout the building.

E. Force-Main Piping: Drainage piping, under pressure.

F. The following are industry abbreviations for plastic and other piping materials:

1. ABS: Acrylonitrile-butadiene-styrene.
2. EPDM: Ethylene-propylene-dyne polymer, rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PVC: Polyvinyl chloride.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Soil, Waste, and Vent Systems: 10-foot head of water.
2. Storm Drainage Systems: 10-foot head of water.

• SYSTEM PERFORMANCE REQUIREMENTS (Cont.')

3. Sewage, Force-Main Piping Systems: 100 psig.

1.5 SUBMITTALS

A. Test Results and Reports: Specified in "Field Quality Control" Article.

1.6 QUALITY ASSURANCE

A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

B. Comply with ASME B31.9, "Building Service Piping", for materials, products, and installation.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials", for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 – PRODUCTS

2.1 PIPES AND TUBES

A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.

B. Ductile-Iron Pipe: AWWA C151 with mechanical- or push-on-joint bell and plain spigot end, unless plain, grooved, or flanged ends are indicated.

C. PVC Plastic Pipe: ASTM D 2665, Schedule 40

2.2 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311 drain, waste, and vent pipe patterns.

2.3 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.

B. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for commonly used joining materials.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Aboveground, Soil, Waste, and Vent Piping: Use the following:

1. 1-¼ and 1-½ inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
2. 2 to 4 inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
3. 5 and 6 inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
4. 8-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
5. 10-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
6. 12-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, Soil, Waste, and Vent Piping: Use the following:

1. 1-½-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
2. 2 to 4-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
3. 5 and 6-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
4. 8-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
5. 10-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
6. 12-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

E. Aboveground, Storm Drainage Piping: Use the following:

1. 2 to 4 Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
2. 5 and 6 Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
3. 8-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
4. 10-inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
5. 12-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

F. Underground, Storm Drainage Piping: Use the following:

1. 3-and 4 Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
2. 5 and 6 Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
3. 8-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
4. 10-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
5. 12-Inch NPS: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

• PIPING APPLICATIONS (Cont.')

G. Aboveground, Sewage Force Mains: Use the following:

1. 2 to 4-Inch NPS: Galvanized steel pipe and cast-iron, threaded fittings.
2. 5 and 6-Inch NPS: Galvanized steel pipe and cast-iron, threaded fittings.

H. Underground, Sewage-Force-Main, Service Entrance Piping: Use the following:

1. 4 and 6-Inch NPS: Ductile-iron pipe; ductile-iron, mechanical or push-on-joint fittings; rubber gaskets; and mechanical or push-on joints.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use gate, ball, or butterfly valves.
2. Throttling Duty: Use globe, ball, or butterfly valves.

B. Grooved-end butterfly valves may be used with grooved-end piping.

3.4 PIPING INSTALLATION, GENERAL

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation.

3.5 SERVICE ENTRANCE PIPING INSTALLATION

A. Refer to Division 2 Section "Sewerage and Drainage" for sanitary and storm sewer piping.

B. Extend building sanitary drain piping and connect to sanitary sewer piping in sizes and locations indicated for service entrances into building. Install cleanout and extension to grade at connections of building sanitary drains with building sanitary sewers.

C. Extend building storm drain piping and connect to storm sewer piping in sizes and locations indicated for service entrances into building. Install cleanout and extension to grade at connections of building storm drains and building storm sewers.

D. Extend building sanitary drain, force-main piping and connect to sanitary sewer piping in size and location indicated for service entrance into building. Install cleanout, fitting with closure plug or equivalent, inside building.

E. Extend building storm drain, force-main piping and connect to storm sewer piping in size and location indicated for service entrance into building. Install cleanout, fitting with closure plug or equivalent, inside building.

• SERVICE ENTRANCE PIPING INSTALLATIONS (Cont.')

F. Ductile-Iron, Force-Main, Service Entrance Piping: Comply with AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Encase piping with polyethylene film according to ASTM A 674 or AWWA C105.

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service entrance pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.

H. Install wall penetration system at each service entrance pipe penetration through foundation wall. Make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for wall penetration systems.

3.6 DRAINAGE AND VENT PIPING INSTALLATION

A. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook", Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings".

B. Make changes in direction for drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep ¼ bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-tum, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not make change in direction of flow greater than 90 degrees. Use proper size of standard increasers and reduces if different sizes of piping are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

D. Install drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Sanitary Building Drain: 2 percent downward in direction of flow for piping 3-inch NPS and smaller, 1 percent downward in direction of flow for piping 4 inch NPS and larger.
2. Horizontal, Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Storm Building Drain: 1 percent downward in direction of flow.
4. Horizontal, Storm Drainage Piping: 2 percent downward in direction of flow.
5. Vent Piping: 1 percent down toward vertical fixture vent of toward vent stack.

E. Install force mains at elevations indicated.

• DRAINAGE AND VENT PIPING INSTALLATIONS (Cont.')

F. Install engineered, sanitary drainage and vent systems in locations indicated and as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Copper, Sovent, Single Stack: Comply with CDA 402/0, "Brass and Bronze Design Handbook, Single-Stack Plumbing System.
3. Cast-Iron, Sovent, Single Stack, Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
4. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

G. Install engineered, controlled-flow, storm drainage systems in locations indicated. Comply with standards of authorities having jurisdiction.

H. Sleeves are not required for cast-iron soil piping passing through concrete slab on grade if slab is without membrane waterproofing.

I. Install ABS plastic drainage piping according to ASTM D 2661.

J. Install PVC plastic drainage piping according to ASTM D 2665.

K. Install underground, ABS and PVC plastic drainage piping according to ASTM D 2321.

3.7 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook", Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings".

1. Compression Joints: Make with rubber gasket matching class of pipe and fittings.
2. Hub-less Joints: Make with rubber gasket and sleeve or clamp.

C. Grooved Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

D. PVC Piping Joints: Join drainage piping according to ASTM D 2665.

E. Handling of Solvent Cements, Primers, and Cleaners: comply with procedures in ASTM F 402 for safe handling during joining of plastic pipe and fittings.

3.8 VALVE INSTALLATION

A. Shutoff Valves: Install shutoff valve on each pump discharge and where indicated. Use gate or ball valves for piping 2-inch NPS and smaller. Use gate or butterfly valves for piping 2-½ inch NPS and larger.

B. Check Valves: Install swing check valve on each pump discharge, downstream from shutoff valve.

3.9 HANGER AND SUPPORT INSTALLATION

A. Install supports according to Division 15 Section "Hangers and Supports".

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum spacing and minimum rod diameters:

1. 1-½ and 2-Inch NPS: Maximum horizontal spacing, 60 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
2. 3-inch NPS: Maximum horizontal spacing, 60 inches with ½-inch minimum rod diameter, maximum vertical spacing, 15 feet.
3. 4 and 5-Inch NPS: Maximum horizontal spacing, 60 inches with 5/8 inch minimum rod diameter, maximum vertical spacing, 15 feet.
4. 6-Inch NPS: Maximum horizontal spacing, 60 inches with ¾-inch minimum rod diameter; maximum vertical spacing, 15 feet.
5. 8 through 12-Inch NPS: Maximum horizontal spacing, 60 inches with 7/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
6. 15-Inch NPS: Maximum horizontal spacing, 60 inches with 1-inch minimum rod diameter, maximum vertical spacing, 15 feet.
7. Spacing for horizontal pipe in 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

E. Install hangers for steel and ductile-iron piping with the following maximum spacing and minimum rod diameters:

1. 1-¼-Inch NPS: Maximum horizontal spacing, 84 inches; 3/8-inch minimum rod diameter, maximum vertical spacing, 15 feet.
2. 1-½-Inch NPS: Maximum horizontal spacing, 108 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
3. 2-Inch NPS: Maximum horizontal spacing, 10 feet with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
4. 2-½-Inch NPS: Maximum horizontal spacing, 11 feet with ½-inch minimum rod diameter, maximum vertical spacing, 15 feet.
5. 3-Inch NPSL: Maximum horizontal spacing, 12 feet with ½-inch minimum rod diameter; maximum vertical spacing, 15 feet.
6. 4 and 5-Inch NPS: Maximum horizontal spacing, 12 feet with 5/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
7. 6-Inch NPS: Maximum horizontal spacing, 12 feet with ¾-inch minimum rod diameter; maximum vertical spacing, 15 feet.
8. 8 through 12-Inch NPS: Maximum horizontal spacing, 12 feet with 7/8-inch minimum rod diameter, maximum vertical spacing, 15 feet.
9. 14 through 18-Inch NPS: Maximum horizontal spacing, 12 feet with 1-inch minimum rod diameter, maximum vertical spacing, 15 feet.

F. Install hangers for ABS and PVC plastic piping with the following maximum spacing and minimum rod diameters:

• HANGER AND SUPPORT INSTALLATION (Cont.')

1. 1-½ and 2-Inch NPS: Maximum horizontal spacing, 48 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 48 inches.
2. 4 and 5-Inch NPS: Maximum horizontal spacing, 48 inches with 5/8-inch minimum rod diameter; maximum vertical spacing, 48 inches.
3. 6-Inch NPS: Maximum horizontal spacing, 48 inches with ¾-inch minimum rod diameter; maximum vertical spacing, 48 inches.
4. 8 through 12-Inch NPS: Maximum horizontal spacing, 48 inches with 7/8-inch minimum rod diameter; maximum vertical spacing, 48 inches.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.10 CONNECTIONS

A. Connect service entrance piping to exterior sewerage and drainage piping. Use transition fitting to join dissimilar piping materials.

3.11 FIELD QUALITY CONTROL

A. Inspect drainage and vent piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

    a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

• FIELD QUALITY CONTROL (Cont.')

3. Roughing-In Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10 feet of head. Water level must not drop from 15 minutes before inspection starts through completion of inspection. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
4. Prepare reports for test and required corrective action.

3.12 CLEANING AND PROTECTING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of water-based latex paint.

END OF SECTION

SECTION 15720

AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY:

A. This section provides the general requirements for air handling units and related equipment and materials to be installed on proposed expansion to special education classroom at Angelita Cordero Bernard Elementary School.

1.02 SCOPE OF WORK:

A. Furnish and install air handling units, conforming in all aspects to the specifications, schedules and plans or drawings.

B. Furnish and install any accessories required by air handling units operation as recommended by manufacturer or distributors and is not specific in drawings. Check with Engineer for approval.

1. Additional accessories include:

i. Roof culvert

ii. Duct works for proper connection between new supply and return and existing duct.

C. Furnish and install safety switch devices for electric motor in air handling units.

1.03 RELATED WORKS:

A. Section 15082- Equipment Insulation

B. Section 15083- Pipe Insulation

C. Section 15180- Heating and Cooling Piping

D. Section 15950- Testing, Adjusting and Balancing.

1.04 RELATED STANDARDS:

A. ARI- Air Conditioning and Refrigeration Institute

B. ASHRAE- American Society of Heating, Refrigeration and Air conditioning Engineers

C. ASTM- American society for Testing Materials

D. NEC- National Electrical Code

E. NFPA- National Fire Protection Association

F. NEMA- National Electric Manufacturers Association

G. UL- United Laboratories

H. OSHA- Office of Safety and Health Act

I. EPA- Environmental Protection Agency

1.05 SUBMITTALS:

A. Submit three (3) copies of data for air handling units.

B. Submittal shall include manufacturer data:

1. Air handling unit capacities, weight, accessories, electrical requirements and wiring diagrams.
2. Drawing showing component layout, piping configuration, connection size, overall dimension and field clearances and piping requirements.
3. Psychometric chart and performance data at design temperatures and thermal loads.
4. Fan performance curves.
5. Data of filter media, filter performance, filter assembly and frames.
6. Installation recommendations.
7. Complete description of controls with sequencing data and wiring diagrams.

C. After air handling units submittal approval send four (4) copies of:

1. Operation manuals.
2. Maintenance manuals, including troubleshooting.
3. Parts manual with exploded part list for each air handling units.
4. Recommended list of spare parts.

1.06 QUALITY ASSURANCE:

A. Inspect air handling units delivered to site for damages

B. Store with minimum handling and comply with manufacturer's instruction for rigging, loading-unloading and transportation.

C. Store and protect as indicated by manufacturer against weather or vandalism.

D. Do not store air handling units directly on ground.

E. Keep materials and equipment free of debris and dirt.

PART 2 - PRODUCTS

2.01 AIR HANDLING UNITS-GENERAL

A. Air handling units shall be interior type.

B. Air handling units shall be DX-Split type.

C. Air handling units shall be single-zone purpose.

D. Air handling units shall to complaint with ARI-430-99 or latest edition.

E. Vibration isolation shall be supply at each supports. Spring kind is recommended.

F. Warranty by one (1) year in parts and labor.

G. Components:

1. Casing
2. Fans
3. Cooling coils
4. Dampers
5. Bearing and Drives
6. Filters
7. Electric motors
8. Others

H. Capacities:

1. Indoor Supply CFM shall be as indicated in DX-split units – evaporator section schedule.
   i. 1,380 CFM for A/C-01
   ii. 1,605 CFM for A/C-02

2. Cooling coil capacity (operating) shall be as indicated in DX-split units – evaporator section schedule.
   i. 54.02 MBTU for A/C-01
   ii. 61.01 MBTU for A/C-02

3. External static pressure shall be as indicated in DX-split units – evaporator section schedule.
   i. 0.5 in WG for A/C-01
   ii. 0.5 in WG for A/C-02

4. Air handling units shall be capable to supply air equal or below to 58°F at rated conditions.

I. Acceptable manufacturers are (in alphabetic order):

1. Carrier
2. Mc Quay
3. Trane
4. York
5. Other as Engineer approval.

2.02 COMPONENTS:

A. Casing:

1. External casing shall be fabricated of galvanized steel. Gauge 16 or better.
2. External casing shall be fabricate with removable panels and mechanical fastened.
3. Sections shall be assembled with compression gaskets between each frame member.
4. Casing leaks shall be no more than 0.5 CFM / ft^2 of exposed cabinet area.
5. Casing panels shall withstand a positive or negative 4 in wg of static pressure without visible deflection.
6. Casing shall be double wall type.
7. Provide access door of galvanized steel and flush mounted. Access door shall be gasketed and easy to remove.
8. Provide drain pan under cooling coil section. Drain pan shall be of stainless steel 304.

B. Fans:

1. Fans shall be backward inclined.
2. Manufacturer shall dynamically balance fan assembly.
3. Fan and motor shall be internally mounted in a steel base with mechanism for vibration absorption.
4. Manufacturer shall certificate that fan rpm area under critical speed.
5. Fan speed shall not be more than 1,800 RPM, consult Engineer to other speeds.
6. Fan velocity shall be less than 400 ft/min.

C. Cooling coils:

1. Provide access to cooling coil at both sides of air handling units.
2. Cooling coil connection shall extend five inches (5") minimum from air handling unit casing.
3. Cooling coil capacities shall be certify by manufacturer using ARI standard 410. Certification shall include:
    i. Cooling capacity
    ii. Air Pressure drop
4. Cooling coils shall provide cooling capacity as indicated in schedule table at rated conditions.
5. Cooling coil fins shall have a minimum thickness of 0.0075 inches.
6. Cooling coil fins shall be fabricated for marine hard corrosion resistance.
7. Cooling coils, tubes shall be seamless copper with nominal wall thickness of 0.025 inches.
8. Cooling coil tube shall be of minimum 5/8' outside diameter.
9. Cooling coil assemblies shall be removable through access panels.

D. Dampers:

1. Air handling units shall be single-zone purpose.
2. Dampers blades shall be of galvanized steel.
3. Damper blades shall rotate 90° and required one actuator per cooling zone.
4. Zone dampers shall be design, sized and constructed for the full rated flow of the unit.

E. Bearings and Drives:

1. Bearings to be used in fans shall be pillow block type, self-alignment and grease lubricated. Provide external connection for maintenance grease activities.
2. Bearings shall be 200,000 hours life at maximum operating conditions.
3. Shafts used in fans shall be hot rolled steel, solid type, ground and polish.
4. Fan assembly shall be V-belt drive type.
5. V-belts drive shall be of cast iron or steel sheaves.
6. Sheaves shall be dynamically balanced.
7. Power band belts or matching set belts are not recommended.
8. If variable pitch sheaves are used, set belts at mid-position to get the required performance.

9. The minimum belts for drive system shall be two (2).

F. Filter section:

1. Filter section with front loading frames and clips.
2. Filters shall be UL 900 listed
3. Filters shall be reusable, with MERV 7 efficiency, for both units (A/C-01 and A/C-02).
4. Use angle filter arrangement with two inches (2") disposable cartridges.
5. Manufacturer shall install differential pressure meter to read pressure drop across filter banks.

G. Electric motors:

1. Electric motor shall be 208 V, 3 Ø, 60 Hz.
2. Electric motor shall be total enclosed fan cooled (TEFC) type.
3. Service factor for electric motor shall be 1.2.
4. Provide factory mounted disconnected switch.

H. Others:

1. Equipment or materials included in this section are:
   i. Drain piping: Use copper type L DWV for drain and discharge to nearest roof drain.
   ii. Strainers
   iii. Roof Culvert
2. Contractor shall replace any equipment here indicated to proper performance of AHU or as required by Engineer or PBA representative.

PART 3 - EXECUTION

3.01 WORK PREPARATION:

A. Contractor shall to coordinate any work with PBA representative or Engineer.

B. Contractor shall coordinate any work to be executing out of regular working hours.

C. Contractor shall be responsible by all necessary permissions and taxes in the transportation from distributor or fabrication facilities to installation site.

D. Contractor shall be responsible for handling and disposal of any kind of hazardous material find it in the pre-bid visit or in the installation process.

3.02 INSTALLATION:

A. Install air handling units according the manufacturer instructions and recommendations.

B. Air handling units shall be located as indicated in drawings or existing site.

C. Air handling units shall be supported according with manufacturer instruction.

D. Rigging or moving of air handling units shall be according manufacturer's instruction and recommendation.

E. Rigging, lifting or moving of any equipment or material shall be according OSHA standards and regulations.

3.03 START-UP:

A. A service factory trained representative (engineer or technician) shall be available on site for start-up of air handling units.

B. Factory start-up services shall be providing for as long a time as is necessary to provide proper operation of air handling units.

C. Air handling units shall be factory lubricated.

D. The factory representative shall train four (4) employees of PBA in the operation, maintenance and troubleshooting of new split system units & equipment.

E. Contractor shall submit four (4) maintenance and operation manual to PBA representative or Engineer.

3.04 PERFORMANCE:

A. Use the Associated Air Balance Council (AABC) standards (last edition) for balancing works.

B. Manufacturer shall perform the standard ARI run test under the supervision of Engineer or PBA representative. Data of test shall be certified and submitted to Engineer.

C. Balancing and adjustment shall be within 5% of design parameters.

D. For calculations use the standard refrigeration ton (12,000 Btu/hr) and evaporative ton equivalent to 15,000 Btu/Hr as required.

E. Contractor shall submit four (4) copies of certificate results of balancing test and adjustment by third party contractor.

END OF SECTION
15720

SECTION 15781

PACKAGED ROOFTOP COOLING UNITS

PART 1. GENERAL:

SUMMARY:

SCOPE OF WORKS:

RELATED WORK:

A. Not Used

RELATED STANDARDS:

A. ARI- Air Conditioning and Refrigeration Institute
B. ASHRAE- American Society of Heating, Refrigeration and Air conditioning Engineers
C. ASTM- American society for Testing Materials
D. NEC- National Electrical Code

E. NFPA- National Fire Protection Association

F. NEMA- National Electric Manufacturers Association

G. UL- United Laboratories

H. OSHA- Office of Safety and Health Act

I. EPA- Environmental Protection Agency

SUBMITTALS:

A. Submit three (3) copies of data for Roof Top packaged units.

B. Submittal shall include manufacturer data:

1. Package units capacities, weight, accessories, electrical requirements and wiring diagrams.
2. Drawing showing component layout, piping configuration, connection size, overall dimension and field clearances.
3. Psychometric chart and performance data at design temperatures and thermal loads.
4. Fan performance curves.
5. Data of filter media, filter performance, filter assembly and frames.
6. Installation recommendations.
7. Complete description of controls with sequencing data and wiring diagrams.

C. After roof top package units submittal approval send four (4) copies of:

1. Operation manuals.
2. Maintenance manuals, including troubleshooting.
3. Parts manual with exploded part list for each top roof package units.
4. Recommended list of spare parts.

QUALITY ASSURANCE:

A. Inspect roof top package units delivered to site for damages

B. Store with minimum handling and comply with manufacturer’s instruction for rigging, loading-unloading and transportation.

C. Store and protect as indicated by manufacturer against weather or vandalism.

D. Do not store top roof package units directly on ground.

E. Keep materials and equipment free of debris and dirt.

WARRANTY

A. Provide 1 year unconditional labor and parts warranty on any component of the units.

B. Provide 5 years unconditional parts warranty on compressor units.

C. Submit warranty documentation and certification after start-up.

PART 2. PRODUCTS:

ROOF TOP PACKAGE UNITS-GENERAL

A. RTU shall be drawn thru type.

B. RTU shall be single-zone purpose.

C. RTU shall to complaint with ARI- 340/360 or latest edition.

D. Vibration isolation shall be supply at each fan-motor supports. Spring kind is recommended.

E. Components:

1. Casing
2. Fans
3. Compressor
4. Cooling coils
5. Condenser coils
6. Condenser fan and motors
7. Dampers
8. Fresh air intake
9. Bearing and Drives
10. Filters
11. Electric motors
12. Others

F. Capacities:

1. Supply CFM, Cooling coil capacity, External static pressure and Fresh air quantity shall be as indicated in drawings schedules.
2. Roof top package units shall be capable to supply air equal or below to 57 ^{o}F db at rated conditions.
3. Roof top package units shall be rated to 95 ^{o}F condenser ambient temperature (**No exception**).
4. Roof top package units shall have an 11.5 EER (energy efficiency ratio) or better.

G. Acceptable manufacturers are (in alphabetic order):

1. Carrier
2. McQuay
3. Trane

4. York
5. Other as Engineer approval.

COMPONENTS:

A. Casing:

1. External casing shall be fabricated of galvanized steel. Gauge 18 or better.
2. External casing shall be with removable panels and mechanical fastened.
3. Sections shall be assembled with compression gaskets between each frame member.
4. Casing leaks shall be no more than 0.5 CFM / ft^2 of exposed cabinet area.
5. Casing panels shall withstand a positive or negative 4 in wg of static pressure without visible deflection.
6. Casing shall be **double wall type**.
7. Provide 1.5" insulation material between panel. Insulation shall meet NFPA-90A.
8. Pitch roof top for drain.
9. Provide access door of galvanized steel and flush mounted. Access door shall be gasketed and easy to remove.
10. Provide drain pan under cooling coil section and internally sloped. Drain pan shall be of **304 stainless steel**. Condensate connection shall be 1" minimum.

B. Fans:

1. Fans shall be forward / curved inclined.
2. Fan shall be double inlet and double width.
3. Manufacturer shall dynamically balance fan assembly.
4. Fan and motor shall be internally mounted in a steel base with mechanism for vibration absorption.
5. Manufacturer shall to certificate that fan rpm area under critical speed.
6. Fan speed shall not be more than 1,800 RPM, consult Engineer to other speeds.
7. Face velocity shall be less than 400 ft/min.
8. Provide neoprene connection to eliminate vibration transmission.

C. Compressors:

1. Compressor shall be hermetic type, direct drive, internally protected with internal high pressure relief.
2. The hermetic motor shall be suction gas cooled and have a voltage range of +/- 10% of unit name plate voltage.

3. Compressor shall have vibration isolation spring or mounts.

D. Cooling coils:

1. Provide access (**DOORS**) to cooling coil at both sides of top roof package units.
2. Cooling coil fins shall have a minimum thickness of 0.0075 inches.
3. Cooling coils, tubes shall be seamless copper with nominal wall thickness of 0.025 inches.
4. Cooling coil assemblies shall be removable through access panels.
5. Cooling coil shall be direct expansion design.

E. Condenser coil:

1. Cooling coil fins shall have a minimum thickness of 0.0075 inches.
2. Cooling coils, tubes shall be seamless copper with nominal wall thickness of 0.025 inches.
3. Cooling coils shall have corrosion protective coating. Red Oxide treatment is not acceptable. Corrosion protective coating shall be for mild marine environment purpose.
4. Cooling coil shall be direct expansion design.

F. Condenser fan and motors:

1. Condenser fans shall be direct drive motors.
2. Condenser fans shall be propeller type.
3. Condenser fans shall include a heavy duty safety guard.
4. Condenser fans motors shall be totally enclosed (TEFC).

G. Dampers:

1. Dampers blades shall be of galvanized steel.
2. Damper blades shall rotate 90^{o} and required one actuator.

H. Fresh air intake:

1. provide fresh air intake, manually operate to supply the required CFM as indicated in drawings and schedules.

I. Bearings and Drives:

1. Bearings to be used in fans shall be pillow block type, self-alignment and grease lubricated. Provide external connection for maintenance grease activities.
2. Bearings shall be 200,000 hours life at maximum operating conditions.
3. Shafts used in fans shall be hot rolled steel, solid type, ground and polish.
4. Fan assembly shall be V-belt drive type.

5. V-belts drive shall be of cast iron or steel sheaves.
6. Sheaves shall be dynamically balanced.
7. Power band belts or matching set belts are not recommended.
8. If variable pitch sheaves are used, set belts at mid-position to get the required performance.
9. The minimum belts for drive system shall be two (2).

J. Filter section:
1. Filter section with side loading frames and clips.
2. Filters shall be UL 900 listed
3. Filters shall be 30 % efficiency.
4. Use angle filter arrangement with 2 inches disposable cartridges.
5. Manufacturer shall install differential pressure meter to read pressure drop across filter banks.

K. Electric motors:
1. Electric motor shall be 460 V, 3 Ø, 60 Hz (contractor have to make a field voltage check before ordering, **MEANS DOUBLE CHECK**).
2. Electric motor shall be total enclosed fan cooled (TEFC) type.
3. Service factor for electric motor shall be 1.2.
4. Provide factory mounted disconnected switch.

L. Operating controls:
1. Provide low-voltage, adjustable thermostat to control compressor and condenser fan, and supply fan to maintain temperature setting.
   i. Include system selector switch ON-COOL-OFF and fan control switch (ON-AUTO).
   ii. Provide thermostat controller for the stages required to proper control of roof top unit.
   iii. Locate thermostat in room as actual controls. Locate temperature sensing element (if required) on air return duct, next of exit of room routing thru top roof package unit.
2. 7 days, 24 hours programming capacity.
3. Touch screen configuration capability. Large display with backlight.
4. Temperature control of +/- 1^{o}F of cooling range.
5. Provide 5 years warranty.

M. Others:
1. Equipment or materials included in this section are:

i. Use PVC for drain and discharge to nearest roof drain.

ii. Roof Curb. Not Used – Roof Top Unit shall be with similar foot-print as existing unit. In case of different Roof Top Unit, Roof curb shall be 14" high, full perimeter curb with wood nailer.

PART 3. EXECUTION

WORK PREPARATION:

A. Contractor shall remove the existing roof top units.

1. Removing include electrical connection and plumbing connections not necessary for futures works or new equipment. Consult Engineer or PBA representative for complete scope of removing scope.

2. Final disposition of removed equipment and material shall in accordance with Puerto Rico environmental standards and regulations, and EPA.

B. Contractor shall to coordinate any work with PBA representative or Engineer.

C. Contractor shall coordinate any work to be executing out of regular offices hours as required by Engineer or PBA representative.

D. Contractor shall be responsible by all necessary permissions and taxes in the transportation from distributor or fabrication facilities to installation site.

E. Contractor shall be responsible for handling and disposal of any kind of hazardous material find it in the pre-bid visit or in the installation process.

INSTALLATION:

A. Install Roof Top Package Units according the manufacturer instructions and recommendations.

B. Roof Top Package units shall be located as indicated in drawings or existing site.

C. Roof Top package units shall be supported according with manufacturer instruction.

D. Contractor shall paint pipes and equipment as indicated by Engineer.

1. Air duct shall be insulated with white top termination.

2. Any water line for fire fighting purpose shall be safety red (if used).

E. Rigging of top roof package units shall be according manufacturer's instruction and recommendation.

F. Rigging and lifting of any equipment of material shall be according OSHA standards and regulations.

START-UP:

A. Service factory trained representative (engineer or technician) shall be available on site for start-up of top roof package units.

B. Factory start-up services shall be provide for as long a time as is necessary to provide proper operation of units.

C. Top roof package units shall be factory charged with the specified refrigerant and oil.

D. Contractor's personnel and factory representative shall adjust and balance air flow to design conditions indicated in this specifications and/or drawings.

E. The factory representative shall train at least four (4) employees of PBA in the operation, maintenance and troubleshooting of top roof package units.

F. Contractor shall submit four (4) maintenance and operation manual to PBA representative or Engineer.

PERFORMANCE:

A. Use the Associated Air Balance Council (AABC) standards (last edition) for balancing works.

B. Manufacturer shall perform the standard run test under the supervision of Engineer or PBA representative. Data of test shall be certified and submitted to Engineer.

C. Balancing and adjustment shall be within 5% of design parameters.

D. Balancing works are limited to air side and readings shall be taken next of transitions of new duct and existing ones.

E. Contractor shall submit four (4) copies of certificate results of balancing test and adjustment by third party contractor.

END OF SECTION
15781

SECTION 15801 - GENERAL SPECIFICATIONS FOR AIR CONDITIONING WORK

A. GENERAL

1. RELATED DOCUMENTS

1.1 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, and the other sections of Division 15.

2. DEFINITIONS

2.1 "The Contractor" means specifically the Sub-contractor working under his respective section of these specifications.

2.2 "Provide" means to supply, erect, install and connect up in complete readiness for regular operation the particular work referred to.

2.3 "Piping" includes, in addition to pipe, all fittings, valves, hangers and other accessories related to such piping.

2.4 "Concealed" means hidden from sight as in chases, furred spaces, shafts, hung ceiling or embedded construction.

2.5 "Exposed" means concealed as define above. Work in trenches, crawl spaces and tunnels shall be considered "exposed" unless otherwise specifically noted.

2.6 "Law and Ordinances", as used herein shall mean local codes, laws, ordinance, standards, rule or regulations of any nature which are in any way pertinent to or regulatory over the work covered by this section of the specifications.

3. SUMMARY AND INTENT

3.1 It is the intention of the work specifications and drawings to call for finished work, tested and ready for operation all materials, equipment and apparatus shall be new and first class quality.

3.2 Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications or vice-versa, or any accessories or minor details not shown but necessary to make the work complete and perfect in all respect and ready for operation, even if not particularly specified, shall be provided by the Contractor without additional expense to the Owner.

3.3 With submission of bid, the Contractor shall give written notice to the Architect and/or Engineer of any materials, apparatus or omissions believed to be in violation of laws, ordinance, rules or regulations to authorities having jurisdiction.

In the absence of such written notice, it is mutually agreed that the Contractor shall include the cost of providing all systems in accordance with applicable regulations without extra compensation.

3.4 The plans and specifications are complementary to each other, so that material and workmanship indicated for or implied by one and not by the other, shall be supplied and installed as through specifically called necessarily showing in detail or to scale all of the minor items. It shall be the responsibility of the bidders to review and make themselves completely familiar with all architectural, structural, electrical and mechanical drawings and to adjust his work to conform to all conditions indicated on them. Failure of the bidder to fully inform themselves of all conditions and to include in their proposal a sum to cover the same sufficiently, shall not entitle them to an extra.

3.5 All items not specifically mentioned in the specification or in the drawings, but which are necessary to make a complete working installation shall be include in the bidder proposal. Failure of the bidders to do so will not entitle them to an extra.

4. INTERPRETATIONS OF DRAWINGS AND SPECIFICATIONS

4.1 Any questions or disagreements arising as to the true intent of these specifications or the drawings or the kind or quality of work required, thereby shall be decided by the Architect and/or Engineer, whose interpretation thereof shall be final but subject to appeal as prescribed by the General Conditions.

4.2 The specifications and the drawings are intended to be in agreement with each other and to be mutually explanatory. However, they are also intended to be complementary and any work or material called for by either, shall be performed and/or provide as faithfully as if called for by both.

4.3 In cases of disagreement between the drawings and the specifications or within either document itself or between one trade and another, the better quality, greater quantity or more costly work shall be include in the contract price, and the matter referred to the Architect's and/or Engineer's attention for decision and/or adjustment.

5. CONTRACTOR'S PROPOSAL

5.1 The Contractor's proposal must cover all items on the drawings and in the specifications exactly as drawn and specified based only on the manufacturers listed.

5.2 If the Contractor proposes substitution of the equipment of other manufacturers than those specified, he shall attach to his base bid an itemized list of substitutions. Directly opposite of each item, he shall indicate the amount to be added to or deducted from his base bid, if his proposal is accepted. In all instances, such request shall be accompanied by all complete descriptive theory literature and performance data. Failure to furnish that the Contractor agrees to provide all items

exactly as drawing and specified. The information given by each Contractor in the above itemized list will in no way affect the determination of low bidder.

6. QUALIFICATIONS FOR BIDDERS

6.1 Examine drawings relating to work of all trades and become fully informed as to extent and character of required and its relation to all other work in project.

6.2 Before submitting bid, Contractor shall visit the site and examined all spaces conditions. He shall report to the Architect any condition which might prevent him from installing his equipment in the manner intended.

6.3 No consideration or allowance will be granted for failure to visit site or for any alleged misunderstanding of materials to be furnished or work to be done; it being agreed that tender of proposals carriers with it agreement to items and conditions referred to herein or indicated on aforementioned drawings.

7. SUBMITTALS

7.1 SHOP DRAWINGS AND SAMPLES

7.1.1 Prior to delivery to job site, but sufficiently in advance to allow Architect and/or Engineer ample time for review, Contract shall submit for approval five (5) copies each of shop drawings of all equipment, materials, piping, ductwork, and wiring, and further obtain written approval for same before installing any of these items.

7.1.2 Shop drawings shall consist of manufacturer's certified scale drawings, cut or catalogs, including descriptive literature and complete certified characteristic of equipment, showing dimensions, capacity, code requirements, motor and drive testing, as indicated on the drawings or specifications.

7.1.3 Certified performance curves for all fans and water pumping equipment shall be submitted for approval.

7.1.4 A sample of materials or equipment, when requested by the Architect and/or Engineer shall be submitted for approval.

7.1.5 Samples, drawings, specifications, catalogs, etc., submitted for approval, shall be properly labeled, indicating specific service for which material or equipment is to be used, section and article number of specifications governing, Contractor's name and the name of the job.

7.1.6 Catalogs, pamphlets or other documents to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc., of item submitted will be clearly made in ink. Data of a general nature will not be accepted.

7.1.7 Approval rendered on shop not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that the drawings have been checked in detail. Said approval does not, in any way, relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

7.1.8 Failure by the Contractor to submit shop drawings in ample time for checking, shall not entitle him to an extension of contract time and no claim for extension by reason of such default will be allowed.

7.1.9 Approval rendered on shop drawings for any material, apparatus, devices, and layouts, shall not relieve the Contractor from the responsibility of furnishing same of proper dimension, size, quantity, quality, and all performance characteristics to efficiently perform the requirements and intent of the contract drawings. Such approval shall not relieve the Contractor from responsibility for errors of any sort on the shop drawings. The Contractor shall notify including the reason for the deviation.

7.1.10 Shop drawing scale 1/4"-1-0" minimum shall be submitted for approval for all ductwork, pipe runs, inserts, sleeves, etc., before work is performed.

B. PRODUCTS

1. EQUIPMENT AND MATERIAL

1.1 Furnish and install were indicated on the drawings of all equipment hereinafter specified or shown on the drawings or specifications.

1.2 Capacities of equipment shall be as specified on the drawings or specifications.

1.3 Equipment construction standard shall be as follows: Pressure vessels shall be constructed in accordance with ASME Code; all electrical equipment shall be listed and approved and conform to be latest edition of the NEC; piping, materials, fittings, valves and accessories shall be constructed in accordance with the latest ASTM and ASME Standards for class of work involved. All the equipment and materials shall be new.

1.4 All component parts of each item of equipment or device shall bear the manufacturer's nameplate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc., in order to facilitate maintenance or replacement. The nameplate of a Sub-Contractor or distributor will not be acceptable.

1.5 All materials and apparatus required for the work shall be new, or first-class quality and shall be furnished, delivered erected, connected and finished inn every detail and shall be so selected and arranged as to fit properly into the building

spaces. Where no specific kind or quality material is given, a first-class standard article as approved by Architect and/or Engineer shall be furnished.

1.6 All item of the same type shall be of the same manufacturer.

2. SUBSTITUTIONS

2.1 Substitutions of material and equipment of brands other than specifically named on the drawings and in the specifications and as provided for in the above paragraph will be approved by the Architect and/or Engineer for the following reasons only:

2.1.1 That the material or equipment proposed for substitution is equal or superior to that specified and that the material or equipment called for on the drawings or in the specifications cannot be delivered to the job in time complete the work in proper sequence to the work or other Contractors, due to conditions beyond control of the Contractor.

2.1.2 To receive consideration, request for substitutions must be accompanied by documentary proof of equality difference in price and delivery, if any, in the form of certified quotations from suppliers of both supplied and proposed equipment. In case of a difference in price, the Owner shall receive, in the form of a credit, all benefit of the difference in cost involved in any substitution.

2.1.3 Should a substitution be approved under the foregoing provisions and should the same subsequently prove to be defective or otherwise unsatisfactory for the service for which it was intended, the Contractor shall, without cost to the Owner and without obligations on the part of the Architect and/or Engineer, replaced the same with the material originally specified.

2.2 Where a Contractor's proposal is accepted to used an item of equipment other than that specified or detailed on the drawings and which required any redesign of structure, partitions, foundations, piping, wiring or of any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and details required thereof shall, with the approval of the Architect and Engineer, be prepared by the Contractor at his own expense.

2.3 Where such approved deviation requires a different quantity and arrangement of duct work, piping, wiring, conduit and equipment from that specified or indicated on the drawings, subject to approval of the Architect, the Contractor shall provide any such duct work, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit and any other additional equipment required by the system at no additional cost to the Owner.

C. EXECUTION

1. SYSTEM INSTALLATION

1.1 The installation of systems described in these specifications and plans will be performed by experienced personnel in this type of work, under the supervision of competent foremen and in accordance with the recommended practices of the ASHRAE and those of the manufacturer of the equipment and the materials involved, to obtain not only a functional installation but a neat installation.

1.2 Architect shall have privilege of stopping any work or use of material that in his opinion is not being properly installed and Contractor shall remove all materials delivered, or work erected, which does not comply with contract drawings as directed by the Architect at no additional cost to the Owner.

1.3 Before installing ductwork and/or piping, check plumbing, electrical, architectural and structural drawings against the drawings of the contract and make accurate layouts of ductwork and/or piping.

1.4 Where interference may appear and departures from indicated arrangement are required, this Contractor shall consult with the other trades involved and come to an agreement as to change locations and elevations for the ductwork and/or piping and shall obtain approval from the Architect and/or Engineer for the proposed changes.

1.5 Foundations and supports for all equipment in this Contract shall be furnished by this Contractor, unless otherwise noted on the plans, as required or as recommended by the manufacturer of each piece apparatus.

1.6 The Contractor shall locate, layout and install all holes and sleeves in walls, ceilings, floors, etc., necessary for the installation of his work. The Contractor shall cooperate with the Contractors of the other divisions, giving due and proper notifications regarding all such work.

2. EQUIPMENT INSTALLATION

2.1 Equipment shall be installed as indicated and in accordance with the manufacturer's installation recommendations. Equipment shall fit into spaces assigned.

2.2 Installation which will cause maintenance or operation problems shall be avoided. Items that may required removal for servicing shall be installed with adequate clearance, so as not to require the removal or damaging or other items or their insulation to permit their own removal. Equipment requiring inspection or service shall be accessible. Access doors shall be installed in mechanical equipment as required and as indicated.

2.3 Piping and specialties which are required for the proper completion of work, but which are not indicated, shall be provided as required or as recommended by the manufacturer of the equipment served. Offsets, connections and take-off in piping shall be made within fittings.

2.4 This Contractor shall investigate each space through which equipment must move. Where necessary, equipment shall be shipped from the manufacturer in crated sections of a size suitable for moving through the restricted available spaces. This shall apply to all equipment whether specified or indicated to be provided "knocked down" or not.

3. LAWS, ORDINANCES, PERMITS AND FEES

3.1 The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, drawings (in addition to contract drawings and documents) in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.

3.2 All materials furnished and all work installed shall comply with the rules and recommendations of the National Board of Fire Underwriters, with all requirements of local utility companies, with the recommendations of the Fire Insurance Rating Organization having jurisdiction and with the requirements of all governmental departments having jurisdiction. Cases of discrepancy between the respective requirements shall be referred to the Architect for decision.

4. COORDINATION OF TRADES

4.1 The Contractors shall give full cooperation to the other trades and shall furnish (in writing, with copies to Architect and/or Engineer) information necessary to permit the work of all trades to be installed satisfactorily and with the least possible delay.

4.2 Where the work of the Contractor is to be installed in close proximity to work of the other trades, or where there is evidence that the work of the Contractor is to interfere with the work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. The Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1/4"-0" clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, he shall make necessary changes in his work to correct the condition without extra care.

5. PROTECTION OF WORK AND PROPERTY

5.1 The Contractor shall be responsible for the maintenance and the protection of all equipment, materials and tools, supplied by him stored or installed on the job site, from loss or damage of all causes until final acceptance by the Architect and /or Engineer.

5.2 The Contractor shall be responsible for the protection of any finished work of other trades from damage or defacement by his operations and must remedy any such damage at his own expense.

6. TEMPORARY OPENINGS

6.1 The Contractor shall ascertain, from his examination of the architectural drawings, whether any special temporary openings in the building will be required for the admission of apparatus provided under his contract and he shall notify the Architect accordingly. In the event of failure of the Contractor to give sufficient notice to the Architect in time to arrange for these openings during construction, the Contractor shall assume all costs of providing such openings thereafter.

7. ACCESSIBILITY

7.1 The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions and the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with the General Contractor and all other Contractors whose work in the same space and shall advise the General Contractor of his requirements. Such spaces and clearances shall, however, be kept to minimum size required.

7.2 The contractor shall install all work so that all parts required are readily accessible for inspection, operation, maintenance and repair, minor deviations from the drawings may be made to accomplish this, but changes of magnitude shall not be made without prior written approval from the Architect and/or Engineer.

7.3 Wherever mechanism requiring access for the operation are concealed in the structure and wherever else indicated on the drawings, the Contractor shall supply access doors of size necessary to provide ready access to the concealed item.

7.4 Where access doors are called for and/or required to maintain, balance or operate the mechanical equipment, this Contractor must furnish on access door. In white plaster ceilings, provide access doors Milcor Style "K" as manufactured by the Inland Steel Products Company. Provide Milcoir Style "M" access doors for unfinished walls. Access doors shall be turned over to the General Contractor for installation.

7.5 Access doors shall be installed in building structure by General Contractor.

8. PIPE EXPANSION

8.1 All pipe connections shall be installed to allow for freedom of movement of the piping during expansions and contraction without springing. Swing joints, expansions loops and expansion joints with proper anchors and guides shall be provide by the Contractor where necessary, and/or when shown on the drawings. Anchors and guides shall be subject to the approval of the Architect.

9. SLEEVES, INSERTS AND ANCHOR BOLTS

9.1 The Contractor shall provide and will be held responsible for he location of any maintaining in proper position all sleeves, inserts and anchor bolts shall be set before concrete is poured and before masonry construction is finished. In the event that failure to do so requires cutting and patching of finished work, it shall be done at the Contractor's expense.

9.2 All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an internal diameter of 1" larger than the outside diameter of pipe, conduit or insulation enclosing pipe or conduit.

9.3 Sleeves through foundation walls shall be James B. Clow & Sons No. F-1430 cast iron sleeve with intermediate integral flange. Sleeves shall be set with ends flush with each face of wall. The space between 2" of each face of wall. The remainder space shall be packed and made watertight with a waterproof compound.

9.4 Sleeves through masonry floors or interior masonry walls shall be schedule 40 black steel pipe, set flush with finished wall or ceiling surfaces but extending 1/2" above finished floors.

9.5 Sleeves through interior partitions shall be 22 gauge galvanized sheet steel, set flush with finished surfaces of partitions.

9.6 Inserts shall be individual or strip type of pressed steel or malleable iron construction with accommodation for removable nuts and threaded rods up to 3/4" diameter, permitting lateral adjustment. Individual inserts shall be fee and Mason Manufacturing Company, Fig.190 with attached rods having hooked ends to allow fastening to reinforce rods.

10. COVERING OF WORK

10.1 No pipe, fitting or other of any kind shall be covered up or hidden from view, before it has been examined by the Architect or from other authority having jurisdiction over the same. Any faithful or imperfect work or materials which may be discovered shall be removed and corrected immediately after being condemned and other work and material shall be furnished which shall be satisfactory to the Architect and/or Engineer.

11. MACHINERY GUARDS

11.1 Moving parts of machinery exposed to contact by personnel shall be guarded as required by authorities having jurisdiction by barrier of a type as approved by the Architect and/or Engineer.

11.2 Exposed moving parts such as belts and couplings shall have 3/4" No. 16 gauge expanded metalmesh guards with all edges rounded . Guards shall have a 1-1/4" X 1/8" angle frame properly supported.

11.3 All machinery guards covering the ends of motor or equipment shafts shall have openings for the insertion of a tachometer.

12. TOOLS

12.1 All special tools required for operation and maintenance of equipment shall be furnished and delivered to Owner's Representatives and a receipt obtained.

13. TESTS

13.1 All piping, ductwork, and equipment shall be tested as specified under the various section of the work and additional tests shall be provided, as may be required for approval by all agencies having jurisdiction. Labor, materials, instruments and power required for testing shall be furnished by the contractor unless otherwise indicated under the particular section of the specification.

13.2 Test shall be performed in the presence and to the satisfaction of the Architect and such other parties as may have legal jurisdiction.

13.3 All defective work shall be promptly repaired or replaced and the test shall be repeated until the particular system and component parts thereof receive the approval of the Architect and/or Engineer.

13.4 Any damages resulting from tests shall be repaired and damaged materials replaced, all to the satisfactions of the Architect.

14. NOISE AND VIBRATION ELIMINATION

14.1 All equipment and material installed by the Contractor shall operate under all conditions of load without any sound or vibration which in the opinion of the Architect is objectionable by the Architect and/or Engineer, the Contractor shall eliminate same in the manner approved by the Architect and/or Engineer, at no additional cost to the Owner.

14.2 The particular attention of this Contractor shall be directed to the problem of preventing noise and vibration transmission from mechanical equipment and fan rooms to adjacent emanating from equipment in these rooms be perceptible in adjacent areas. The Contractor shall incorporate in his installation all devices and accessories to accomplish this result. Such devices shall include vibration isolator bases and sound absorber pads, sound insulation, all as may be required. The above also applies to equipment suspended in ceilings or mounted on roof.

14.3 Vibration isolators exposed to the weather shall be equipped with limit stops to resist wind velocity. Steel parts other that springs shall be galvanized; springs shall be cadmium plated or suitable coated to resist corrosion.

14.4 Rubber-in-shear isolators shall be properly housed and provided with adequate facilities for bolting. Single rubber-in-shear shall be molded mound shaped element designed for 1/4" deflection under the imposed load. Double rubber-in-shear shall be two elements described above, assembled in series to provide 1/2" deflection under the imposed load.

14.5 All vibration isolation system shall be guaranteed to have the static deflections as specified and indicated on the drawings. The vibration isolation system shall be installed in accordance with the manufacturer's instructions.

15. RUBBISH

15.1 Work shall be done in such a manner as to maintain a clean construction area and reduce fire hazards to a minimum. The Contractor shall remove his own debris from the site and no accumulation of inflammable combustible will be permitted.

16. CLEANING PIPING, DUCTS AND EQUIPMENT

16.1 The Contractor shall thoroughly clean all piping, ducts and equipment of all foreign substances inside and out before being placed in operation. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstruction material.

16.2 If any part of a system should be stopped by a foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected whether necessary to locate and removed obstruction. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

17. FINAL INSPECTION

17.1 The Contractor should arrange and schedule final inspection of the mechanical work and shall notify the Architect and/or Engineer in writing that the Contractor has thoroughly checked his work and in the opinion of the Contractor is ready for final inspection. This check will include a record of air quantities to each space, balancing of systems, proper function of each place of electrical equipment and individual system.

17.2 During the entire period scheduled for these inspections, the General Contractor, the Sub-Contractor involved and representative of each manufacturer of equipment involved will be present. All of these organizations will have sufficient and competent personnel present so that adjustment can be made to all systems without delay.

17.3 Only after all systems and equipment are inspected and approved in writing and lists of instructions, etc., are submitted, will final payment be made.

18. GUARANTEES

18.1 The Contractor shall guarantee that all work installed will be free from any and all defects and that all apparatus will be develop capacities and characteristics specified and that if during a period of one (1) year from the date of acceptance of work any such defect in workmanship, material or performance appear, he shall immediately replace, repair or otherwise correct the defect or deficiency without cost to the Owner.

18.2 The Contractor shall also replaced or repair to the satisfaction of the Owner any and all damage done to the building or its contents or work of other trades in consequence of work performed in fulfilling guarantee.

18.3 In the event of default on this guarantee by the Contractor, the Owner may have such work done as required and charge the cost to the Contractor.

19. INSURANCE

19.1 The Contractor shall carry and pay for liability and workmen compensation insurance for the duration of this contract and shall protect the Owner against all claims that may arise. All premiums are to be paid by the Contractor and the policies are to cover any and all persons and contingencies in connection with the installation of the work included in this contract. Also a 100% payment and 100% performance bond will be required.

20. SURVEYS AND MEASUREMENTS

20.1 Contractor shall base all measurements, both horizontal and vertical, from established marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

20.2 Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevent following good practice or the intent of the drawings and specifications, he shall notify the Architect and/or Engineer and shall not proceed with his work until he has received instructions from them.

21. SCAFFOLDING, RIGGINGS AND HOISTING

21.1 Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from the premises when no longer required.

22. WATERPROOFING

22.1 Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by Architect before work is done. Contractor shall furnish all necessary caulking and flashing required to make openings absolutely watertight.

23. TESTING AND BALANCING

23.1 Work shall consist of testing, balancing and adjusting of all air and water systems and components called for on the drawings and/or other Contract Documents. This shall be accomplished as follows:

23.1.1 Obtain the required air quantities at various operating conditions of the system to demonstrate compliance with the design. This will require simulation of maximum pressure drops due to dirty filters and wetted cooling coils, and, in the case of variable air volume systems, variation of air volume through the range from minimum to maximum.

23.1.2 Obtain the hot and/or chilled water quantities required by the various components, equipment and devices.

23.2 All work shall performed by an independent test and balance agency under direct supervision of qualified air conditioning and ventilating engineer approved by the consulting engineer and Owner. All instruments used shall have been accurately calibrated within the last six month and maintained in good working order. (Affidavits attesting to the date, method (s) of calibration, and by who calibrated shall be furnished to the Owner's Engineer and/or his Representative. Test And Balance (TAB) Contractor and Owner Representative shall meet at least two (2) weeks prior to the anticipated start of testing to finalize procedures and assure complete understanding of the methods used.

23.3 Testing and balancing shall not begin until systems have been completed and are in full working order. The ventilating and air conditioning Contractor shall put all ventilating and air conditioning equipment into full operation and shall continue the operation of same during each working say of testing and balancing.

23.4 TAB Contractors shall include an extended warranty of ninety (90) days after completion of test and balance work and submissions of the report, during which time the Owner's Representative at his direction may request a recheck or resetting of any outlet, supply air fan, exhaust fan, control valves or balance valves to adjust technicians to assist the Engineer in making any tests he may require during this period.

23.5 Upon the completion of the system, the TAB Contractor shall submit seven (7) copies of the balancing report. In addition, one marked-up set of mechanical drawings indicating and identifying test point locations shall be furnished. Balancing reports shall be done in SMACNA'S, NBB or AABC Forms, as specified on drawings.

23.6 The TAB Contractor shall check all controls for proper calibration and furnish a list of all controls needing adjustment. Any controls needing adjustment shall be attended to by the controls Contractor, and this Contractor shall validate and verify the adjustment repeating the process until satisfactory operation is achieved.

24. RECORD DRAWINGS AND DOCUMENTS

24.1 The Contractor shall keep concurrently with the progress or the installation, a set of "as built" record drawings, consisting of a reproducible marked set of Engineer's drawing with additional sketches as required, denoting and dimensioning accurately all changes in elevation, location and size of material deviating from Engineer's drawing. In addition, all offsets and valves shall be recorded. Upon completion of the work, the Contractor shall deliver to the Architect an up-to-date set of these "as built" record drawings. "As built" drawings must be presented on transparent cloth.

24.2 Before final payment is made, the Contractor shall deliver to the Architect for approval the following items:

24.2.1 Five (5) books with approved equipment submittal data, operation instructions and maintenance instructions.

24.2.2 The following "as built" record drawings and "as built" shop drawings.

a. Original "as built" set (translucent bond or mylar).

b. Five (5) blue or black print sets.

END OF SECTION 15801

SECTION 15815 - METAL DUCTS

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 metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2500 Pa), as shown on drawings. Metal ducts include the following:

1. Rectangular ducts and fittings.

B. Related Sections include the following:

1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

A. Shop Drawings: **CAD-generated and drawn** to 1/4 inch equals 1 foot (1:50) scale. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Welding certificates.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to **AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.**

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

D. Mockups:

1. Before installing duct systems, build mockups representing pressure classes higher than **3-inch wg (750 Pa)**. Build mockups to comply with the following requirements, using materials indicated for the completed Work, and include 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 duct and apparatus.
e. Perform tests specified in Part 3 "Field Quality Control" Article. Modify mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having **G90 (Z275)** coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:

a. CertainTeed Corp.; Insulation Group.
b. Johns Manville International, Inc.
c. Knauf Fiber Glass GmbH.

d. Owens Corning.

2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

a. Thickness: 1 inch (25 mm).
b. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- (23-kg-) tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch (3 mm) into airstream.
3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

B. Flexible Elastomeric Duct Liner: Comply with NFPA 90A or NFPA 90B.

1. Manufacturers:

a. Armstrong World Industries, Inc.

2. Materials: Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.

a. Thickness: 1 inch (25 mm).
b. Thermal Conductivity (k-Value): 0.24 at 75 deg F (0.034 at 24 deg C) mean temperature.
c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
d. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.4 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, and Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.6 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:

a. Ductmate Industries, Inc.
b. Nexus Inc.
c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:

a. Ductmate Industries, Inc.
b. Lockformer.

2. Duct Size: Maximum 30 inches (750 mm) wide and up to 2-inch wg (500-Pa) pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of nonbraced panel area unless ducts are lined.

2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).

G. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharges.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

I. Secure insulation between perforated sheet metal inner ducts of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

1. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.

J. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used; secure buildouts to duct walls with bolts, screws, rivets, or welds.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: **6-inch wg (1,500 Pa).**
2. Return Ducts (Negative Pressure): **3-inch wg (750 Pa).**
3. Exhaust Ducts (Negative Pressure): **2-inch wg (500 Pa).**

B. All ducts shall be galvanized steel except as follows:

1. Range Hood Exhaust Ducts: Comply with NFPA 96.

a. Concealed: Carbon-steel sheet. Insulated as per section 15081 "Duct Insulation".
b. Exposed: Type 304, stainless steel, gauge 18, minimum with finish to match kitchen equipment and range hood.
c. Weld and flange seams and joints.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install ducts with fewest possible joints.

C. Install fabricated fittings for changes in directions, size, and shape and for connections.

D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.

E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

I. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).

M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."

N. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to **SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**

O. Protect duct interiors from the elements and foreign materials until building is enclosed. **Follow SMACNA's "Duct Cleanliness for New Construction."**

P. Paint interiors of metal ducts that do not have duct liner, for 24 inches (600 mm) upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.3 UNDERSLAB DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Verify undamaged condition of ducts before enclosure with fill or encasement.

B. Protect ducts from damage by equipment used in placing fill materials and concrete on or around ducts.

C. Protect duct openings from damage and prevent entrance of foreign materials.

3.4 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Install ducts to allow for thermal expansion through 2000 deg F (1110 deg C) temperature range.

B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.

C. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches (38 mm) from bottom; and fit with grease-tight covers of same material as duct.

D. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.

3.5 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.

B. Seal ducts before external insulation is applied.

3.6 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (500 Pa) (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg (500 to 2500 Pa), but in any case leakage shall not be greater than 5%. Period.
4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.9 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

3.10 CLEANING EXISTING SYSTEMS

A. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtrations to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for washdown procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and reinspect ducts.

G. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.

1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.

H. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION 15815

SECTION 15820 - DUCT ACCESSORIES

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. Backdraft dampers.
2. Volume dampers.
3. Ceiling fire dampers.
4. Combination fire and smoke dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

B. Related Sections include the following:

1. Division 13 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Ceiling fire dampers.
4. Combination fire and smoke dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Special fittings.
2. Manual-volume damper installations.

3. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems,"

1.5 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. Fusible Links: Furnish quantity equal to **10** percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having **G90 (Z275)** coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. Description: Multiple-blade, parallel action gravity balanced, with **center-pivoted** blades of maximum 6-inch (150-mm) width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: **0.063-inch- (1.6-mm-) thick extruded aluminum**, with welded corners **and mounting flange**.

D. Blades: **0.050-inch- (1.2-mm-) thick aluminum sheet**.

E. Blade Seals: **Neoprene**.

F. Blade Axles: **Stainless steel**.

G. Tie Bars and Brackets: **Aluminum**.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow Corporation.
5. METALAIRE, Inc.
6. Nailor Industries Inc.

7. Penn Ventilation Company, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Multiple- opposed-blade (OBD) design as indicated, standard leakage rating, **with linkage outside airstream,** and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, **galvanized** sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, **galvanized** sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
6. Blade Axles: **Stainless steel.**
7. Bearings: **Stainless-steel sleeve.**
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, **with linkage outside airstream,** and suitable for horizontal or vertical applications.

1. Steel Frames: **U**-shaped, **galvanized** sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, **galvanized** sheet steel.
3. Aluminum Frames: **U**-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
6. Blade Axles: **Stainless steel.**
7. Bearings: **Stainless-steel sleeve** thrust or ball.
8. Blade Seals: **Neoprene.**
9. Jamb Seals: Cambered **aluminum.**
10. Tie Bars and Brackets: **Aluminum.**

E. Jackshaft: 1-inch- (25-mm-) diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 CEILING FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. CESCO Products.
3. Greenheck.
4. McGill AirFlow Corporation.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Prefco Products, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.

B. General Description: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Fusible Links: Replaceable, **165 deg F (74 deg C)** rated.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. CESCO Products.
3. Greenheck.
4. Nailor Industries Inc.
5. Penn Ventilation Company, Inc.
6. Ruskin Company.

B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Fusible Links: Replaceable, **165 deg F (74 deg C)** rated.

D. Frame and Blades: 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- (38-mm-) wide, **double** thickness-vane, curved blades of galvanized sheet steel set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into vane runners suitable for duct mounting.

1. Manufacturers:

    a. Ductmate Industries, Inc.
    b. Duro Dyne Corp.
    c. METALAIRE, Inc.
    d. Ward Industries, Inc.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.

1. Manufacturers:

    a. American Warming and Ventilating.
    b. CESCO Products.
    c. Ductmate Industries, Inc.
    d. Flexmaster U.S.A., Inc.
    e. Greenheck.
    f. McGill AirFlow Corporation.
    g. Nailor Industries Inc.
    h. Ventfabrics, Inc.
    i. Ward Industries, Inc.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:

    a. Less Than 12 Inches (300 mm) Square: Secure with two sash locks.
    b. Up to 18 Inches (450 mm) Square: Two hinges and two sash locks.

c. Up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches **with outside handles**.
d. Sizes 24 by 48 Inches (600 by 1200 mm) and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch (25-mm) thickness. Include cam latches.

1. Manufacturers:

a. Flexmaster U.S.A., Inc.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Pressure Relief Access Door: **Single** wall and duct mounting; fabricated of galvanized sheet metal as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.

1. Manufacturers:

a. American Warming and Ventilating.
b. CESCO Products.
c. Ductmate Industries, Inc.
d. Greenheck.
e. KEES, Inc.
f. McGill AirFlow Corporation.
g. Nexus PDQ.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

F. Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Duro Dyne Corp.
2. Ventfabrics, Inc.
3. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip **[3-1/2 inches (89 mm)] [5-3/4 inches (146 mm)]** wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz. /sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz. /sq. yd. (810 g/sq. m).
2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz. /sq. yd. (542 g/sq. m).
2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz. /sq. yd. (474 g/sq. m).
2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

2.10 FLEXIBLE DUCTS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Flexmaster U.S.A., Inc.
3. Hart & Cooley, Inc.
4. McGill AirFlow Corporation.

B. Noninsulated-Duct Connectors: UL 181, Class 0, interlocking spiral of aluminum foil.

1. Pressure Rating: 8-inch wg (2280 Pa) positive or negative.
2. Maximum Air Velocity: 5000 fpm (25.4 m/s).
3. Temperature Range: Minus 100 to plus 435 deg F (Minus 73 to plus 224 deg C).

C. Insulated-Duct Connectors: UL 181, Class 1, 2-ply black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; **polyethylene** vapor barrier film.

1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20.3 m/s).
3. Temperature Range: Minus 20 to plus 175 deg F (Minus 28 to plus 79 deg C).

D. Flexible Duct Clamps: **Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action**, in sizes 3 through 18 inches (75 to 450 mm) to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

B. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

D. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

E. Provide test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

G. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers, turning vanes, and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.

4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
5. On sides of ducts where adequate clearance is available.

H. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body Plus Ladder Access: 25 by 17 inches (635 by 430 mm).

I. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches (200 mm) in diameter.
2. Two-Hand Access: 10 inches (250 mm) in diameter.
3. Head and Hand Access: 12 inches (300 mm) in diameter.
4. Head and Shoulders Access: 18 inches (460 mm) in diameter.
5. Body Access: 24 inches (600 mm) in diameter.

J. Install the following sizes for duct-mounting, pressure relief access doors:

1. One-Hand or Inspection Access: **7 inches (175 mm)** in diameter.
2. Two-Hand Access: 10 inches (250 mm) in diameter.
3. Head and Hand Access: 13 inches (330 mm) in diameter.
4. Head and Shoulders Access: 19 inches (480 mm) in diameter.

K. Label access doors according to Division 15 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. For fans, developing static pressures of 5-inch wg (1250 Pa) and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts **directly or** with maximum 70-inch (1750-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to low pressure ducts **directly with a 6" length neck or** with maximum 70-inch (1750-mm) lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with **liquid adhesive plus tape** and **draw bands** on a scooper damper, as shown on the drawings.

Q. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15820

SECTION 15839 - DUCTWORK

A. GENERAL

1. RELATED DOCUMENTS

1.1 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, and the other sections of Division 15.

2. SUMMARY

2.1 Do all ductwork construction and installation as shown in the drawings. Raise, drop and offset ductwork as require to clear obstructions after notifying Architect/Engineer, and obtaining approval.

B. PRODUCTS

1. MATERIALS

1.1 All ductwork shall be of galvanized steel sheet metal, or stainless steel Ga. 18 construction as specified on drawings.

C. EXECUTION

1. CONSTRUCTION

1.1 Low Pressure Ductwork: Any ductwork whose air velocity does not exceed 2000 FPM and whose static pressure does not exceed 2" WAG. construct in accordance with Smacna's Low Pressure Manual, unless otherwise specified on drawings or in the "Special Ductwork" Section of these specifications.

1.2 Medium Pressure Ductwork: Any ductwork whose air velocity exceeds 2000 FPM and whose static pressure exceeds 2" wg., but is not greater than 6" wg. construct in accordance with Smacna's Medium Pressure Manual, unless otherwise specified on drawings or in the "Special Ductwork" Section of these specifications.

1.3 Any ductwork shown on drawings as flexible shall be "Thermaflex" Type M-KH, insulated or approved equal.

2. DUCT SEALING:

2.1 A11 sheet metal duct joints shall be sealed with BG flame resistance high velocity duct sealant #30-02. Follow Manufacturer's recommendations for application.

3. LEAK TESTING:

3.1 All ductwork shall be tested for leaks according to the procedures descried in Chapter 8 of Smacna's "Manual for Balancing and Adjustment of Air Distribution Systems" unless otherwise specified on drawings total leakage shall not exceed 2.5% of design.

4. SPECIAL DUCTWORK:

4.1 Ductwork exhausting moist air from dishwashers and kitchen hoods shall be made of round stainless steel Ga. 18.

4.2 Pitch horizontal runs toward the hood a minimum of 1/8" ft.

4.3 Duct transitions shall be made flat on bottom.

5. ACCESS DOORS:

5.1 Where necessary in ductwork or casings, suitable access doors, and frames to permit inspection, operation and maintenance of all valves, controls, fire dampers, smoke dampers, manual dampers, automatic dampers, filters sprays bearings, coils or other apparatus concealed behind the sheet metal work shall be provided. All such doors in insulated ducts shall be double panel insulated of not less than No. 230 gauge.

5.2 All access doors in ductwork shall be hung on separate frames on heavy flat hinges and shall be secured in the closed position with ventlok No. 100 cast zinc latch or as approved. Where space conditions preclude the use of hinges a minimum of four heavy window-type latches shall be provided.

5.3 In no case shall access to any items of equipment requiring inspection, adjustment or servicing, require the removal of nuts, bolts, screws, wingnuts, wedges, or any other screwed or loose device. It is the intention that all access doors be hinged and latched.

5.4 Access doors into ducts shall in general not be smaller than 9 inches x 9 inches, except for ductwork of smaller sizes.

5.5 Direct location and setting of access doors in hung ceilings, furred spaces, walls, etc. to provide access to concealed work items requiring maintenance and/or adjustment. Locations of such access doors shall be as approved by the Architect.

6. DAMPERS:

6.1 Fire dampers shall be installed in all ducts piercing and as shown on drawings. Body of fire damper shall be set inside of duct.

6.2 Install fusible link dampers at any other location where necessary to meet U.L. Requirements. Provide conveniently located access doors, of ample size for resetting the dampers. Entire fire damper assembly shall be either galvanized or

painted with one coat of rust inhibiting paint before installation. Fire dampers must be approved by N.F.B.U. and also have approval of all governing authorities.

6.3 Manual dampers, as shown on the drawings and as required shall be installed in the various branches of the ductwork to be used in balancing the system. Note that these dampers shall be separate and independent from the registers hereinafter specified to be set behind supply air grilles. Multiple dampers shall be provided as shown on drawings.

6.4 Manual dampers shall be of the quadrant type, of heavy construction, pivoted to turn easily, and provided with approved operating and locking devices, mounted on outside of the duct in an accessible place. Details as directed.

6.5 Backdraft dampers shall be all aluminum and will be installed as shown on drawings.

7. FLEXIBLE CONNECTIONS

7.1 Fin connections, both at inlet and discharge, shall be made with flexible material so as to prohibit the transfer of vibration from fans to ductwork connecting thereto. Connections shall be made of heavy fire resistive canvas cloth for range hood exhaust fans, and or vinyl and neoprene cloth for conventional systems, except as otherwise required by authorities having jurisdiction and except as otherwise noted below.

7.2 The flexible connections shall be approximately 6 inches long and held and place with heavy metal bands or double hemlock securely attached to prevent any leakage at the connection points.

7.3 The flexible connections at the discharge ends of the fans for the high pressure air conditioning systems shall be of vinyl covered glass fiber, of lengths noted above and fastened as above. It is the intent that these flexible connections shall withstand the operating air pressure, shall not permit air leakage and shall not transmit vibration.

END OF SECTION OF 15839

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

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 ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GRILLES AND REGISTERS

A. Fixed Face **Register** (Return and Exhaust) (RR-; ER-)

1. Manufacturers:

   a. A-J Manufacturing Co., Inc.
   b. Anemostat; a Mestek Company.
   c. Carnes.
   d. Dayus Register & Grille.
   e. Hart & Cooley, Inc.; Hart & Cooley Div.
   f. Krueger.
   g. Nailor Industries of Texas Inc.
   h. Metal-Aire Industries.
   i. Titus.
   j. Tuttle & Bailey.

2. Material: Anodized **Aluminum**.
3. Face Arrangement: 45° Horizontal Vanes.
4. Frame: **1 inch (25 mm)** wide.
5. Mounting: **Lay in**.
6. Damper Type: **Adjustable opposed-blade assembly**.

2.3 LINEAR SLOT OUTLETS

A. Linear Slot Diffuser (LSD-):

1. Manufacturers:

   a. Air Research Diffuser Products, Inc.
   b. Anemostat; a Mestek Company.

c. Carnes.
d. Hart & Cooley, Inc.; Hart & Cooley Div.
e. Krueger.
f. METAL-AIRE, Inc.; Metal Industries Inc.
g. Nailor Industries of Texas Inc.
h. Price Industries.
i. Titus.
j. Tuttle & Bailey.

2. Material - Shell: Anodized **Aluminum, insulated.**
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Pattern Controller: **Baked enamel, black.**
5. Finish - Tees: **Baked enamel, color selected by Architect.**
6. Slot Width: As shown on drawings.
7. Number of Slots: As shown on drawings.
8. Length: **48 inches (1200 mm).**
9. Accessories: **T-bar clips on both sides.**

2.4 CEILING DIFFUSER OUTLETS

A. Perforated Diffuser (PCD-) Variable Air Volume Diffuser (VAV):

1. Manufacturers:

a. Anemostat; a Mestek Company.
b. Carnes.
c. Hart & Cooley, Inc.; Hart & Cooley Div.
d. Krueger.
e. METAL-AIRE, Inc.; Metal Industries Inc.
f. Nailor Industries of Texas Inc.
g. Titus.
h. Therma-Fuser, by Acutherm, Inc.
i. Tuttle & Bailey.

2. Material: Steel backpan and pattern controllers, with **aluminum** face.
3. Finish: **Baked enamel, white.**
4. Face Size: **24 by 24 inches (600 by 600).**
5. Duct Inlet: **Round.** Size as shown on drawings.
6. Face Style: **Flush.**
7. Pattern Controller: **Adjustable with louvered pattern modules at inlet.**
8. Mounting: **Surface or T-bar**, as required, according to type of ceiling.
9. Dampers: **Radial opposed blade.**
10. Accessories:

a. Equaling grid.
b. Plaster ring.
c. Wire guard.
d. Sectorizing baffles.
e. Operating rod extension.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15855

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 AABC.

B. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by NEBB.

C. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

D. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Engineer'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.

E. 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.

F. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."

G. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

H. Testing, Adjusting, and Balancing Reports: Use standard forms from SMACNA's "HVAC Systems--Testing, Adjusting, and Balancing."

I. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Architect.

J. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.

K. 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."

L. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

B. 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 Engineer'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.

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. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems--Testing, Adjusting, and Balancing" and this Section.

D. 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.

E. 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 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES

A. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
3. Measure total system airflow. Adjust to within 10 percent of design airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to design airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum design airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum design airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units being tested at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to

design airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 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.

3.8 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.

3.9 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 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.

3.12 CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of design flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator water entering and leaving temperatures, pressure drop, and water flow.
2. Condenser water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kW.
5. The kW input if factory-installed instrumentation is furnished for measuring kW.
6. Capacity: Calculate in tons of cooling.
7. Air-Cooled Chillers: Verify condenser-fan rotation and record fan data, including number of fans and entering- and leaving-air temperatures.

3.13 COOLING TOWERS

A. Shut off makeup water for the duration of the test, and then make sure the makeup and blow-down systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser water flow rate recirculating through the cooling tower.
6. Measure cooling tower pump discharge pressure.
7. Adjust water level and feed rate of makeup-water system.

3.14 CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.15 HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperatures.
2. Water flow rate in GPM
3. Water pressure drop in Ft.wg.
4. Dry-bulb temperatures of entering and leaving air.
5. Wet-bulb temperatures of entering and leaving air.
6. Airflow I CFM
7. Air pressure drop in In.wg.

B. Electric-Heating Coils: Measure the following data for each coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperatures at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kW at full load.
6. Fuse or circuit-breaker rating for overload protection.

3.16 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.

3.17 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.

3.18 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: ± 5%
2. Air Outlets and Inlets: ± 5%
3. Heating-Water Flow Rate: ± 5%
4. Chilled and Condenser-Water Flow Rate: ± 5%

3.19 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.

3.20 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.
6. CFM sa, CFM ra and CFM oa
7. Entering and leaving DB/WB °F of cooling coils
8. Coil Face velocity in FPM.
9. Individual Rooms or areas average DB°F and %RH.
10. Average Return Air DB °F and % RH.
11. Fan ESP and TSP in inches of water.
12. Saturated Evaporator Temperature (SET) on DX Coils
13. Entering Water Temperature (EWT °F) and Temp. Diff. Delta-T in Chilled Water Coils.

14. Chilled Water Coils GPM and WPD in Ft. wg.
15. Pumps GPM and Total Discharge Head (TDH) in Ft.wg.
16. Fan CFM and Total Static Pressure (TSP) in In.wg.
17. Chiller Evaporator or Cooler GPM, LVG/ENT Water Temp. and PD in Ft. wg.
18. Chiller Condenser GPM, EWT/LWT Water Temp. and PD in Ft. wg.
19. Cooling Water GPM, EWT/LWT Water Temp and OA WB°F near the Tower.

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. Engineer'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 and 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 (mm), and bore.
    i. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
    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 (mm), and bore.
    f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

3. Test Data: Include design and actual values for the following:

    a. Total airflow rate in cfm (L/s).
    b. Total system static pressure in inches wg (Pa).
    c. Fan rpm.
    d. Discharge static pressure in inches wg (Pa).
    e. Filter static-pressure differential in inches wg (Pa).
    f. Preheat coil static-pressure differential in inches wg (Pa).
    g. Cooling coil static-pressure differential in inches wg (Pa).
    h. Heating coil static-pressure differential in inches wg (Pa).
    i. Outside airflow in cfm (L/s).
    j. Return airflow in cfm (L/s).
    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 (mm o.c.).
    f. Make and model number.
    g. Face area in sq. ft. (sq. m).
    h. Tube size in NPS (DN).

i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outside-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btuh (kW).
i. High-fire fuel input in Btuh (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btuh (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh (kW).

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data: Include the following:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btuh (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.

h. Airflow rate in cfm (L/s).
i. Face area in sq. ft. (sq. m).
j. Minimum face velocity in fpm (m/s).

2. Test Data: Include design and actual values for the following:

a. Heat output in Btuh (kW).
b. Airflow rate in cfm (L/s).
c. Air velocity in fpm (m/s).
d. Entering-air temperature in deg F (deg C).
e. Leaving-air temperature in deg F (deg C).
f. Voltage at each connection.
g. Amperage for each phase.

I. 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 (mm), and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

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 (mm), and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

J. 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 (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. ((sq. m)).
g. Design airflow rate in cfm (L/s).
h. Design velocity in fpm (m/s).
i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

K. 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. ((sq. m)).

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary airflow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final airflow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

L. 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 (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).

d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C).

M. Packaged Chiller Reports: For each chiller, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Make and model number.
c. Manufacturer's serial number.
d. Refrigerant type and capacity in gal. (L).
e. Starter type and size.
f. Starter thermal protection size.

2. Condenser Test Data: Include design and actual values for the following:

a. Refrigerant pressure in psig (kPa).
b. Refrigerant temperature in deg F (deg C).
c. Entering-water temperature in deg F (deg C).
d. Leaving-water temperature in deg F (deg C).
e. Entering-water pressure in feet of head or psig (kPa).
f. Water pressure differential in feet of head or psig (kPa).

3. Evaporator Test Reports: Include design and actual values for the following:

a. Refrigerant pressure in psig (kPa).
b. Refrigerant temperature in deg F (deg C).
c. Entering-water temperature in deg F (deg C).
d. Leaving-water temperature in deg F (deg C).
e. Entering-water pressure in feet of head or psig (kPa).
f. Water pressure differential in feet of head or psig (kPa).

4. Compressor Test Data: Include design and actual values for the following:

a. Make and model number.
b. Manufacturer's serial number.
c. Suction pressure in psig (kPa).
d. Suction temperature in deg F (deg C).
e. Discharge pressure in psig (kPa).
f. Discharge temperature in deg F (deg C).
g. Oil pressure in psig (kPa).
h. Oil temperature in deg F (deg C).
i. Voltage at each connection.
j. Amperage for each phase.
k. The kW input.
l. Crankcase heater kW.
m. Chilled water control set point in deg F (deg C).
n. Condenser water control set point in deg F (deg C).
o. Refrigerant low-pressure-cutoff set point in psig (kPa).
p. Refrigerant high-pressure-cutoff set point in psig (kPa).

5. Refrigerant Test Data: Include design and actual values for the following:

    a. Oil level.
    b. Refrigerant level.
    c. Relief valve setting in psig (kPa).
    d. Unloader set points in psig (kPa).
    e. Percentage of cylinders unloaded.
    f. Bearing temperatures in deg F (deg C).
    g. Vane position.
    h. Low-temperature-cutoff set point in deg F (deg C).

N. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data: Include the following:

    a. Unit identification.
    b. Location.
    c. Unit make and model number.
    d. Manufacturer's compressor serial numbers.
    e. Compressor make.
    f. Compressor model and serial numbers.
    g. Refrigerant weight in lb (kg).
    h. Low ambient temperature cutoff in deg F (deg C).

2. Test Data: Include design and actual values for the following:

    a. Inlet-duct static pressure in inches wg (Pa).
    b. Outlet-duct static pressure in inches wg (Pa).
    c. Entering-air, dry-bulb temperature in deg F (deg C).
    d. Leaving-air, dry-bulb temperature in deg F (deg C).
    e. Condenser entering-water temperature in deg F (deg C).
    f. Condenser leaving-water temperature in deg F (deg C).
    g. Condenser water temperature differential in deg F (deg C).
    h. Condenser entering-water pressure in feet of head or psig (kPa).
    i. Condenser leaving-water pressure in feet of head or psig (kPa).
    j. Condenser water pressure differential in feet of head or psig (kPa).
    k. Control settings.
    l. Unloader set points.
    m. Low-pressure-cutout set point in psig (kPa).
    n. High-pressure-cutout set point in psig (kPa).
    o. Suction pressure in psig (kPa).
    p. Suction temperature in deg F (deg C).
    q. Condenser refrigerant pressure in psig (kPa).
    r. Condenser refrigerant temperature in deg F (deg C).
    s. Oil pressure in psig (kPa).
    t. Oil temperature in deg F (deg C).
    u. Voltage at each connection.
    v. Amperage for each phase.
    w. The kW input.

x. Crankcase heater kW.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm (L/s).
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

O. Cooling Tower or Condenser Test Reports: For cooling towers or condensers, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Make and type.
c. Model and serial numbers.
d. Nominal cooling capacity in tons (kW).
e. Refrigerant type and weight in lb (kg).
f. Water-treatment chemical feeder and chemical.
g. Number and type of fans.
h. Fan motor make, frame size, rpm, and horsepower.
i. Fan motor voltage at each connection.
j. Sheave make, size in inches (mm), and bore.
k. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
l. Number of belts, make, and size.

2. Pump Test Data: Include design and actual values for the following:

a. Make and model number.
b. Manufacturer's serial number.
c. Motor make and frame size.
d. Motor horsepower and rpm.
e. Voltage at each connection.
f. Amperage for each phase.
g. Water flow rate in gpm (L/s).

3. Water Test Data: Include design and actual values for the following:

a. Entering-water temperature in deg F (deg C).
b. Leaving-water temperature in deg F (deg C).
c. Water temperature differential in deg F (deg C).
d. Entering-water pressure in feet of head or psig (kPa).
e. Leaving-water pressure in feet of head or psig (kPa).
f. Water pressure differential in feet of head or psig (kPa).
g. Water flow rate in gpm (L/s).
h. Bleed water flow rate in gpm (L/s).

4. Air Data: Include design and actual values for the following:

a. Duct airflow rate in cfm (L/s).

b. Inlet-duct static pressure in inches wg (Pa).
c. Outlet-duct static pressure in inches wg (Pa).
d. Average entering-air, wet-bulb temperature in deg F (deg C).
e. Average leaving-air, wet-bulb temperature in deg F (deg C).
f. Ambient wet-bulb temperature in deg F (deg C).

5. Primary Water Test Data: Include design and actual values for the following:

a. Entering-water temperature in deg F (deg C).
b. Leaving-water temperature in deg F (deg C).
c. Entering-water pressure in feet of head or psig (kPa).
d. Water pressure differential in feet of head or psig (kPa).
e. Water flow rate in gpm (L/s).

6. Secondary Water Test Data: Include design and actual values for the following:

a. Entering-water temperature in deg F (deg C).
b. Leaving-water temperature in deg F (deg C).
c. Entering-water pressure in feet of head or psig (kPa).
d. Water pressure differential in feet of head or psig (kPa).
e. Water flow rate in gpm (L/s).

P. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches (mm).
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data: Include design and actual values for the following:

a. Static head in feet of head or psig (kPa).
b. Pump shutoff pressure in feet of head or psig (kPa).
c. Actual impeller size in inches (mm).
d. Full-open flow rate in gpm (L/s).

e. Full-open pressure in feet of head or psig (kPa).
f. Final discharge pressure in feet of head or psig (kPa).
g. Final suction pressure in feet of head or psig (kPa).
h. Final total pressure in feet of head or psig (kPa).
i. Final water flow rate in gpm (L/s).
j. Voltage at each connection.
k. Amperage for each phase.

Q. 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.

3.21 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 16000

ELECTRICAL WORK – GENERAL

1. SCOPE

The work described in this section shall include the furnishing all labor, materials, equipment and services to be rendered, and the installation of the complete electrical distribution system as shown in the accompanying drawings and specified herein. Although the work might not be restricted to these, it shall include the following:

a. High and low-voltage feeders, distribution system for power and lighting, panel-boards, branch circuits, control switches, receptacles outlets, lighting fixtures, and any other system or equipment shown in the drawings necessary for a complete and ready-to-use installation.

b. Grounding system.

c. Exterior underground conduits for power and telephone/CATV systems.

d. All concrete work for the protection of underground conduits.

e. Any other system or part of a system shown in the drawings.

2. GENERAL REQUIREMENTS

a. It shall be the direct responsibility of the Contractor to orient himself and become acquainted with all the requirements of the Puerto Rico Electric Power Authority (PREPA) and the Puerto Rico Telecommunication Regulations Board (JRT-PR) as they may pertain to this project. Such requirements will be as much as part of this contracting as so stated herein.

b. The Contractor shall maintain a complete and accurate record of any variations or changes to the contract drawings that may be necessary during the installation due to field or structural conditions. At termination of the work, and prior to the final payment, the contractor shall deliver these drawings for the architect's approval before liquidation of the contract. The architect shall then incorporate the variations or changes into a set of sepia prints, as originally issued, in such a manner that they will reproduce legibly, and any competent person may readily comprehend them, as well as all the changes and revisions made during the installation of the work. The work to be done in the sepia prints shall be performed by an experienced draftsman. This revised set of sepia prints must be delivered to the owner prior to the receipt of the final payment.

3. DRAWINGS

a. The drawings, which constitute an integral part of this contract, shall serve as the working drawings. They will indicate the general layout of the complete electrical system, i.e. the arrangements of the feeders, circuits, outlets, switches, controls, panel-boards, lighting fixtures and any other work.

b. A field verification of the scale dimensions in the plans will be carried out in the actual locations, and all distances and levels will be governed by the actual field conditions.

c. The Contractor shall review the architectural, structural, and plumbing plans, etc., and shall adjust the electrical work to conform to all conditions indicated thereon.

d. The discrepancies shown between different plans, between plans and actual field conditions or between plans and specifications shall be promptly brought to the attention of the architect or engineer for a decision.

e. All items not specifically mentioned in the specifications or noted in the drawings but that are obviously necessary to make a complete working installation shall be included with no additional cost to the Owner.

f. The Contractor shall submit to the architect or engineer detailed, dimensioned shop drawings covering all items or equipment and brochures of the lighting fixtures. No equipment should be put into manufacture (or ordered) until these shop drawings or brochures have been approved by the architect or engineer.

4. MATERIALS

a. If the materials, equipment, apparatus or other products are specified by manufacturer, brand name, type or catalog numbers, such designation will establish the standards of desired quality and style, and shall be the basis for the bid.

b. If the Contractor desires, he (she) may submit a request to use any materials or products other than those specified. The contractor shall provide a list of the proposed substitutions to the owner's representative to determine if such substitutions are equivalent in quality and style to the ones initially specified.

c. The acceptance or rejection of the proposed substitutions shall be subject to the approval by the architect or engineer.

d. The approvals of any submittal shall not relieve the Contractor from the responsibility of furnishing materials and systems of the proper dimensions, capacities, sizes, quantities, quality, and installation details to effectively comply with the requirements and intent of the Contract Documents. Such approval shall not relieve this trade from the responsibility of errors in submittals.

e. All submittals shall be presented sufficiently in advance to the field requirements to allow ample time for checking. No claim for extension of time will be granted by reason of failure in this respect.

5. SAMPLES

a. The Contractor shall submit samples of the following items to the architect or engineer for their approval:

1. Light switches: one of each type.
2. Receptacles and plugs: one of each type.
3. Wire and cable: `1-foot length of each type.
4. Conduit and conduit fittings: one of each type.
5. Switch plates or covers: one of each type.
6. Outlet boxes: one of each type.
7. Cable connectors and bushings: one of each type.
8. Plates: one of each type.
9. Lighting fixtures: one of each type.

b. All materials installed or work performed without the approval of materials will be done at the risk of the contractor, and the cost of removal of such materials of work (if it is judged unsatisfactory for any reason by the owner's representative) shall be done at the expense of the Contractor.

6. CODES, PERMITS AND INSPECTION

a. The Contractor shall contact and coordinate with the nearest PREPA and JRT-PR local offices and the corresponding telecommunications services provider, all the details of the related electrical and telephone/CATV installations for this project before the beginning of such installations.

b. The installation work shall comply with all the laws applying to electrical installation in effect in Puerto Rico, and the latest rules and regulations of the National Electrical Code, the PREPA and the JRT-PR. The Contractor shall obtain all permits and certificates of inspection and pay all the fees necessary for the execution of the work. After completion of the work, the Contractor shall provide to the architect or engineer a certificate of final inspection and approval from the PREPA and the JRT-PR local offices.

7. STANDARDS OF MATERIALS AND WORKMANSHIP

a. All materials and/or equipment described or found necessary for the electrical installation shall be new and free from defects. They shall also be listed by the Underwriters Laboratories (UL), Inc. and the National Electrical manufacturer's Association (NEMA) as conforming to their standards in every case where such standards have been established for the particular type of material in question. The materials shall be in accordance with the PREPA and JRT-PR standards. All materials and/or equipment shall be approved by the architect or engineer.

b. The Contractor shall provide the services of an experienced licensed electrician, who shall constantly be in charge of the work together with skilled workmen, fitters, helpers, and the labor force required to properly unload, transfer, erect, connect, adjust, start, operate, and test the system. The work shall be performed in a workman-like manner and shall be subject to the approval of the architect or engineer.

8. PROGRESS OF THE WORK

The electrical work shall progress in coordination with the progress of the construction work and shall be completed as soon as the conditions of the building will permit.

9. SLEEVES, INSERTS AND OPENING

a. The Contractor shall layout and installs all required materials and/or equipment in advance to the pouring of concrete floors, walls, and roofs. He (she) shall furnish and install all the necessary sleeves or openings through floors or walls required for the passage of all conduits, pipes or ducts to be installed by him (her).

b. The Contractor shall furnish and install the inserts and hangers required to support conduits, pull boxes, etc.

c. If any material and/or equipment is not properly installed, the contractor shall do all the necessary cutting and patching at his (her) own expense to rectify the errors, subject to the approval of the architect or engineer.

10. TESTS

The tests listed below shall be made in the presence of the architect, engineer or owner's representative. All testing instruments and methods shall be subject to the approval of the architect, engineer or owner's representative. All necessary arrangements to obtain all instruments, assistance personnel and materials necessary for the performance of the tests shall be made by the contractor.

a. The Contractor shall test all the wiring and shall leave the electrical installation free of grounds, shorts, etc.

b. The Contractor shall also test all lighting fixtures and electrical apparatus or equipment to be furnished under this section of the specifications.

c. Before and application for final acceptance of the work could be considered, all tests deemed necessary to show proper execution of the work must have been performed and completed in the presence of the architect, engineer or owner's representative. The scheduling for all testing procedures shall be arranged to suit the convenience of the architect, engineer or owner's representative. The scheduling for all testing procedures shall be arranged to suit the convenience of the architect, engineer or owner's representative.

d. The electrical work shall include the provision of any assistance (such as the removal of panel-board trims and junction, and pull boxes covers) deemed necessary for the architect, engineer or owner's representative to demonstrate compliance with the requirements of the drawings and specifications.

e. If the electricity-utilizing equipment supplied by other trades is energized, controlled or otherwise made operative by the electric work wiring systems, the testing to demonstrate the proper functional performance of such wiring systems shall be conducted by the trade responsible for the equipment.

f. Any test required in any section of the electrical specifications that is not listed here shall also be the responsibility of the electrical contractor.

g. Any defects or deficiencies discovered in any of the electrical works shall be corrected by the contractor.

11. TEMPORARY SERVICE

a. The Contractor shall provide and maintain a temporary electric service to be used during the construction period. This service shall comprise with the required number of outlets and extension cords with lamps and guards located as required, together with a supply of wiring-run conveniently located and a temporary main switch with required fuses or breaker. The arrangements for this supply shall be made with PREPA.

b. A temporary service of similar characteristics as the final service shall be provided by the Contractor at his (her) own expense to perform all the tests required by the owner and/or the different trades.

12. GUARANTEE

a. The Contractor shall leave the entire electrical installation included under this contract in proper working conditions. He (She) shall also replace, without additional charge, any work, materials and/or equipment or any of its component parts that develop defects different from ordinary use, within one (1) year from the date of substantial acceptance of the project by the Owner's representative.

b. The Contractor shall also be responsible for any or all damages resulting from defective materials and/or equipment, and shall repair or replace, without additional charge, all damages to the existing work caused by such defects or replacement to the satisfaction of the architect or engineer.

c. The Contractor shall provide a certificate of guarantee from the manufacturers of specialties to the effect that they will furnish new parts or equipment in which defects occur due to faulty manufacture, for a period of one (1) year from the date of substantial acceptance of the project by the Owner's representative.

d. If, at request of the architect or engineer, a part of electrical system is placed in service prior to the date of substantial acceptance, that particular part of the system will then commence its one-year period of guarantee. This guarantee will expire one year after such part of the system was placed in service regardless to the date when the final acceptance or approval (covering the entire system) is granted.

13. RECORD DRAWINGS AND INSTRUCTIONS BOOKLETS

a. The Contractor shall complete an exact detailed record of all changes or variations in the electrical installation that take place during the progress of the work. The records shall

include detailed plans or diagrams of the changes showing the method of connection, wiring diagrams, etc.

b. The architect shall then incorporate into a set of sepia prints supplied by the owner all changes and revisions made during the installation of the work. This set of sepia prints with all changes, additions, and omissions listed thereon shall be returned to the owner upon completion of the contract.

c. The Contractor shall also provide the architect or engineer with three copies of each instruction booklet supplied by the manufacturer with their respective equipment upon the completion of the work.

END OF SECTION 16000

SECTION 16011

PANELBOARDS

1. The Contractor shall supply and install the lighting and power panel-boards as indicated in the drawings.

2. The panel-boards shall be of the dead-front type and shall be equipped with automatic circuit breakers for each branch circuit as shown in the plans. The circuit breakers shall be of the thermal-magnetic type, employing quick-make and quick-break toggle mechanism for manual operation as well as automatic operation. The breaker-operating mechanism and handle shall be trip-free, thus, preventing contacts from being held in a closed position against abnormal overloads or short circuits. The automatic operation shall be indicated by the breaker handle assuming a clearly distinct position form the manual "ON" and "OFF". All circuit breakers shall be of the bolt-on type. Some breakers shall be installed for ground-fault protection where so indicated.

3. The panels shall be provided with copper bus bars, rated at 1000A per square inch, maximum.

4. The panels shall be provided with a ground bus for connecting all ground wires or cables entering or leaving the panel-board. The ground bus shall be similar to the bus used to connect the neutral conductors. Single connectors shall not be used. It shall be a copper bus.

5. The panels shall have main protection when so listed. If not listed, only main lugs of the required capacity shall be supplied.

6. The panels shall be mounted as indicated in the plans in an enclosing cabinet consisting of a code gauge, steel-sheet box with trim and door. The door shall be manufactured from a commercial galvanized steel sheet. The trim shall be manufactured from a one-piece, full-finished sheet (not galvanized) and finished with two coats of paint, the first being a prime coat and the second, a finish coat of neutral gray lacquer. The door shall be equipped with a flush-type4 combination lock and catch, all locks keyed alike. Two keys shall be provided with each lock.

7. The doors shall be supplied with a full-length piano hinge in order to increase the rigidity, strength and attractive appearance of the door.

8. All doors of forty-eight inches (48") or more in height shall be supplied with two (2) flush-type locks.

9. The cabinets shall be of sufficient size to allow a gutter space of, at least, four inches (4") on all sides.

10. The trim shall be fastenee3d to the cabinet by approved adjustable clamps and shall have a door equipped with a chrome-plated latch.

11. The cabinets shall be provided with a suitable schedule form secured in an approved metal frame pocket, with spaces for the names and numbers of the feeders that supply the panel and of every branch circuit originating from the panel. The schedule form shall be protected by a piece of transparent plastic material secured to the metal frame. The contractor shall be responsible for typing out and inserting the schedule form in the metal pocket, and shall indicate the voltage (Example 120/208V).

12. All panel-boards shall have and identifying nameplate mounted on the outside of the trim. Nameplate, including designation and voltage characteristics, shall be laminated phenolic with two inches (2") white letters on black background.

13. When two (2) or more panel-boards or cabinets are shown together in adjacent location, the top of all the panel-boards or cabinets shall be aligned with the top of the biggest one, so that all the tops are exactly at the same height from the finished floor.

14. The circuit breakers, the interior cover and the hot wires shall be identified with the corresponding circuit number.

END OF SECTION 16011

SECTION 16020

CONDUIT WORK

1. All the wiring proposed for installation within the building or structures shall be installed in PVC schedule 40 plastic conduit, except where otherwise EMT conduit, rigid galvanized steel conduit, or metal raceway are deemed required as shown in the drawings. All exposed conduits shall consist of heavy-walled rigid galvanized steel of the size indicated in the drawings. The use of flexible non-metallic conduit (ENT) is not allowed. Exposed conduits above roof shall consist of PVC schedule 80.

2. Where noted in the drawings, all the underground wiring shall be installed in PVC schedule 40 plastic conduit and encased in concrete as noted. Wherever plastic conduit is installed, the contractor will be required to provide and additional wire of green insulation in every section of conduit for grounding purposes only. This wire, as well as the proposed live and neutral wires, and wires for other purposes shall be as described in the CONDUCTORS section of these specifications. The size and general procedures for the installation of these conductors shall follow the descriptions in the Article 250 of the NEC latest edition.

3. The route of the conduits shown in the layouts will be schematic and intended to indicate interconnections between outlets. The exact routing shall be determined at the work site to conform to its structural conditions.

4. The sizes of the conduits or tubing shall be as noted in the drawings and in accordance with the NEC latest edition. Except where otherwise indicated, the minimum size of the conduits shall be three-quarters of an inch (¾").

5. All conduits, outlets, etc., shall be run in a concealed manner, except where otherwise noted in the drawings.

6. In those cases where the conduits are run exposed, they shall be installed in a neat and workman-like manner at right angles and parallel to the walls and partitions. Threaded conduit fittings shall be used with the outlet boxes in all such cases.

7. If the conduits cannot be run in furred ceilings or floor fill, they shall be installed in the neutral axis of the concrete beams or concrete floor construction.

8. All conduits shall be securely fastened to the outlet boxes and panels with approved locknuts and bushings. Special attention shall be given to the full number of threads projecting through the conduit to allow the bushing to butt up tight against the end of the threads. After that, the locknut shall be screwed up to bring the bushing into a firm contact with the box. All joints shall be made with an approved conduit coupling in such a manner that the ends of the conduit shall butt together to make all the joints watertight throughout the system.

9. The conduit run to all panels shall be installed with the fewest possible number of crossings in a straight line between the outlets; bends shall be avoided whenever possible.

10. All bends and offsets in conduits measuring up to ¾" can be performed at the work site if they are made with an approved hickey or conduit-bending machine. In the case of conduits measuring 1" or

more, the elbows or offsets made by the manufacturer shall be used unless the contractor in authorized by the architect or engineer to make them at the work site using a conduit-bending machine that will not deform, crush or damage the conduits. The inside and outside parts of all bends and offsets shall be smooth and free from irregularities. The minimum radius of the bends shall be six times the radius of the conduits.

11. All conduits shall be cut with a hacksaw, and the ends shall be reamed and squared. All threads shall be cut and cleaned before reaming.

12. The maximum length of any conduit run between two outlets, boxes or cabinets shall not exceed 150 ft., including two (2) 90º bends.

13. All conduits shall be provided with metallic bushings in the panel boards, junction boxes, outlet boxes, etc.

14. The bushings for conduits larger than 1" shall be of the metallic and plastic type, with an insulating ring where the conductors touch the bushing. These bushings shall be of the grounded type and shall be grounded.

15. The contractor shall take all possible precautions to prevent the accumulation of dirt, mortar, concrete or any foreign matter within the conduits. Any accumulation of matter shall be properly cleaned before the wiring work is done. If it cannot be cleaned, the conduit shall be replaced at the contractor's expense.

16. To prevent the accumulation of debris, water, and foreign particles, all installed conduits shall be suitably plugged with bushings capped with a metal disk, a plastic cap or any other device approved by the architect or engineer. Paper, tape, wood or concrete plugs will not be permitted. All conduits shall be free of water after the wiring.

17. At the motor terminals and other electrical devices where so required, the contractor shall furnish and install a piece of flexible seal-tight conduit of not less than 24" in length to be connected between the conduit and the motor or device terminals.

18. All exposed conduits shall be properly secured at not more than 5'- 0" centers.

19. The expansion fittings shall be provided in the conduits system where required by the structural conditions.

20. Concrete and watertight conduit fittings shall be used for all EMT conduits.

21. Unless otherwise indicated in the drawings, all exposed conduits below the hung-ceiling level shall consist of heavy-walled, rigid, galvanized steel of the size indicated in the drawings.

22. Unless otherwise indicated in the drawings, all exposed conduits above hung ceiling level shall be EMT type. The use of plastic conduits is not allowed in this area.

23. The openings for conduits and cables crossing through fire-rated wall must be fire-sealed to avoid any possible spread of fire.

END OF SECTION

SECTION 16030

BOXES

1. All outlets, junctions, pull boxes, and fittings shall be galvanized or plated, and shall be installed in a plumb, rigid and satisfactory manner with an alignment tolerance of 1/16".

2. The ceiling outlets in slabs and metal-pan constructions shall consist of 4" octagonal concrete ring with 2½" minimum depth and ¾" K.O. to fit the conduit; include cover with knock-outs. When so advisable, 4" x 4" or larger outlet boxes equipped with a canopy cover may be used instead of the octagonal boxes. The ceiling outlets shall be provide3d with a ⅜" fixture stud when necessary to support the fixtures. The outlet boxes shall be flush with the ceiling surface. A 4" x 4" x 2⅛" box with a cover shall be used in hung ceilings.

3. The wall outlets for lighting fixtures shall consist of 4" octagonal boxes, 2½" in depth (or 4"x4"x 2⅛" boxes) with canopy covers with ⅜" fixture studs and K.O. to fit the conduits.

4. The wall outlet boxes for convenience outlets, switches, and other devices shall measure 4"x4"x 2⅛" minimum with K.O. to fit the conduits. The outlet boxes shall be equipped with raised covers of the required height and gang to bring them flush with the finished wall surface. The installation of raised covers on the boxes prior to the pouring of the concrete to be plastered will be strictly prohibited. In all cases, the raised covers shall be installed after the forms are removed and shall have the same depth as the plaster thickness. If several switches are indicated in adjacent positions, they will be ganged together in an outlet box of the proper size, and only one switch plate will be installed, unless otherwise indicated. If emergency power (red) and normal power (ivory) switches are indicated in adjacent position, they shall not be ganged together; use individual outlet boxes. All wall outlets shall be located at the height indicated in the plans.

5. Wall outlet boxes for electric ranges receptacles shall measure 5"x 5" x 2⅛" with 1"ø knock outs to fit the conduits.

6. Where outlets at different levels are shown adjacent, they shall be installed in one vertical line if possible.

7. The boxes for other outlets (like dryers, special purpose outlets, etc.) shall be of the size and type recommended by the manufacturer of the device. The raised covers shall be of the required size and gang to bring them flush with the finished wall surface. When located on columns or over doors, they shall be set symmetrically to the columns or doors.

8. The contractor shall provide suitable approved junctions or pull boxes when so deemed desirable for the insertion of conductors, or when so indicated. All junctions or pull boxes not over 150 cu. in. in size shall be constructed similarly to the outlet boxes of not less than #12 gauge steel sheet. All junctions or pull boxes over 150 cubic inches in size shall be constructed as same as specified for the panel-boards cabinets, except that the covers will have the same thickness as the boxes secured by screws or bolts instead of hinges.

9. All junctions and pull boxes must be accessible after the completion of the building.

10. The contractor shall provide a #12 (minimum) THHN green bonding jumper to every outlet or junction box for grounding continuity. It shall be connected to the electrical device grounding terminal and to the conduit grounding conductor.

END OF SECTION 16030

SECTION 16040

LIGHTING FIXTURES

• PART I – GENERAL

1.1 SECTION SCOPE:

This section includes all fluorescent, light-emitting diodes (LED) and high intensity discharge (HID) luminaries required for proper illumination of existing facilities (to be rehabilitated or remodeled) and/or new facilities (to be constructed or installed), including fluorescent energy-efficiency ecologic lamps, HID lamps, LED approved lamps, exit signs and emergency lighting units, all in accordance to proposed lighting fixtures schedule indicated on plans and specified mounting hardware, ballasts, lighting fixtures equipment & miscellaneous accessories.

1.2 SUBMITTALS:

A. Product Data: For each type of lighting fixture indicated on plans and arranged in order of fixture designation. Submittals must include data on features, accessories and the following items:

1. Dimensions of fixtures.
2. Certified results of independent laboratory tests for fixtures and lamps in terms of electrical ratings, photometric data and photometric performance.
3. Fluorescent and HID ballasts
4. Emergency lighting unit battery and charger.
5. Types of lamps.

B. Shop Drawings: Show details of non-standard or custom-made fixtures. Indicate dimensions, weights, method of field assembly, components, features and accessories. Submit wiring diagrams indicating detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

C. Samples for Verification: Submit samples of lighting fixtures as indicated on lighting fixture schedule or as directed by inspector or PBA designated representative. Samples must include the following:

1. Lamps: Specified units installed.
2. Ballast: Specified ballast type.
3. Accessories: As specified.

D. Product Certificates: Signed by manufacturers of lighting fixtures certifying that products comply with requirements.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Maintenance Data: For lighting fixture to be included on maintenance manuals, as specified on Division 1 (General Requirements).

1.3 WARRANTY:

A. General Warranty: Special warranty specified on this article shall not deprive PBA of other rights may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements stipulated on aforementioned Contract Documents.

B. Special Warranty for Batteries: Written warranty executed by manufacturer, agreeing to replace rechargeable batteries that fail in materials or workmanship within a manufacturer's standard period not less than ten (10) years from date of Substantial Completion. Full warranty must apply for first year and prorated warranty for the remaining years.

C. Special Warranties for Fluorescent Ballasts: Written warranty executed by manufacturer, agreeing to replace fluorescent ballasts that fail in materials or workmanship within a period of five (5) years from date of manufacture but not less than four (4) years from date of Substantial Completion.

• PART II - PRODUCTS

2.1 FIXTURES AND FIXTURE COMPONENTS – GENERAL:

A. All lighting fixture products incorporated into project's work (luminaries, lamps, ballasts, mounting hardware, related equipment & accessories, etc.) shall be furnished in strict compliance with the drawings, technical specifications, details and all latest applicable electrical codes and regulations.

B. All lighting fixture products incorporated into project's work include, but is not limited to the products indicated on lighting fixtures schedule shown on drawings. All series, models or catalog numbers of the manufacturer shall be indicated to establish standards of quality.

C. The lighting fixtures will be indicated in the drawings by their type. The letter will indicate the basic type. If several fixtures are shown in a room and only one is identified, it shall be understood that the other fixtures are identical.

D. All lighting fixtures to be supplied & installed shall be brand new and approved by the architect, engineer or designated PBA representative, prior to their delivery to the project's site.

E. Lighting fixtures layout and installation (including mounting hardware and trim) must be coordinated with ceiling system and other construction items.

F. All materials and accessories, whether specifically described or not, shall be of the best grade of commercial manufacture and all workmanship shall be first class in every respect.

G. Lighting fixtures' finishes must be manufacturer's standard, unless otherwise indicated. All paint finish must be applied over corrosion-resistant treatment or primer, free of defects. All metallic finish must be corrosion resistant.

H. Wherever practical, the components of built-in lighting arrangements shall be standard products of the same manufacturers designed to be assembled and used together without field alterations.

2.2 FIXTURE COMPONENTS – EQUIPMENT AND ACCESSORIES:

A. Metal Parts: Metal parts must be free from burrs, sharp corners and edges.

B. Sheet Metal Components: Sheet metal components must be on steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Reflecting surfaces: **Minimum reflectance** as follows, unless otherwise indicated:

SURFACE	PERCENT OF REFLECTANCE
White Surfaces	85%
Specular Surfaces	83%
Diffusing Specular Surfaces	75%

SURFACE	PERCENT OF REFLECTANCE
Laminated Silver Metallized Film	90%

D. Lenses, diffusers, covers and globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation.

2. Lens thickness: 0.125 inch (3 mm.) minimum, unless grater thickness is indicated.

E. Connectors: Approved solder-less connectors shall be used in making connections in the wiring within the fixtures or in connecting the fixtures wiring to the wiring of the building.

F. Doors, frames and other internal access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange access doors, frames, lenses, diffusers and other pieces to prevent accidental falling during re-lamping and when secured in operating position.

G. Support Components: Support Components must comply with Section 16000 (Electrical Work – General) or Section 26 00 00 (Basic Electrical Materials and Methods), whichever applies, for channel & angle-iron supports and non-metallic & angle supports.

1. Single-Stem Hangers: ½" (12 mm.) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

2. Twin-Stem Hangers: Two (2) ½" (12 mm.) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

3. Rod Hangers: 3/16" (5 mm.) minimum diameter, cadmium-plated, threaded steel rod.

4. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord and locking-type plug.

5. Aircraft Cable Support: Use cable, anchorages and intermediate supports recommended by fixture manufacturer.

2.3 FLUORESCENT LAMP BALLASTS:

A. Unless otherwise indicated, all ballast used in connection with the ecologic T8 fluorescent lighting equipment shall be as follows:

1. Designed for type and quantity of lamps indicated at full light output
2. UL listed, thermally protected, resetting, Class P, **non-PCB**
3. Minimum line transient as shown in IEEE87, Category A and ANSI 62.41.
4. Ballast operates at 120V nominal (108V-132V) - 60 Hz. or 277V nominal (249-305V) – 60 Hz.
5. Meets most recent (latest) Federal Efficiency Standard (Law 100-357).
6. Meets FCC rules/regulations, Part 18, 15J for EMI/RFI.
7. Meets all requirements of ANSI C82.11.
8. Power factor equal or greater than 0.95. Maximum lamp current crest factor of 1.7.
9. Ballast shall be electronic type with equal or less than 10% of total harmonic distortion (THD≤10%).
10. Minimum 5-year ballast manufacturer's warranty, in compliance with special warranty indicated on Article 1.3.
11. A complete application data of the ballast and the submitted fixture shall be included for approval as described.

2.4 HIGH-INTENSITY DISCHARGE LAMP BALLASTS:

A. Unless otherwise indicated, all HID lighting fixtures ballast shall comply with ANSI C82.4 and includes the following parameters:

1. Type: High power factor (HPF) constant wattage.
2. Operating voltage: Must match system voltage.
3. Minimum starting temperature: Minus 22ºF (minus 30ºC) for single lamp ballast.

4. Normal ambient operating temperature: 104ºF (40ºC).

5. Open circuit operation that will not reduce average life.

6. Auxiliary, Instant-on, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

B. Encapsulation: Manufacturer's standard epoxy-encapsulated model designed to minimize audible fixture noise.

2.5 EXIT SIGNS:

A. Exit signs must comply with UL-924. Sign color and lettering size shall comply with specifications issued by authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC operation: LED lamps with not less than 70,000 hours rated lamp life.
2. Additional lamps for DC operation: Two (2) minimum bayonet-base type for connection to external dc source.

C. Self-Powered Exit Signs (Battery Type):

1. Battery: Sealed, maintenance-free, nickel-cadmium type, in compliance with special warranty indicated on Article 1.3.
2. Charger: Integral in a self-contained power pack, fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnect lamps, and battery is automatically recharged and floated on charger.

2.6 EMERGENCY LIGHTING UNITS:

A. Emergency lights must be self-contained units in compliance with UL-924, including the following features:

1. Battery: Sealed, maintenance-free, lead-acid type with not less than ten (10) years nominal life, in compliance with special warranty indicated on Article 1.3.
2. Charger: fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turn lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnect from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnect lamps, and battery is automatically recharged and floated on charge.
4. Wire Guard: Where indicated, heavy-chrome-plated wire guard arranged to protect lamp heads or fixtures.
5. Integral Time-Delay Relay: Arranged to hold unit on, for fixed interval, after restoring electric power service interrupted by an outage. Provides adequate time delay to permit any existing high-intensity-discharge lamps to restrike and develop adequate output.

2.7 EMERGENCY FLUORESCENT POWER SUPPLY UNIT:

A. Internal Type: Power supply unit must be self-contained, modular, battery-inverter unit factory mounted within fixture body, in compliance with UL-924, including the following features:

1. Test switch and LED indicator light: Visible and accessible without opening fixture or entering ceiling space.
2. Battery: Sealed, maintenance-free, nickel-cadmium type with not less than ten (10) years nominal life, in compliance with special warranty indicated on Article 1.3.
3. Charger: Fully automatic, solid-state constant current type.
4. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnect lamps, and battery is automatically recharged and floated on charger.

B. External Type: Power supply unit must be self-contained, modular, battery-inverter unit, in compliance with UL-924, including the following features:

1. Test switch and LED indicator light: Visible and accessible without entering ceiling space.
2. Battery: Sealed, maintenance-free, nickel-cadmium type with not less than ten (10) years nominal life, in compliance with special warranty indicated on Article 1.3.
3. Charger: Fully automatic, solid-state constant current type.
4. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnect lamps, and battery is automatically recharged and floated on charger.
5. Housing: NEMA 250, Class 1 enclosure.

2.8 LAMPS:

A. Fluorescent:

1. Unless otherwise indicated, all new fluorescent lamps shall be deluxe color white, energy-saving & ecologic type, T8, correlated color temperature (C.C.T.) of 4100ºK, color rendering index (C.R.I.) equal or greater than 85, with electrode protectors, **approved equal** to product manufactured by Phillips Co., GE Corp. or Sylvania.

2. Lamp Life: Rated average must be 20,000 hours at three (3) hours per start, when used on rapid-start circuits.

B. High Intensity Discharge (HID):

Unless otherwise indicated, all new HID lamps shall be metal-halide, correlated color temperature (C.C.T.) of 3600ºK, color rendering index (C.R.I.) equal or greater than 70, 80% minimum reflecting efficiency, **approved equal** to product manufactured by GE Corp., SIMCAR or manufacturer specified on lighting fixtures schedule.

C. Light-Emitting Diode (LED):

LED lamps will be considered and properly accepted by PBA as substitute of T-8 fluorescent or high-intensity discharge (HID) lamps, as long as proposed LED lamps comply with aforementioned specifications and/or any other specifications submitted for fluorescent or HID lamps on lighting fixtures schedule.

• PART III – EXECUTION

3.1 FIXTURE INSTALLATION:

A. Set level, plumb and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. The vandal-proof luminaries shall be installed strictly according to the manufacturer recommendations and with vandal proof screws.

C. All luminaries that are not vandal-proof shall be installed using the TAPCON Masonry Fastening System. This screw will be placed directly into the concrete and has maximum anchor strength. The installer shall

drill a hole in the concrete (through the mounting holes of the fixture) using a drill bit of the size recommended by the manufacturer. A screw of an approved size shall be used.

D. All rows of fixtures (flush, surface or suspended) shall be installed accurately on straight line. The fastening and suspensions shall be firmly set up so that the lines and lamps will be secured against normal vibrations and will not be affected or distorted by the handling incident of the normal maintenance.

E. Support for Fixtures: In or On Grid-Type Suspended Ceilings

1. Use grid for support
2. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than six (6) inches (150 mm.) from fixture corners.
3. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
4. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two (2) - ¾" (20 mm.) metal channels spanning and secured to ceiling tees.

F. Suspended Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1,200 mm.), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one-point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Suspend from cable installed according to fixture manufacturer's written instructions and details on drawings.

G. Air Handling Fixtures: Install with dampers closed.

H. Upon completion of the installation of the lighting equipment, it must be in first-class operating order and in perfect condition. At the time of the final inspection, the equipment must be complete, with the required glassware or reflectors, which must be clean and free from defects.

3.2 CONNECTIONS:

A. Provide a 3"ø hole at the back plate of any surface mounted fluorescent luminaries to access the outlet box.

B. All lighting fixtures shall be grounded. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL-486A and UL-486B.

C. After lighting fixtures and lighting equipment are connected to the wiring system of the building or project, the wiring system and the fixtures or equipment must be test free from short circuits and must show an insulation resistance between conductors and ground, based on minimum load, not less than resistance required by latest edition of NEC.

3.3 FIELD QUALITY CONTROL:

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: As follows

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
3. Verify normal transfer to battery source and retransfer to normal.
4. Report results in writing.

E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedures until units operate properly.

F. Corrosive fixtures must be replaced during warranty period.

3.4 CLEANING AND ADJUSTING:

A. Clean fixtures internally and externally after installation, using methods and materials recommended by manufacturer.

B. Adjust installed fixtures to provide required light intensities.

END OF SECTION 16040

SECTION 16041

WIRING DEVICES

1. WALL SWITCHES

a. The Contractor shall provide and install all switches as shown in the plans and in accordance with the swing of the doors. All switches shall be located on the strike side of the door, unless otherwise indicated, and at the height indicated in the plans.

b. If several switches are indicated in adjacent position, they shall be ganged together in one outlet box of the proper size and only one switch plate, unless otherwise indicated.

c. If emergency power (red) and normal power (ivory) switches are indicated in adjacent position, they shall not be ganged together. They shall be installed in individual outlet boxes.

d. Except where otherwise indicated, all switches shall be as hereinafter specified.

1. SWITCH

Flush-toggle handles; 20 AMP and 120/277 volts A.C. quiet; back and side wiring, industrial specification grade; heavy duty, tungsten rated, grounding type, with gold-plated, oversize silver-cadmium oxide contacts; grain-oriented, extra-heavy duty phosphor-bronze contact arms; super positive quiet action; extra-large binding head terminal for #10, #12 and #14 wires; rigid steel strap, heavily plated, with washer type plaster ears; switching mechanism, fully enclosed in a reinforced urea-molded body, riveted to mounting. The cover plate shall be no. 302 stainless steel, non magnetic, satin finish.

All switches shall be equal to:

Manufacturers Name	Single Pole	Two Poles	Three-Way	Four-Way
Pass & Seymour	20AC1-I	20AC2-I	20AC3-I	20AC4-I
Hubble	1221I	1222I	1223I	1224I
Leviton	1221-2I	1222-2I	1223-2I	1224-2I
Eagle	2221V	2222V	2223V	2224V
General Electric	5951-2G	5952-2G	5953-2G	5954-2G
Bryant	4901-GI	4902-GI	4903-GI	4904-GI
Arrow Hart	1221I	1222I	1223I	1994I

2. SWITCH WITH PILOT LIGHT

All specifications and catalog series are the same as above except for a red pilot light handle (Switch On, Light On).

3. SWITCH WITH RED COLORED HANDLE

The switches that are energized by emergency circuits shall be red-colored and shall be provided with polycarbonate red-colored plates equal to Slater catalog number SH-95071. All specifications and catalog series are the same as above except for red colored handle.

2. WALL RECEPTACLES

a. The Contractor shall furnish and install all wall receptacles as indicated in the drawings and hereinafter specified.

CONVENIENCE OUTLETS

Three-wires grounding, duplex receptacle industrial specification grade or extra hard use specification grade, heavy duty, weather-proof where indicated in the plans, polarized 20 AMP, 125 volts, back and side wiring, U-ground, NEMA 5-20R type parallel slot, tow-ground terminal screw with: break-off feature for two-circuits wiring; current carrying contacts, securely held in body at four points to maintain rigidity when the break-off is employed; triple wiping phosphor-bronze T-slot contacts; auto ground; body and cap must be of molded urea; terminal screws for #10 and #12 wires; heavily reinforced arc-resistant urea body. The cover plate shall be no. 302 stainless steel, nonmagnetic, satin finish.

b. All receptacles shall be equal to:

Manufacturers Name	20A, Duplex 5-20R	20A, Duplex Tamper Resistant	20A, Combination 125/250 V	20A, GFI	20A, Surge Supp. TVSS
Pass & Seymour	5362-I	SG63-HI	5890-I	2091-SI	6362-ISP
Hubble	5362-I	_____	5492-I	GF8300I	_____
Leviton	5362-I	_____	5844-I	6898-HGI	8380-I
Eagle	5362-V	_____	_____	_____	_____
General Electric	5362-2	GE8300-TI	GE5492-2	SF(R)8322-2	5362-S-2
Bryant	5362-I	_____	5492-I	GFR83FT-I	_____
Arrow Hart	5362-1	_____	5492-1	GF8300I	_____

c. All receptacles that are energized by emergency circuits shall be red-colored and shall be supplied with polycarbonate red-colored plates equal to Slater catalog number SH-95101. All specifications and catalog series shall be the same as above except for red colored face.

d. All the outlets outside the building shall be of the weather-proof type and ground fault-protected, as indicated in the drawings.

e. All outlets for water coolers shall be ground fault protected. In addition, shall have a permanent use type weatherproof cover.

f. The clock receptacles shall be Pass & Seymour 3733-SS.

g. All single receptacles shall be rated 20 Amps (unless otherwise indicated) and shall exhibit the same characteristics of the 20 Amps convenience outlets.

h. Receptacles for clothes dryer, ranges and water heaters shall be equal to:

Manufacturers Name	**30A Dryer 14-30R**	**50A Range 14-50R**	**30A Water Heater 6-30R**
Pass & Seymour	5744	5754	5930
Hubble	9430A	9450A	9330
Leviton	278	279	5372
Eagle	1257	1258	1234
General Electric	4191-3	4181-3	4139
Bryant	9430-FR	9450-FR	9632-FR
Arrow Hart	5744N	_____	5700N

i. Commercial Specification Grade wiring devices are not accepted as substitutes.

j. Surge suppressor to be used for computer and electronic peripherals.

C. DEVICE PLATES

a. All plates for the wall convenience receptacles, switches, telephone, junction box outlets, intercom facilities, etc. shall be no. 302 stainless steel satin finish, of the non-magnetic type.

b. The telephone outlet plates shall be provided with a rubber bushing in the center hole.

END OF SECTION 16041

SECTION 16050

CONDUCTORS

1. The Contractor shall furnish and install all conductors as specified herein and indicated in the drawings.

2. Except where otherwise indicated in the drawings or specified, no conductor shall be smaller than #12 AWG. All conductors shall be stranded.

3. Unless otherwise indicated, all conductors shall be of the moisture and heat resistant type (THHN) rated 600 volts insulation 90ºC Cu.

4. All feeder and branch circuit conductors shall be color-coded as follows:

PHASE	120/208 V	277/480 V
Ø A	Black	Brown
Ø B	Red	Orange
Ø C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

Note: Isolated ground conductors shall be green with yellow stripes.

5. All building wires shall be of the UL approved types. The conductors shall not be over six months old. They shall also be suitable protected from weather or damage during their storage and handling and shall be in first-class condition when installed.

6. All conductors shall be continuous from outlet to outlet, and so splices shall be made except in the boxes. The conductors in the outlets shall be of sufficient length to allow making all the device connections without any strain.

7. All conductors #6 AWG in size or smaller shall be factory-finished in the desired identifying colors.

8. If not factory-finished in the desired color, all conductors #4 AWG in size or larger used in branch circuits shall be identified by using tape in the desired color the last twelve inches (12") of every length conductor.

9. When used for underground installation, all conductors or cables, regardless of the type, shall be protected by schedule 40 PVC conduits of the adequate size per NEC. They shall also be embedded in a concrete encasement of a minimum thickness of four inches (4") on all sides. All underground feeders or branch circuits shall be RHw-2, XLP 90ºC Cu.

10. The Contractor shall provide a ground wire in all motor circuits for grounding purposes. He (she) shall size it according to the latest edition of the National Electrical Code.

11. The Contractor shall provide a #12 THHN green bonding jumper between the receptacles grounding terminal and the grounded outlet box for grounding continuity.

END OF SECTION 16050

SECTION 16060

GROUNDING AND BONDING

1PART GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rod electrodes.
2. Active electrodes.
3. Wire.
4. Grounding well components.
5. Exothermic connections.

B. Related Sections:

1. Section 02590 - Site Electrical: Site related grounding components for buildings and facilities.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:

1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.
2. NFPA 99 - Standard for Health Care Facilities.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:

1. Rod electrode.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum.

1.5 SUBMITTALS

A. Product Data: Submit data on grounding electrodes and connections.

B. Test Reports: Indicate overall resistance to ground.

1.6 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with PREPA 's standard.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum two years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.9 COORDINATION

A. Section 01300 - Administrative Requirements: Requirements for coordination.

B. Complete grounding and bonding of building prior concrete placement.

2PART PRODUCTS

2.1 ROD ELECTRODES

A. Furnish materials in accordance with PREPA’s standards.

B. Product Description:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.

3. Length: 10 feet.

C. Connector: Connector for exothermic welded connection..

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 4/0 AWG.

C. Grounding Electrode Conductor: Copper conductor bare.

D. Bonding Conductor: Copper conductor bare.

2.3 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches by 24 inches long concrete pipe with belled end.

B. Well Cover: Fiberglass with legend "GROUND" embossed on cover.

2.4 EXOTHERMIC CONNECTIONS

A. Furnish materials in accordance with PREPA's standards.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

3PART EXECUTION

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

A. Remove surface contaminants at connection points.

3.3 INSTALLATION

A. Install in accordance with IEEE 142.

B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding and bonding conductors concealed from view.

D. Install grounding well pipe with cover at rod locations as indicated on Drawings. Install well pipe top flush with finished grade.

E. Install 4/0 AWG bare copper wire in foundation footing as indicated on Drawings.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Bond together reinforcing steel and metal accessories in pool and fountain structures.

H. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

I. Connect to site grounding system. Refer to Section 02590.

J. Install continuous grounding using underground artificial station ground by means of driven rods or buried electrodes.

K. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

L. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

M. Install a ground loop as shown on plans consisting of #4/0 AWG bare copper conductor installed at 3 ft. below final grade. Connect to this ground loop the electrical, telephone, cable T V, and antenna grounding electrode conductors using Cadweld connection.

N. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.4 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements, 01700 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART I - GENERAL

A. SUMMARY

1. Section Includes:

    a. Nameplates.
    b. Labels.
    c. Wire markers.
    d. Conduit markers.
    e. Stencils
    f. Underground Warning Tape.
    g. Lockout Devices.

2. Related Sections:

    a. Section 09900 – Paints and Coatings: Execution requirements for painting specified by this section.

B. SUBMITTALS

1. Section 01330 – Submittal Procedures: Submittal procedures.

2. Product Data:

    a. Submit manufacturer's catalog literature for each product required.
    b. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
    c. Submit two samples of each type of identification products applicable to project.
    d. Submit two nameplates, 4 x 4 inch in size illustrating materials and engraving quality.

3. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

C. QUALITY ASSURANCE

1. Perform Work in accordance with PHA standard.

D. QUALIFICATIONS

1. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

2. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

E. DELIVERY, STORAGE, AND HANDLING

1. Section 01600 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

2. Accept identification products on site in original containers. Inspect for damage.

3. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

4. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

F. ENVIRONMENTAL REQUIREMENTS

1. Section 01600 – Product Requirements: Environmental conditions affecting products on site.

2. Install nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART II - PRODUCTS

A. NAMEPLATES

1. Furnish materials in accordance with PHA standards.

2. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

3. Letter Size:

   a. ⅛ inch high letters for identifying individual equipment and loads.
   b. ¼ inch high letters for identifying grouped equipment and loads.

4. Minimum nameplate thickness: ⅛ inch.

B. LABELS

1. Furnish materials in accordance with standards.

2. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.

C. WIRE MARKERS

1. Furnish materials in accordance with PHA standards.

2. Description: Cloth tape, split sleeve, or tubing type wire markers.

3. Legend:

   a. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
   b. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.

D. CONDUIT AND RACEWAY MARKERS

1. Furnish materials in accordance with PHA standards.

2. Description: Stencils.

3. Color:

   a. 480 Volt System: Black lettering on white background.
   b. 208 Volt System: Black lettering on white background.
   c. Fire Alarm System: Red lettering on white background.
   d. Telephone/CATV System: Blue lettering on white background.

E. STENCILS

1. Furnish materials in accordance with PHA standards.

2. Stencils: With clean cut symbols and letters of following size:

   a. Up to 2 inches Outside Diameter of Raceway: ½ inch high letters.
   b. 2-½ to 6 inches Outside Diameter of Raceway: 1 inch high letters.

3. Stencil Paint: As specified in Section 09900, semi-gloss enamel, colors conforming to the following:

   a. Black lettering on white background.
   b. White lettering on gray background.
   c. Red lettering on white background.
   d. Blue lettering on white background.

F. UNDERGROUND WARNING TAPE

1. Description: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines as per PREPA and JRT regulations.

G. LOCKOUT DEVICES

1. Lockout Hasps:

a. Manufacturers:

1. Substitutions: Section 01600 – Product Requirements.

b. Anodized aluminum hasp with erasable label surface; size minimum 7-¼ x 3 inches.

PART III - EXECUTION

A. PREPARATION

1. Degrease and clean surfaces to receive adhesive for identification materials.

2. Prepare surfaces in accordance with Section 09900 for stencil painting.

B. EXISTING WORK

1. Install identification on existing equipment to remain in accordance with this section.

2. Install identification on unmarked existing equipment.

3. Replace lost nameplates.

4. Re-stencil existing equipment.

C. INSTALLATION

1. Install identifying devices after completion of painting.

2. Nameplate Installation:

a. Install nameplate parallel to equipment lines.
b. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
c. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
d. Secure nameplate to equipment front using screws, rivets, or adhesive.
e. Secure nameplate to inside surface of door on recessed panel-board in finished locations.

f. Install nameplates for the following:

1. Switchboards.

2. Panel-boards.
3. Transformers.
4. Service Disconnect.

3. Label Installation:

   a. Install label parallel to equipment lines.
   b. Install label for identification of individual control device stations.
   c. Install labels for permanent adhesion and seal with clear lacquer.

4. Wire Marker Installation:

   a. Install wire marker for each conductor at panel-board gutters, pull boxes, outlet and junction boxes, and each load connection.
   b. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
   c. Install labels at data outlets identifying patch panel and port designation as indicated on Drawings.

5. Conduit Raceway Marker Installation:

   a. Install conduit raceway marker for each conduit raceway longer than 6 feet.
   b. Conduit Raceway Marker Spacing: 20 feet on center.
   c. Raceway Painting: Identify conduit using field painting in accordance with Section 09900.

      1. Paint colored band on each conduit longer than 6 feet.
      2. Paint bands 20 feet on center.
      3. Color:

         a. 480 Volt System: Blue.
         b. 208 Volt System: Yellow.
         c. Fire Alarm System: Red.
         d. Telephone/CATV System: Green.

6. Stencil Installation: Apply stencil painting in accordance with Section 09900.

7. Underground Warning Tape Installation: Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable as per PREPA and JRT regulations.

END OF SECTION 16075

SECTION 16095

MINOR ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal of existing electrical equipment, (including telephone, and fire alarm) wiring, and conduit in areas to be remodeled; removal of designated construction; dismantling, cutting and alterations for completion of the Work.

2. Disposal of materials.

3. Storage of removed materials.

4. Identification of utilities.

5. Salvaged items.

6. Protection of items to remain as indicated on Drawings.

7. Relocate existing equipment to accommodate construction.

1.2 SUBMITTALS

A. Section 01330 – Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate demolition and removal sequence and location of salvageable items; location and construction of temporary work. Describe demolition removal procedures and schedule.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with PHA standard.

1.4 PRE-INSTALLATION MEETINGS

A. Section 01300 – Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.5 SCHEDULING

A. Section 01300 – Administrative Requirements, 01323 – Network Analysis Schedules: Requirements for scheduling.

B. Schedule work to coincide with new construction.

C. Cease operations immediately when structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

1.6 COORDINATION

A. Section 01300 – Administrative Requirements: Requirements for coordination.

B. Conduct demolition to minimize interference with adjacent and occupied building areas.

C. Coordinate demolition work with PHA.

D. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.

E. Shut-down Periods

1. Arrange timing of shut-down periods of in service panels with PHA. Do not shut down any utility without prior written approval.

2. Keep shut-down period to minimum or use intermittent period as directed by.

F. Identify salvage items in cooperation with Owner.

PART 2 – EXECUTION

2.1 EXAMINATION

A. Section 01300 – Administrative Requirements: Verification of existing conditions before starting work.

B. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.

C. Verify termination points for demolished services.

2.2 PREPARATION

A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.

B. Temporary egress signage and emergency lighting.

C. Coordinate utility service outages with Utility Company.

D. Beginning of demolition means installer accepts existing conditions.

2.3 DEMOLITION

A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Owner before disturbing existing installation.

B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

C. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.

D. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

E. Reconnect equipment being disturbed by renovation work and required for continue service to nearest available panel.

F. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.

G. Install temporary wiring and connections to maintain existing systems in service during construction.

H. Perform work on energized equipment or circuits with experienced and trained personnel.

I. Remove, relocate, and extend existing installations to accommodate new construction.

J. Repair adjacent construction and finishes damaged during demolition and extension work.

K. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finishes. Cut embedded support elements flush with walls and floors.

L. Clean and repair existing equipment to remain or to be reinstalled.

M. Protect and retain power to existing active equipment remaining.

N. Cap abandoned empty conduit at both ends.

O. Fill with concrete all holes of outlets, switches, panel-boards, etc.

2.4 EXISTING PANELBOARDS TO REMAIN

A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.

B. Tag unused circuits as spare.

C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.

D. Remove existing wire no longer in use from panel to equipment.

E. Provide new updated directories where more than three circuits have been modified or rewired.

2.5 SALVAGE ITEMS

A. Remove and protect items indicated in Schedule to be salvaged and turn over to PHA.

B. Items of salvageable value may be removed as work progresses. Transport salvaged items form site as they are removed to the warehouse selected by PHA.

2.6 REUSABLE ELECTRICAL EQUIPMENT

A. Carefully remove equipment, materials, or fixtures which are to be reused.

B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.

C. Relocate existing lighting fixtures as indicated on Drawings. Clean fixtures and re-lamp. Test fixture to see if it is in good working condition before installation at new location.

2.7 CLEANING

A. Section 01700 – Execution Requirements: Requirements for cleaning.

B. Remove demolished materials as work progresses. Legally dispose.

C. Keep workplace neat.

2.8 PROTECTION OF FINISHED WORK

A. Section 01700 – Execution Requirements: Requirements for protecting finished Work.

END OF SECTION 16095

SECTION 16485

LIGHTING CONTACTORS

a. Furnish and install where shown a lighting contactor in the plans.

b. The contactors shall be Square D Series 8903 Type S.

c. They shall be Two, Three, Four Poles or as required.

d. The contacts ratings shall be 30, 60, 100, 200 amperes, or as indicated in the plans, for all types of ballast and tungsten lighting, resistive heating and motor loads.

e. They shall be U.L. approved as suitable for purpose specified and shown.

f. The contacts shall be totally enclosed, double break silver cadmium-oxide power contacts. Contacts inspection and replacement shall be possible without disturbing line or load wiring.

g. The wiring shall be straight-through wiring with all terminals clearly marked.

h. The installation shall be exposed type or flush as required.

i. The enclosure shall be NEMA 1, 3R, 4, 4X or 12 as required to meet the conditions of installation.

j. The contactor shall be provided with disconnecting means in the same enclosure if required.

k. The enclosure shall be provided with ON-OFF pushbuttons, control transformer, Hand-Off-Auto Selector Switch, and red indicating light.

l. The coil shall be of the encapsulated type.

END OF SECTION 16485

SECTION 16500

TIME SWITCHES

1. The timer system shall be able to accommodate the varying sunrise and sunset times by simulating them through microprocessor control.

2. The timer system permits the programming of ON/OFF functions related to sunrise and sunset at any point on Earth.

3. Programming must be set for the number of minutes before or after sunrise or sunset.

4. Programming must accommodate a maximum of four hundred (400) programmable control events.

5. The time system shall be capable of accepting adjustable timed override for last minute, nonrecurring program changes without disturbing existing programs.

6. The time system shall be capable of operating up to seven different programs plus daily repeat, timed override, and immediate events.

7. The timer system shall have a panic button that activates programmed emergency operations.

8. The timer system shall provide sequenced restart after power failure.

9. Resolution for timed events shall be one minute

10. Time accuracy is to be based on line frequency (60 Hz).

11. The timer system shall have a power-failure back up provided by a lithium battery with a ten-year shall life that retains programming for two years of accumulated power outages.

12. The timer system shall retain clock accuracy for 72 hour per power failure.

13. The timer system consists of a 24-vac transformer power a low-voltage timer unit that connects to control relay units capable of operating loads (per pole) as follows:

    a) 240 VAC, 6 A, General use.
    b) 24 VDC to 250 VDC, 75 V A resistive.
    c) 24 VDC, 5 A resistive.
    d) 1/10 hp at 120 VAC across line motor starting.
    e) ¼ hp at 240 VAC across line motor starting.
    f) 360 VA pilot duty.

14. Control relay units shall consist of four (4) single poles, normally open maintained contacts with transient protection and four (4) manual override switches.

15. The connection between the timer unit and the control relay units shall be with signal cable (Belden #9640 o equal) ten conductor shielded and jacketed. Data cable not to exceed 1000 feet. A maximum of seven of the control relay units may be wired in series-parallel configuration as desired.

16. The control relay units shall be connected to lighting contactors for load switching. See-lighting contactors.

17. Enclosure type shall be high-impact, high temperature (UL listed) plastic back box with hinged, locking clear plastic front cover. Shall have knockouts of ½ inch.

18. Timer system shall be UL listed as Energy Management Equipment.

19. Availability: The timer system (and its individual components) shall be readily available through local distributors in Puerto Rico.

20. Shall be equal or similar to Leviton model: time clock ALMA 001, transformer TR24, control relay units LCM461.

21. The time switch (as) shall be installed in a terminal cabinet with door and key operated latch. The cabinet dimensions shall be as required.

22. The contractors shall warrant any equipment installed under this specification to be free from defects for a period of two (2) years from date of final acceptance.

23. The contractors shall provide a minimum of four (4) hours training for school district personnel on proper operating procedures for the system.

END OF SECTION 16500

SECTION 16540

FIRE ALARM SYSTEM

A. General Requirements

1. The requirements of the Contract Documents, including the General and Supplementary General Condition and Division 1 – General Requirements shall apply to the work of this section.

2. At the time of bid, all exceptions taken to these Specifications, all variances from these Specifications and all substitutions of operating capabilities or equipment called for in these Specifications shall be listed in writing and forwarded to the Engineer. Any such exception, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment.

B. Scope

The work covered by this Section of the Specification shall include all labor, equipment, materials and services to furnish and install a complete fire alarm. It shall be complete with all-necessary hardware, software and memory. It shall be possible to permanently modify the software on site by using the integral programmer. The system shall consist of, but no be limited to, the following:

a. Fire alarm control panel Addressable

b. Manual fire alarm stations Addressable.

c. Smoke detectors Addressable.

d. Heat detectors Addressable.

e. Alarm Horn/Strobe

FIRE ALARM SYSTEM (CONT.)

C. Applicable Codes and Standards

1. All equipment shall be U.L. listed for its intended use.

2. NFPA Standards 72.

3. The National Electric Code.

4. All other local codes and authorities having jurisdiction.

D. Related Documents

1. Secure permits and approvals prior to installation.

2. Prior to commencement and after completion of work, notify authorities having jurisdiction.

3. Submit letter of approval for installation before requesting acceptance of system.

E. Related Work

1. The Contractor shall coordinate work in this Section with all related trades. Work and/or equipment provided in other Sections and related to the fire alarm system shall include, but not be limited to:

   a. Duct smoke detectors shall be furnished, wired and connected by the electrical contractor. The HVAC contractor shall furnish necessary duct opening to install the duct smoke detectors.

   b. Electrical contractors shall furnish conduit.

   c. Fire alarm contractors shall provide wire and Cables.

FIRE ALARM SYSTEM (CONT.)

F. Submittal

1. Provide list of all types of equipment and components provided.

2. Provide description of operation of the system, similar to that provided in part 2 of this Section of the Specifications to include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment.

3. Provide manufacturer's printed product data, catalog cuts description and special installation procedures.

4. Provide samples of various items when requested.

5. Provide shop drawings as follows:

   a. Drawing of the alarm control panel.

   b. Single line riser diagrams showing all equipment and types number and size of all conductors.

G. Warranty

1. Manufacturer shall guarantee the system equipment for a period of one (1) year from date of final acceptance of the system.

2. The contractor shall guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.

3. The contractor shall warranty all materials, equipment, wiring, devices, installation and workmanship, including service labor for one year from date of acceptance.

4. The supplier and/or contractor shall have sufficient stock of spare parts or devices on hand and have a fully equipped service organization, base in Puerto Rico, capable of guaranteeing response time within (6) hours of service and/or emergency calls. The service shall be available (24) hours a day or (7) days a week, and (365) days a year for the complete installed system.

5. Upon completion of the installation of fire alarm system equipment, the electrical contractor shall provide to the architect a signed written emend, substantially in form as follows: "The undersigned, having engaged as the Electrical Contractor on the project confirms that the fire alarm system equipment was installed in accordance with the wiring diagrams, instructions and directions provided to us by the manufacturer".

H. Products

1. Operation of any alarm-initiating device shall automatically:

   a. Sound all alarm signals throughout the building at the continuous evacuation rate.

   b. Turn on al strobe lights throughout the building.

   c. Turn on the system's red common alarm LED.

   d. Turn on the red zone active LED for the circuit of alarm at the fire alarm control panel.

   e. Start the reset / alarm silence disable timer to guarantee that alarm signals will sound for a minimum period of 1 minute.

   f. Start the alarm signal silence timer to turn the signals off after a minimum period of 20 minutes.

   g. Operate alarm relay contacts to return all elevators to the ground floor.

2. The fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens or grounds on system wiring and shorts across indicating circuit wiring shall automatically:

   a. Sound and audible signal at the fire alarm control panel at 20 SPM. The audible signal shall be capable of being silenced during the trouble condition.

   b. Slow flash a zone trouble LED at 20 SPM to indicate the source of the wire trouble. The visual indication shall remain on until the trouble condition is repaired.

   c. Operate a relay / city tie contact to initiate the transmission of a trouble indication to the central agency.

d. Sound and audible signal at the remote annunciator panel. The audible signal may be silenced during the trouble condition.

3. Subsequent alarms, supervisory signals, or trouble activations shall repeat their respective response sequence.

I. Materials

1. Fire Alarm control panel:

   The addressable fire alarm panels shall be equal to Edwards Systems Technology EST-2 type and shall incorporate all control electronics, relays, and necessary modules and components ins a semi-flush mounted cabinet. The operating controls and zone/supervisory indicators shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified. The cabinet shall be steel, with a gray finish. The assembly shall contain a base panel, system power supply and battery charger with optional modules suitable to meet the requirements of these specifications.

   The system shall be supervised, site programmable, and of modular design with expansion modules to serve up to 192 detector and 188 remote modules, and four notification appliance circuits convertible to power risers to serve remote multiple NAC modules for zoned signal applications.

2. The Manual Station Addressable should be equal to EST Model SIGA-270 with vandal proof cover with horn model ST11100. The SIGA-270 model features the familiar "teardrop" design with simple positive pull action and sturdy die-cast metal body manufactured to strict international quality standards for highest reliability.

3. The Addressable Heat Detector should be equal to an EST Model SIGA HRS. EST's Signature Series Model SIGA-HRS Intelligent Heat Detectors gather analog information from their fixed temperature and / or rate-of-rise heat sensing elements and converts it into digital signals. The detector's on board microprocessor measures and analyses these signals. It compares the information to historical readings and time patterns to make an alarm decision.

FIRE ALARM SYSTEM (CONT.)

4. The Addressable Smoke Detector shall be equal to EST Model SIGA-IPHS. The SIGA-IPHS Intelligent 4D Multisensor Detector gathers analog information from each o its three fire sensing elements (ionization, photoelectric, and heat) and covers it into digital signals. The detector's on-board microprocessor measures and analyzes these signals separately with respect to a four element-time. This technology is called 4D. It compares the information to historical readings, time patterns and several known fire characteristics to make an alarm decision. The microprocessor in each detector shall provide four additional benefits – Self-diagnostics and History log, Automatic device mapping, Stand-alone operation and fast, stable communication and also the following features:

   a. Integrates three (3)- sensing technologies.

   b. Non-volatile memory.

   c. Automatic device mapping.

   d. Electronic Addressing.

   e. Environmental compensation.

   f. Integral microprocessor – Intelligent detector.

   g. Wide 0.67 – 3.70 % / FT. Sensitivity range window: Program the detector to operate at any one of five (5) sensitivity settings within the window.

   h. Pre-Alarm: The detector stores a pre-alarm a sensitivity value to alert local personnel prior to the sensor reaching a full evacuation sensitivity.

   i. Identification of dirty or defective detector.

   j. Automatic day/night sensitivity adjustment: Makes detector more sensitive during inactive nighttime periods.

   k. Stand – Alone operation.

   l. Stable design: Sensitivity remains stable with air velocity up to 500 ft. Min. (2.53 m/sec) making it suitable for direct insertion in low velocity duct applications. Design for high ambient temperature operation up to 100º F (38ºC).

   m. Twin status leads.

n. Standards relay and fault isolator-mounting bases.

o. Design to ISO 9001 standards.

5. The horn and strobe fire annunciators shall be equal to EST Models 692-7A-003. Combination signaling appliances are designed for use with compatible control equipment associate with life safety and communications systems. These high quality EST Horn/Strobes are part of a full line of attractive similarly styled fire alarm Audible/Visual signals. The housing /bezel is finished in "Fire Red" and is made form durable, fire retardant high impact Lexan. These supervised appliances come with wire lead terminals type connections and are available in two flash intensity levels.

J. Acceptable Manufacturers

1. The catalog numbers used are those of Edwards Systems Technology (EST), Farmington, CT, and constitute the type and quality of equipment to be furnished.

2. If equipment of another manufacturer is to be submitted for approval as equal, the contractor shall, at the time of bid, list all exceptions taken to these Specifications, all variances from these Specification and all substitutions of operating capabilities or equipment called for in these Specifications and forward said list to the Engineer. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment. Final determination of compliance with this Specification shall rest with the Engineer, who, at his discretion, may require proof of performance.

K. Execution

1. Installation:

a. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagram. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the manufacturer, approved by the local Fire Department, and shall be installed in rigid, threaded conduit throughout.

b. All penetration of floor slabs and firewalls shall be fire stopped in accordance with all local fire codes.

c. End of Line Resistors: Shall be furnished as required for mounting as directed by the manufacturer.

d. All wiring shall be color coded throughout, to National Electrical Code Standards.

e. The system shall be arranged to receive power from one three wire 120 Vac, 15 A supply. All low voltage operation shall be provided from the fire alarm control panel.

f. Field Quality Control: The system shall be installed and fully tested under the supervision of a trained manufacturer's representative.

g. The system shall be demonstrated to perform all of the functions specified.

2. Test

a. Report of any field testing during installation shall be forwarded the Engineer.

b. Each individual system operation on a circuit by circuit basis shall be tested for its complete operation. The procedure for testing the entire fire alarm system shall be set forth with the consent of the code enforcement official, the Engineer and the manufacturer.

3. Documentation and Training

a. The contractor shall compile and provide to the owners three (3) complete manuals on the complete system to include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams and a manufacturer's suggested spare parts list.

b. In addition to the above manuals, the contractor shall provide the services of the manufacturer's trained representative for a period of four (4) hours to instruct the owners' designated personnel on the operation and maintenance of the entire system.

FIRE ALARM SYSTEM (CONT.)

L. Experience and Qualifications

1. The manufacturer of equipment shall have 10 years experience manufacturing similar equipment to that specified. He shall submit names, addresses and telephone numbers of ten similar projects successfully completed.

2. Installing contractor shall have 10 years experience and shall be authorized distributor of the equipment manufacturer. He shall summit similar information to that listed in item one.

3. All technicians on the project shall have a minimum off 2 years experience on similar equipment and shall be factory certified on the specific equipment being installed.

END OF SECTION

SECTION 16600

EMERGENCY GENERATOR

A. Emergency Generator:

1. Diesel Engine-Generator Set:

   4-cycle, 1800 rpm, diesel engine generator set. Generator set ratings: ____ kW, ____ kVA at 0.8 PF, standby rating. System voltage of: _____ volts AC, three phases, four wire, 60 hertz.

2. Prototype Tests and Evaluation:

   Prototype tests shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement. Prototype testing shall comply with the requirements of NFPA 110 for level 1 systems.

3. Performance:

   Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.

4. Frequency regulation shall be isochronous form steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.

5. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable de-rating factors, with the engine-generator set at operating temperature.

6. Motor starting capability shall be a minimum of ____ kVA. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

7. Engine:

   The engine shall be diesel, 4 cycle, radiator and fan cooled. Minimum displacement shall be ___ cubic inches, with ___ cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

   a) An electronic governor system shall provide automatic isochronous frequency regulation.

Engine (Cont.)

b) Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per OSHA requirements.

c) An electric starter(s) capable of three complete cranking cycles without overheating.

d) Positive displacement, mechanical, full pressure, lubrication oil pump.

e) Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

f) An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element.

g) Replaceable dry element air cleaner with restriction indicator.

h) Flexible supply and return fuel lines.

i) Engine mounted battery charging alternator, 45 ampere minimum, and solid-state voltage regulator.

8. AC Generator

a) The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MGI temperature limits for Class H insulation system for 120/208V and insulation class F for 277/480 V. Actual temperature rise measured by resistance method at full load shall not exceed 80 degrees Centigrade.

b) The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

c) A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

d) Provide two embedded *rtd* per phase and temperature indication equipment.

9. Engine-Generator Set Control:

a) The generator set shall be provided with a microprocessor-based control system which is designed to provide automatic starting, monitoring, and control functions for the generator

set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

b) The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

c) The control shall be UL508 listed, CSA282-M1989 certified, and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std. 801.2, 801.3., and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.

10. The generator set mounted control shall include the following features and functions:

a) Three position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

b) Red "mushroom-head" push-button EMERGENCY STOP switch. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

c) Push-button RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

d) Push-button PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

11. Generator Set AC Output Metering:

The generator set shall be provided with a metering set including the following features and functions: Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.

12. Generator Set Alarm and Status Message Display:

The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting

conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:

Low oil pressure (alarm)
Los oil pressure (shutdown)
Oil pressure sender failure (alarm)
Low coolant temperature (alarm)
High coolant temperature (alarm)
High coolant temperature (shutdown)
Engine temperature sender failure (alarm)
Low coolant level (alarm or shutdown-selectable)
Fail to crank (shutdown)
Over-crank (shutdown)
Over-speed (shutdown)
Low DC voltage (alarm)
High DC voltage (alarm)
Weak battery (alarm)
Low fuel-day tank (alarm)
High AC voltage (shutdown)
Low AC voltage (shutdown)
Under frequency (shutdown)
Over current (warning)
Over current (shutdown)
Short circuit (shutdown)
Ground fault (alarm) (optional-when required by code or specified)
Over load (alarm)
Emergency stop (shutdown)

In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

13. Engine Status Monitoring:

    a) The following information shall be available from a digital status panel on the generator set control:

    • Engine oil pressure (psi or kPA)

    • Engine coolant temperature (degrees F or C) both left and right bank temperature shall be indicated on V-block engines.

    • Engine oil temperature (degrees F or C)

    • Engine speed (rpm)

Engine Status Monitoring (Cont.)

- Number of hours of operation (hours)
- Number of start attempts
- Battery voltage (DC volts)

b) The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

14. Control Functions:

a) The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.

b) The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

c) The control system shall include an engine governor control, which functions to provide steady state frequency regulations as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

d) The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

e) The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

15. Alternator Control Functions:

a) The generator set shall include an automatic voltage regulation system which is matched and prototype tested with the governing system provided. It shall be immune from disoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off.

Alternator Control Functions (Cont.):

Adjustments shall be broad range, and made via digital raise-lower switches, with an alpha-numeric LED readout to indicate setting level. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

b) Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

c) Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of five (5) seconds.

d) Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

e) An AC over/under voltage monitoring system which responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator –set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

f) A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

g) When required by National Electrical Code or indicated on project drawings, the control System shall includes a ground-fault monitoring relay. The relay shall be adjustable form 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay which will function correctly in system as installed.

16. Control Interfaces for Remote Monitoring:

All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:

a) Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.

b) One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.

c) A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

d) A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

e) The control shall be provided with a direct serial communication link for the Lon Works communication network interface as described elsewhere in this specification and shown on the drawings.

17. Base:

a) The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

B. Generator Set Auxiliary Equipment and Accessories:

1. Coolant Heater:

a) Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings.

b) The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

c) The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

d) The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements.

2. Vibration Isolators:

a) Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints.

3. Starting and Control Batteries:

   a) Starting battery bank, calcium/lead antimony type, 24 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.

4. Exhaust Silencer (s):

   a) Exhaust muffler(s) shall be provided for each engine, size and type as recommended by the generator set manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.

   b) Contractor shall mount silencer over the unit an approved way so its weight is not supported by the engine.

   c) Flexible exhaust connection shall be provided as required for connection between engine exhaust manifold and exhaust line.

   d) Contractor shall mount and install all exhaust components as required for codes compliance. All components shall be properly sized to assure proper operation without excessive back pressure when installed. Make provisions as required for pipe expansion and contraction.

   e) Contractor shall cover exhaust silencer and all indoor exhaust piping with a proper insulating material approved by the Architect, in a manner not to interfere with flexible exhaust connection.

   f) The location and mounting of exhaust silencer shall be coordinated with the Architect prior to installation.

5. Remote Annunciator:

   Provide and install a 20-light LED remote alarm annunciator with horn, located at reception office, as shown on the drawings and in a location which can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger and low fuel level. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch (es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA 110 3-5.6.2.

6. Battery Charger:

   A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be located in the automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:

   Loss of AC power – red light
   Low battery voltage – red light
   High battery voltage – red light
   Power ON – green light (no relay contact)

   Analog DC voltmeter and ammeter, 12 hour equalize charge timer, AC and DC fuses shall also be provided on the charger.

7. Outdoor Weather-Protective Sound Attenuating Housing (If outdoor mounted):

   a) The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of ___ dBA at any location 7 meters from the generator set in a free field environment. Housing shall be gauge 14 #304 stainless steel vandal proof.

   b) The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and pad lockable door latches shall be provided for all doors. Door hinges shall be stainless steel.

   c) The enclosure shall be provided with a critical exhaust silencer which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a rain cap and rain shield.

   d) All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color. All surfaces of all metal parts shall be primed and painted.

   e) Painting of hoses, clamps, wiring harnesses, and other nonmetallic service parts shall not be acceptable. Fasteners used shall be stainless steel, and designed to minimize marring of the painted surface when removed for normal installation or service work.

C. Engine Fuel System:

1. Contractor shall provide all fuel system piping, which shall be black iron pipe and shall be sized as required for proper fuel flow to engine. Contractor shall provide all supply, return, vent, and fill lines as required along with all fittings. Provide flexible connections for connections fuel system to engine.

Engine Fuel System (Cont.'):

2. Provide a fuel day tank of minimum 50 gallons capacity, for each generator set. Day tank shall be equipped for automatic unattended operation. The fuel transfer day tank shall be a standard product of the manufacturer of the engine-generator set. The tank shall be UL listed, made of aluminized steel with welded construction, and pressure tested to 3 PSI. The day tank shall incorporate an integral fuel pump and motor; ¼ HP, 120/240 volt, 1-phase, 2 GPM with 20 foot lift. Provide a hand operated pump to bypass the motor driven pump and valves, for emergency use. The fuel day tank control shall be provided with On/Off/Emergency Run Switch, Test/Reset Switch, AC Circuit Breaker, DC Circuit Breaker, and Indicator lamps:

   Ready (green) – AC supply & DC control power available.

   High Fuel (red) – Latching fault, indicates fuel level near overflow, shuts down pump, and closes N/O dry contacts.

   Low Fuel (red) – Latching fault, indicates pump failure or operating float switch failure, Closes N/O dry contacts.

   Low Fuel Shutdown (red) – latching fault, indicates near empty tank, closes N/O contacts which may be used to shutdown generator set to avoid air in the injection system.

   Overflow to basing (red) – Latching fault, indicates fuel in overflow/rupture basin, shuts down pump, closes N/O dry contacts.

   Spare (red) – with N/O and N/C dry contacts

   Pump Running (green)

   Contacts shall be rated not less than 2 amps at 30VDC and 0.5 amps at 120VAC. Provide an overflow/rupture basin for the day tank with a minimum capacity of 150% of the day tank volume. Include and overflow alarm to indicate fuel in the basin.

3. Contractor shall provide a 1000 gals. UL approved, outdoor mounted, fuel storage tank, gauges, valves, tank filler cap with padlock fittings, tank vent fittings, and necessary items to comply with E.P.A. and applicable codes and regulation. The tank shall be ¼" thick, minimum.

4. A low fuel supply and tank leak sensing device, to signal the electric set alarm annunciator panel specified herein, shall be installed in the fuel tank. The sensing device shall be adjusted to signal low fuel level when the tank contains less than a three (3) hour supply. The three hour supply level shall be as recommended by the manufacturer of the electric set. A tank level meter shall be installed in the generator room. Location to be determined by the Architect.

5. Contractor shall leave the storage tank full after the testing and approval of system.

D. Automatic Transfer Switch

1. Transfer Switch Equipment:

   Provide complete factory assembled transfer equipment with electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.

2. Transfer Switch Ratings:

   a) Refer to the project drawings form specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosures, and accessories.

   b) All transfer switches and accessories shall be UL listed and labeled, tested per UL Standard 1008, and CSA Approved. Transfer switches used for fire pump applications shall be specifically listed for that service, per NFPA20.

   c) Main contacts shall be rated for 600 Volts AC minimum.

   d) Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure, in ambient temperatures of -40 to +50 degrees C, relative humidity up 95% (non-condensing), and altitudes up to 10,000 feet (3000M).

   e) Transfer switch equipment shall have withstand and closing rating (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third-party listed and labeled for use with the specific protective device(s) installed in the application.

3. Construction:

   a) Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in both positions.

   b) Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms suitable for safe manual operation under load. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions.

   c) Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have are chutes for positive are extinguishing. Are chutes shall have insulating covers to prevent interphase flashover. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

   d) Transfer switches shall be 4-poles, with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be

switched simultaneously using a common crossbar. Equipment using add-on accessory overlapping contacts are not acceptable.

e) Enclosures shall be UL listed. The enclosure shall provide NEC wire bend space. The cabinet door shall be key-locking. Controls on cabinet door shall be key-operated.

f) Transfer switches shall be mounted in enclosures as designated on the drawings. If mounted outdoors, the enclosure shall be NEMA 4 stainless steel. Separate enclosures shall be the NEMA type specified. The cabinet shall provide required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

4. Automatic Controls:

a) Transfer switches shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.

b) Control shall be solid-state and designed for a high level of immunity to power line surges and transients, demonstrated by test to IEEE Standard 587-1980. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs.

c) Solid-state under-voltage sensors shall simultaneously monitor all phases of both sources. Pick-up and drop-out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensors shall have field calibration of actual supply voltage to nominal system voltage.

d) Controls shall be provided with solid-state over voltage sensors, adjustable from 100-130% of nominal, to monitor all phases of the normal and emergency sources. Provide adjustable time delay of 0.5 to 2.2 sec.

e) Controls shall be provided with a solid-state over and under frequency sensor to monitor the normal and emergency sources. Pickup bandwidth shall be adjustable from a minimum of +/- 4% to a maximum of +/- 20% of nominal frequency. Dropout shall be +/-5% of nominal wider than pickup frequency bandwidth. Adjustable time delay shall be from 0.1 to 15 sec. Automatic controls shall signal the engine-generator set to start upon signal from normal source sensors. Solid-state time delay start, adjustable from 0 to 5 seconds (factory set at 2 seconds) shall avoid nuisance start-ups. Battery voltage starting contacts shall be gold, dry type contacts factory wire to a field wiring terminal block.

f) Provide Phase Sequence Monitor and Balance module to protect against inadvertent phase rotation hookup and monitor for voltage phase imbalance between phases.

g) The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.

h) The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable form 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.

i) Controls shall signal the engine-generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.

j) Power for transfer operation shall be from the source to which the load is being transferred.

k) The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:

Source 1 OK
Start Gen Set
Source 2 OK
Transfer Timing
Transfer Complete
Retransfer Timing
Retransfer Complete
Timing for Stop

l) The control shall include remote transfer inhibit and area protection features.

m) Transfer switches shall be equipped with a field adjustable controls to allow the operator to control the transfer switch operating time during switching in both directions. The controls shall control the time the load is isolated from both power sources, to allow load residual voltage to decay before closure to the opposite source. The transfer switch operating speed control feature shall have an adjustable range of 0 to 7.5 seconds. Phase angle monitor is not acceptable substitute for this feature.

5. Front Panel Devices:

Provide devices mounted on cabinet front consisting of:

a) A key-operated selector switch to provide the following positions and functions:

b) Test – Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.

c) Normal – Normal operating position.

d) Retransfer – Momentary position to override retransfer time delay and cause immediate return to normal source, if available.

e) Transfer switch position and source available lamps.

6. Transfer switches shall be equipped with accessories as follows:

    a) Exerciser Clock: Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide with or without load selector switch for the exercise period.

    b) Manual Selector Switch: Provide a manual/automatic retransfer selector switch to provide either automatic retransfer after the retransfer time delay, or a manual retransfer when selected when selected by an operator.

    c) Load Shed: Provide a load shed relay, to move the transfer switch from the emergency position to a neutral position, on receipt of a signal from a remote device.

    d) Signal Module: Provide signal module, to delay the transfer and retransfer of the switch for up to 50 seconds to provide a pre-transfer warning signal contact. Provide signals for the following conditions:

        Source 1 available
        Source 2 available
        Test/exercise
        Backup source available

    Contacts for these functions are to be form C type, rated for 120 VAC or 30 VDC at 4 amps.

E. Warranty:

The complete standby electric power system (equipped with set exerciser and running time mater) shall be warranted for a period of three years or nine hundred operating hours whichever occurs first, from the date of initial start-up. The warranty must be provided by the system manufacturer. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided.

F. Contractor Responsibility:

1. The design of the emergency stand-by unit is based on all electrical load as specified in the contract drawings and specifications and equipment starting sequence.

2. If a substitution of any electrical equipment and/or starting method and/or starting sequence is made then the contractor is required to submit to the Architect technical data demonstrating that the emergency stand-by unit will operate satisfactorily under these new conditions.

3. The approval of any electrical equipment and/or starting method and/or starting sequence as equal to the one specified in contract drawings and specifications do not relieve the contractor of the responsibility to guarantee that the stand-by unit will operate satisfactorily under any different conditions.

Contractor Responsibility (Cont.):

4. Any not satisfactory operation of the stand-by unit because of not complying with above requirements shall be the responsibility of the contractor and any change in the characteristics and/or size of the unit, to comply with above requirements, shall be borne by the contractor.

END OF SECTION 16600