

San Diego International Airport

Facilities Criteria Document
20 February 2015





San Diego County Regional Airport Authority Facilities Criteria Document
20 February 2015

EXECUTIVE SUMMARY

San Diego International Airport (SDIA) aims to provide consistent world class service to millions of passengers annually. The employees of SDIA maintain the highest operational standards throughout airport's functional activities and constructed facilities. It is the continual goal of SDIA to establish and maintain an atmosphere that enhances customer satisfaction, improves the appearance of the terminals, and increases operational and economic performance of SDIA's facilities.

This Facilities Criteria Document establishes the requirements for functional, durable, maintainable, sustainable and aesthetically pleasing facilities at SDIA. The objectives for this Facilities Criteria Document are:

- ✦ To support the integration and streamlining of existing facilities asset management applications in order to improve business operations from project inception to decommissioning and disposal, through enhanced functionality and streamlining of existing processes;
- ✦ To enhance the currently planned Terminal Development Program by providing insight into the products and systems that the Airport Authority considers acceptable in form and function; and
- ✦ To focus the design and decision-making processes on multi-dimensional sustainability concepts; and in support of that effort, to provide guidance in the implementation of new and renovation works so that they are in alignment with SDIA's established policy on sustainability.

SDCRAA embraced the complex challenges faced by an airport authority engaged in being environmentally responsible, as evidenced by the adoption of their Sustainability Policy. This policy has been included as Appendix A, "SDCRAA Sustainability Policy 8.31." It sets forth the purpose "To establish a formal policy,..formalizing commitment to a sustainable future for the airport, the Authority, and the region" and recognizes four sustainability elements: Economic Viability (E), Operational Excellence (O), Natural Resource Conservation (N), and Social Responsibility (S) – or EONS.

"Sustainability improves our lives for EONS"

The architectural and engineering design community, whenever working in a consulting capacity for San Diego International Airport, must achieve the intent of these criteria throughout all phases of any project, regardless of its size or scope. Manufacturers and products listed should be considered as the preferred solution, however professionals engaged in problem-solving on behalf of the Airport Authority may propose alternatives by using the Alternative Resolution Form included as Appendix B.

Facilities Criteria Document

Practices and projects shall comply with the standards set forth in this document and those referenced below.

- ✦ San Diego County Regional Airport Authority Design, Technical and Construction Requirements; 08-26-2008.
- ✦ Requirements for Architects & Engineers Performing Services for the San Diego International Airport; August 2006 revision.
- ✦ Retail Tenant Criteria, San Diego International Airport; 2005.
- ✦ Interior Design Standards, San Diego International Airport; 2003.
- ✦ Comprehensive Sign Program, current version.

This Facilities Criteria Document is a “living” standard in that it is routinely revised based upon identified changes in technologies, improvements made by manufacturers, and lessons learned through project execution and operations and maintenance activities. Such revisions have been identified as “hidden text” at the beginning of each section. To view, click on the “show/hide” symbol in the Word toolbar.

As a matter of clarification and for coordination purposes, various sources of information were used in the compilation of this Facilities Criteria Document. These sources have been identified within brackets at the end of various requirements and are provided for information:

- ✦ FMD – Facilities Management Department
- ✦ IDS – SDCRAA Interior Design Standards
- ✦ MasterSpec – Nationally available specifications subscription service that is marketed by ARCOM
- ✦ PerfSpec – Performance Specifications developed exclusively for the Terminal Development Program

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06 20 23 INTERIOR FINISH CARPENTRY

A. SUMMARY

1. This section includes:
 - a. New and replacement wood cabinetry.
 - b. Interior wood paneling.
 - c. Interior composite paneling.
 - d. Stair railings.
 - e. Shelving and associated trim.
2. Construction and installation quality of wood components is governed by various trade associations that establish material grades, manufacturing standards, and installation standards that tradesmen will observe.

B. MANUFACTURERS

1. Unlike pre-manufactured construction items, the majority of components are custom manufactured or configured from standardized modules in the shop or on site and will vary with field conditions.

C. PRODUCTS

1. Use wood species and module consistently throughout, unless otherwise determined. [IDS]
2. Incorporate wood paneling at either full height or as a wainscot in approved areas. [IDS]
3. Use 3/16-inch joints, with veneer returned at exposed surfaces, including joint interiors that have species and stains that complement accent colors; be most similar to natural wood colors depicted in the color palette. [IDS]
4. Use satin or matte finishes. [IDS]
5. Use solid wood along exposed edges. [IDS]
6. Hide fasteners. [IDS]
7. Do not use rotary and other “busy” cuts. [IDS]
8. Interior composite paneling: ‘Trespa’ can be incorporated at either full height or as a wainscot in approved areas. Apply integral stainless steel corner/edge profile at exposed corners and edges from floor to ceiling. Hide fasteners. [IDS]
9. Identify fire-retardent-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
 - b. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. VOC ratings of adhesives.

- b. VOC ratings of manufactured wood components (MDF, particleboard, etc.)
 - c. Wood sourcing limitations/chain of custody documentation.
 - d. Wood species restrictions are included in manufacturing standards which limit or prevent the use of non-sustainable varieties.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: 15-year life span.
 - b. Operational:
 - 1) Durability: 15 years functional service life.
 - 2) Maintenance: Use manufacturer recommended cleaning methods.

06 41 19 METAL CLAD ARCHITECTURAL CABINETS

A. SUMMARY

1. Section includes:
 - a. Metal clad ticket counters.
 - b. Gate podiums and backwall units. [IDS]
2. Comments:
 - a. Construction and installation quality of wood components is governed by various trade associations that establish material grades, manufacturing standards, and installation standards that tradesmen will observe.
 - b. Provide for and support "common use" functions in ticket counters, gate podiums and backwall units. Equipment contained in casework will be airport-furnished. [IDS]
 - c. As a high profile element, ticket counters shall function seamlessly and allow for easy, comfortable transaction between airline ticket agent and passenger. [IDS]

B. MANUFACTURERS

1. Unlike other manufactured construction items, the majority of components included in this section are custom manufactured or configured from standardized modules in the shop or on site and will vary with field conditions.

C. PRODUCTS

1. Metal Clad Ticket Counters: Approved ticket counter design in accordance with SDCRAA Interior Design Standards [IDS]
2. ADA compliant for passenger and agent sides of every unit. [IDS]
3. Include bag well on sides of unit at ticket counter locations (not gatehold check-in) that matches measurements and stainless steel material of approved bag wells currently in use. [IDS]
4. Gaps where bag wells meet counter will not be acceptable. [IDS]
5. Use stainless steel surround at baggage belt locations. [IDS]
6. Laminate, other than small color accent, will not be acceptable. [IDS]
7. Open from front of unit for maintenance. [IDS]
8. Gate Podiums and Backwall Units: Approved ticket counter design in accordance with SDCRAA Interior Design Standards. [IDS]
9. Materials: Match stainless steel and accent color of existing ticket counter materials. [IDS]

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. VOC ratings of adhesives.
 - b. VOC ratings of manufactured wood components (MDF, particleboard, etc.)
 - c. Wood sourcing limitations/chain of custody documentation.
 - d. Wood species restrictions are included in manufacturing standards which limit or prevent use of non-sustainable varieties.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

07 18 00 TRAFFIC COATINGS

A. SUMMARY

1. Section includes:
 - a. Landside: Fluid applied indicator markings on vehicular and pedestrian traffic areas including pavement, curb, and walk areas; parking lot striping, accessibility path markings, and traffic restriction markings.
 - b. Airside Areas: Limited to those maintained directly by SDCRAA maintenance personnel; vehicular traffic and parking areas on aprons, along taxiways, and around airport buildings are included. AOA markings for aircraft movement are limited to apron and taxiway.
2. Comments:
 - a. Observe Caltrans standards for landside applications for materials and installers.
 - b. Observe FAA standards for airside applications for materials and installers.

B. MANUFACTURERS

1. Limit sourcing to locally available products that have been identified by Airport as acceptable.
2. Parking Striping:
 - a. Ennis Traffic Safety Solutions (Pervo).
 - b. Vista Paint.

C. PRODUCTS

1. No identified products.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: For traffic coatings used inside weatherproofing system - Comply with the VOC limits stated in Credit 4.2 (Low-Emitting Materials) and established by South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings & Green Seal Standard for Commercial Adhesives (GS-11).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

07 21 00 THERMAL INSULATION

A. SUMMARY

1. Section includes: Insulation for use within walls or above ceilings.
2. Glass fiber products will not be acceptable.

B. MANUFACTURERS

1. No identified manufacturers.

C. PRODUCTS

1. Glass fiber products will not be acceptable.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content should be provided with submittals.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

07 51 13 BUILT UP ASPHALT ROOFING

A. SUMMARY

1. Built up asphalt roofing is currently used on several buildings including the existing Terminal 1 at the east and west piers and Terminal 2 East.
2. The built up asphalt roofing system employs a layered system of tar based impregnated felt sheets (between 3 and 6 or more) laid over rigid substrate (such as plywood or metal decking) and layer of insulating, tapered rigid insulation that allows roof to be sloped for drainage to roof drains and/or scuppers.
3. System is usually capped with aggregate (rock) type ballast.
4. Incorporate walk pads to provide reinforced path of travel across roof to protect it from wear by maintenance personnel and equipment.

B. MANUFACTURERS

1. Existing built-up roof system is manufactured by Tremco, Inc.
2. Other Available Manufacturers/Sources:
 - a. CertainTeed Corporation.
 - b. Ecology Roof Systems.
 - c. Fields Company, LLC.
 - d. Firestone Building Products Company.
 - e. GAF Materials Corporation.
 - f. Honeywell Commercial Roofing
 - g. Intec/Permaglas; Div. of U.S. Intec,
 - h. Johns Manville International, Inc.
 - i. Malarkey Roofing Company.
 - j. TAMKO Roofing Products, Inc.

C. PRODUCTS

1. Base Sheet Materials:
 - a. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft.
 - b. Base Sheet: ASTM D 4601, Type I, nonperforated, asphalt-impregnated and coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
2. Roofing Membrane Plies:
 - a. Ply Sheet: ASTM D 2718, Type IV, asphalt-impregnated, glass-fiber felt.
 - b. Cap Sheet: ASTM D 3909, asphalt-impregnated and coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine material surfacing on bottom surface.\
3. Flashing Materials:
 - a. Backer Sheet: ASTM D 2718, Type IV, asphalt-impregnated, glass-fiber felt.

- b. Flashing Sheet: ASTM D 6164, Type I or II, polyester-reinforced, SBS modified asphalt sheet, granular surfaced; Gray.
- 4. Asphalt Materials:
 - a. Asphalt Primer: ASTM D 41.
 - b. Roofing Asphalt: ASTM D 312, Type III or IV as recommended by built-up roofing system manufacturer for application.
- 5. Auxiliary Roofing Membrane Materials:
 - a. As recommended by roofing system manufacturer for intended use and compatible with built-up roofing.
 - b. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.
 - c. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up roofing base flashings.
 - d. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM 4470; designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength; and acceptable to roofing system manufacturer.
 - e. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry or opaque, water-worn gravel or crushed stone, free of sharp edges.
- 6. Substrate Boards:
 - a. Board: ASTM C 36, Type X gypsum wall board, 5/8-inch thick.
 - b. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening substrate panel to roof deck.
- 7. Roof Insulation:
 - a. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4-inch per 12 inches (1:48).
 - b. Provide preformed saddles, crickets, tapered edges strips and other insulation shapes for sloping to drain.
- 8. Insulation Accessories:
 - a. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
 - b. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

- c. Tapered Edge Strips: ASTM C 726, glass-fiber insulation board.
- d. Cover Board: ASTM C 1177, glass-mat, water resistant gypsum substrate, 1/4-inch thick.
- 9. Walkway Pads: slip-resistant pads, manufactured as a traffic pad for foot traffic and acceptable to roofing manufacturer.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. VOC ratings of applied coatings (hot mopped tar).
 - b. For adhesives and sealants, comply with requirements of VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - c. For Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have Solar Reflectance Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.
 - d. For Steep Sloped Roofs (Slope greater than 2:12): Roofing surface shall have Solar Reflectance Index (SRI) equal to or greater than 29 for minimum of 75 percent of roof surface EPDM, PVC, or other types of "single-ply" systems.
 - e. Note that while constituent components of built-up asphalt roofs can comply with LEED credit criteria, the system as a whole usually does not have the reflectance characteristics of other systems such as EPDM, PVC, or other types of "single-ply" systems.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within 20 years of Substantial Completion. Failure includes roof leaks. [MASTERSPEC]
 - b. Operational: Warranties provided by manufacturers may include maintenance and service contracts. Consider local sources as they may best be suited to provide warranty service.
 - c. Natural Resource:
 - 1) Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products. [MASTERSPEC]
 - 2) Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRCC-1 (Cool Roof Rating Council) [MASTERSPEC & Notes]

07 51 16 BUILT UP COAL TAR ROOFING

A. SUMMARY

1. Built up coal tar roofing is currently used on a variety of older buildings including buildings in the cargo and maintenance areas.
2. Built-up roof systems employ a layered system of coal tar based impregnated felt sheets (between 3 and 6 or more) laid over rigid substrate (such as plywood or metal decking) and layer of insulating, tapered rigid insulation that allows the roof to be sloped for drainage to roof drains and/or scuppers. System is usually capped with aggregate (rock) type ballast.
3. Along with use in a repair capacity for existing built-up roofs, incorporate walk pads to provide a reinforced path of travel across the roof to protect it from wear by maintenance personnel and equipment.

B. MANUFACTURERS

1. Hickman System.
2. Koppers Industries.

C. PRODUCTS

1. No products identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. For adhesives and sealants, comply with the requirements of the VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - b. or Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.
 - c. For Steep Sloped Roofs (Slope greater than 2:12) : Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 29 for a minimum of 75 percent of the roof surface EPDM, PVC, or other types of "single-ply" systems.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within 20 years of Substantial Completion. Failure includes roof leaks. [MASTERSPEC]
 - b. Operational: Warranties provided by manufacturers may include maintenance and service contracts.

- Consider local sources as they may best be suited to provide warranty service.
- c. Natural Resource: Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

07 52 13 ATACTIC POLYPROPYLENE (APP) MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM

A. SUMMARY

1. Atactic Polypropylene roof is a type of modified bitumen roofing; a hybrid built-up roof with built-in redundancy benefits of BUR, and added strength, flexibility and UV resistance of a modified membrane.
2. Modified Bitumen or "modbit" membranes consist of an asphalt and polymer blend which allows the asphalt to take on characteristics of the polymer. There are several surfacing options for this system which include a factory applied mineral surface, a gravel surface laid in bitumen or a liquid applied coating that is typically reflective in nature.
3. The APP roof system specifically employs a layered system of atactic polypropylene sheet membranes (usually torch welded) and traditional tar impregnated felt sheets (between 3 and 5 or more) which is laid over a rigid substrate such as metal decking (plywood decking not recommended) and a layer of insulating, tapered rigid insulation that allows the roof to be sloped for drainage to roof drains and/or scuppers. The system is usually capped with an aggregate (rock) type ballast.
4. This system is currently not in use at San Diego International Airport.
5. The finish layer of APP-BM roofs has a "plasticized" quality that may provide additional wear resistance due to traffic. APP roofs have been known to not perform well where ponding water is common.

B. MANUFACTURERS

1. GAF, Inc.
2. Hickman Systems, Inc.
3. Tremco, Inc.

C. PRODUCTS

1. No products identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. For adhesives and sealants, comply with the requirements of the VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - b. For Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.

- c. For Steep Sloped Roofs (Slope greater than 2:12) :
Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 29 for a minimum of 75 percent of the roof surface EPDM, PVC, or other types of “single-ply” systems.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within 20 years of Substantial Completion. Failure includes roof leaks.
 - b. Operational: Warranties provided by manufacturers may include maintenance and service contracts. Consider local sources as they may best be suited to provide warranty service.
 - c. Natural Resource:
 - 1) Provide roofing system that is listed on DOE's ENERGY STAR “Roof Products Qualified Product List” for low-slope roof products.
[MASTERSPEC]
 - 2) Conventional built-up roofing (BUR) is made from multiple layers of asphalt-impregnated felt alternated with layers of hot-mopped bitumen. Material use is relatively high, and considerable waste is generated during reroofing.
 - 3) Recycled-Content modified bituminous products can reduce overall environmental impacts.

07 52 16 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

A. SUMMARY

1. This system is currently not in use at San Diego International Airport.
2. Styrene-Butadiene-Styrene roofing is a type of modified bitumen roofing
3. The modified bitumen roofing system is a hybrid built-up roof with built-in redundancy benefits of BUR, and added strength, flexibility and UV resistance of modified membrane.
4. Modified Bitumen or "modbit" membranes consist of an asphalt and polymer blend which allows the asphalt to take on characteristics of the polymer. There are several surfacing option for this system which include a factory applied mineral surface, a gravel surface laid in bitumen or a liquid applied coating that is typically reflective in nature
5. SBS roof system employs layered system of styrene-butadiene-styrene sheet membranes (usually hot mopped) and traditional tar impregnated felt sheets (between 3 and 5 or more) which is laid over a rigid substrate such as plywood or metal decking and a layer of insulating, tapered rigid insulation that allows the roof to be sloped for drainage to roof drains and/or scuppers. System is usually capped with an aggregate (rock) type ballast.
6. Finish layer of SBS-BM roofs has a "rubberized" quality (somewhat like single ply membrane roofs) that may provide additional waterproofing characteristics.

B. MANUFACTURERS

1. GAF, Inc.
2. Hickman Systems, Inc.
3. Tremco, Inc.

C. PRODUCTS

1. No products identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. For adhesives and sealants, comply with the requirements of VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - b. For Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.
 - c. For Steep Sloped Roofs (Slope greater than 2:12) : Roofing surface shall have a Solar Reflectance

- Index (SRI) equal to or greater than 29 for a minimum of 75 percent of the roof surface EPDM, PVC, or other types of “single-ply” systems.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
- a. Economic: Manufacturer’s standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within 20 years of Substantial Completion. Failure includes roof leaks.
 - b. Operational: Warranties provided by manufacturers may include maintenance and service contracts. Consider local sources as they may best be suited to provide warranty service.
 - c. Natural Resource:
 - 1) Provide roofing system that is listed on DOE’s ENERGY STAR “Roof Products Qualified Product List” for low-slope roof products. [MASTERSPEC]
 - 2) Conventional built-up roofing (BUR) is made from multiple layers of asphalt-impregnated felt alternated with layers of hot-mopped bitumen. Material use is relatively high, and considerable waste is generated during reroofing.
 - 3) Recycled-Content modified bituminous products can reduce overall environmental impacts.

07 53 00 ELASTOMERIC MEMBRANE ROOFING

A. SUMMARY

1. Section includes elastomeric membrane or “single ply” roofing systems
2. California law limits the number of roofs on a building to three, therefore single ply roofing can be applied over existing built up systems provided that a rigid barrier is laid down over an existing roof and that there are no more than two other, previously installed systems in place.

B. MANUFACTURERS

1. Burke Industries (CSPE)
2. Firestone Building Products (TPO)
3. GAF (PVC)

C. PRODUCTS

1. CSPE, EPDM, EIP, PVC and TPO Roofing: Types of elastomeric membrane or “single ply” roofing systems formed with non-vulcanized and vulcanized elastomeric membranes. These systems include ballasted, fully-adhered, and mechanically attached installations.
2. Single-ply roofing: Flexible or semi-flexible pre-manufactured membrane typically made of rubber or plastic materials which provide monolithic diaphragm that seals roof from edge to edge. These types of roofs are preferable to built-up roofs when foot traffic, large numbers of penetrations, and mechanical curbs are factors. Repairs are generally simple and clean.
3. Single-ply roofing comes in large rolls and shall be glued or mechanically fastened to a roof and sealed at seams either by means of chemical or heat activated sealants, in contrast to built-up roofs which utilize hot asphalt and other components that are constructed in place. Full adhesive installation is slightly more expensive than mechanical fastening but provides a superior life span and water tightness.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. For adhesives and sealants, comply with the requirements of VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - b. For Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.
 - c. For Steep Sloped Roofs (Slope greater than 2:12) : Roofing surface shall have a Solar Reflectance

- Index (SRI) equal to or greater than 29 for a minimum of 75 percent of the roof surface EPDM, PVC, or other types of “single-ply” systems.
 - d. Note that CSPE/PVC/EIP/TPO roofs are Green Roof certified and LEED compliant for minimum solar reflectance values. EPDM does not comply with this value unless an optional white finish coating is applied. This coating provides the necessary reflectance but has been observed to be prone to cracking within 5 years of installation.
 - 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Life Span for CSPE: 20 years warranted and plus or minus 40 years actual service.
 - 2) Life Span for PVC/EID: 20 years warranted and plus or minus 25 years actual service (Note that this product must be thicker to achieve comparable warranty to CSPE).
 - 3) Life Span for TPO/EPDM: Less than 15-year warranty (relatively new products).
 - b. Operational:
 - 1) Install/Maintenance costs for TPO/EPDM: Lower initial costs / higher maintenance costs.
 - 2) Install/Maintenance costs all others: Higher initial costs / lower maintenance costs.
 - 3) Warranties provided by manufacturers may include maintenance and service contracts. Local sources may be best suited to provide such service.

07 54 00 THERMOPLASTIC MEMBRANE ROOFING

A. SUMMARY

1. California law limits the number of roofs on a building to three. Therefore, single ply roofing can be applied over existing built up systems provided that a rigid barrier is laid down over any existing roof and that there are no more than two other, previously installed systems in place.

B. MANUFACTURERS

1. Burke Industries (CSPE).
2. Firestone Building Products (TPO).
3. GAF (PVC).

C. PRODUCTS

1. EIP, PVC AND TPO Roofing: Types of elastomeric membrane or "single ply" roofing assembly formed with non-vulcanized and vulcanized elastomeric membranes. These include ballasted, fully-adhered, and mechanically attached installations.
2. Single-ply Roofing: Flexible or semi-flexible pre-manufactured membrane typically made of rubber or plastic materials which provide monolithic diaphragm that seals a roof from edge to edge. These types of roofs are preferable to built up roofs when foot traffic, large numbers of penetrations, and mechanical curbs are factors. Repairs are generally simple and clean.
3. Single-ply roofing comes in large rolls and must be glued or mechanically fastened to a roof and sealed at seams either by means of chemical or heat activated sealants. This is in contrast to built-up roofs which utilize hot asphalt and other components which are constructed in place. Full adhesive installation is slightly more expensive than mechanical fastening but provides a superior life span and water tightness.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. For adhesives and sealants, comply with the requirements of the VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - b. For Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.
 - c. For Steep Sloped Roofs (Slope greater than 2:12) : Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 29 for a

- minimum of 75 percent of the roof surface EPDM, PVC, or other types of “single-ply” systems.
 - d. Note that CSPE/PVC/EIP/TPO roofs are Green Roof certified and LEED compliant as is for minimum solar reflectance values. EPDM does not comply with this value unless an optional white finish coating is applied. This coating provides the necessary reflectance but has been observed to be prone to cracking within 5 years of installation.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Life Span for CSPE: 20 years warranted and plus or minus 40 years actual service.
 - 2) Life Span for PVC/EID: 20 years warranted and plus or minus 25 years actual service (Note that this product must be thicker to achieve comparable warranty to CSPE).
 - 3) Life Span for TPO/EPDM: Less than 15-year warranty (relatively new products).
 - b. Operational:
 - 1) Install/Maintenance costs for TPO/EPDM: Lower initial costs / higher maintenance costs.
 - 2) Install/Maintenance costs for all others: Higher initial costs / lower maintenance costs.
 - 3) Warranties provided by manufacturers may include maintenance and service contracts. Local sources may be best suited to provide such service.
 - c. Natural Resource:
 - 1) Thermoplastic membranes can be heat-welded at seams, minimizing use of solvent-based adhesives.
 - 2) For roof membranes, PVC requires plasticizers for flexibility; these chemicals, which may dissipate over time and cause brittleness, are a major cause of membrane failure.
 - d. Social: PVC is targeted by some environmental groups for its chlorine content and the risk of dioxin production in the event of an unintentional fire or incineration.

07 57 00 COATED FOAMED ROOFING

A. SUMMARY

1. Section includes sprayed polyurethane foam (SPF).
2. SPF is a combination of isocyanate and polyglycol. The two components are fed through a spray gun, where products are mixed and sprayed onto substrate. Because foam is sprayed onto roof as a liquid, it forms a single continuous structure that is monolithic.
3. SPF requires a clean surface for proper application which must be dry, free of contaminants like oil, and properly fastened to substrate in accordance with specific building codes. A protective elastomeric top coat is required which is typically sprayed on as well, but it is also possible to be applied with hand or power rollers. The top coat is critical for protection from degradation in weather and solar reflectance.
4. SPF roofs can accommodate the presence of numerous roof penetrations and curbs and easily adapts to sloped substrates for drainage. It is a relatively lightweight product and provides very distinct advantages when considering thermal insulation qualities (R-value of 7.14 per 1 inch thickness). The efficacy of this may not be as much of an issue in a temperate climate like San Diego.
5. Significant disadvantages of a sprayed foam roofing system as compared to other systems include higher repair costs for damaged sections, less puncture resistance in non reinforced areas, and shorter warranty coverages.

B. MANUFACTURERS

1. BASF.
2. Dow Corning.
3. Pacific Polymers.

C. PRODUCTS

1. Rigid cellular polyurethane, spray applied, produced by catalyzed chemical reaction of polyisocyanates with polyhydroxyls, with stabilizers, fire retardants and blowing agents added; and complying with ASTM C 1029 Type III, as certified by a qualified independent testing agency. [MASTERSPEC].

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. For adhesives and sealants, comply with the requirements of the VOC limits under South Coast Air Quality Management District (SCQAMD) Rule #1168.
 - b. For Low Sloped Roofs (Slope less than equal 2:12): Roofing surface shall have a Solar Reflectance

- Index (SRI) equal to or greater than 78 for a minimum of 75 percent of the roof surface.
 - c. For Steep Sloped Roofs (Slope greater than 2:12) : Roofing surface shall have a Solar Reflectance Index (SRI) equal to or greater than 29 for a minimum of 75 percent of the roof surface EPDM, PVC, or other types of “single-ply” systems.
 - 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within 20 years of Substantial Completion. Failure includes roof leaks.
 - b. Operational: Warranties provided by manufacturers may include maintenance and service contracts. Consider local sources as they may best be suited to provide warranty service.
 - 3. Natural Resource: Provide roofing system that is listed on DOE's ENERGY STAR “Roof Products Qualified Product List” for low-slope roof products.

08 11 13 HOLLOW METAL DOORS AND FRAMES

A. SUMMARY

1. Hollow metal doors and frames are used widely throughout San Diego Airport. Fully welded frames are standard and have proven to provide superior life span and wear resistance to aluminum “knock-down” type door frames.
2. The majority of metal doors and frames are subject to extremely heavy use and significant damage, primarily in baggage handling and ramp service areas. Where low maintenance is of primary importance, even the most substantially constructed doors are projected as having a 10-year life span.
3. In many service locations, a double door configuration is preferred. Double doors shall feature removable, lockable center strike mullions that allow for large items to be occasionally passed through the doorway.
4. Doors at security/card swipe conditions shall be equipped with continuous, rather than butt type hinges.
5. Doors throughout shall be assessed for the benefits that vision glass in the door will provide for safety when passing into hazardous areas. Also consider the fire separation requirements between occupancies.
6. Ramp access doors require window lite.
7. When specifying hollow metal doors, field verify doors equipped with continuous hinges for proper fit in each corresponding frame to ensure smooth operation.
8. Maximum Leaf Size: 3'-6".
9. Pneumatic wheels on gates will not be acceptable. [FMD]

B. MANUFACTURERS

1. Ceco Door Products.
2. Curries Company.
3. Security Metal Products, Inc.
4. Steelcraft; a division of Ingersoll-Rand.
5. Any current member of Steel Door Institute will be acceptable. Members of Hollow Metal Manufacturers Association, division of the National Association of Architectural Metal manufacturers, will be acceptable if doors and frames are manufacturer-certified to meet or exceed SDI requirements.

C. PRODUCTS

1. Frames:
 - a. Meet requirements of SDI 100.
 - b. Mitered, full (continuously) welded, and ground smooth.
 - c. Factory prepped for applicable door hardware.
 - d. Exterior Frames: Comply with requirements of ANSI A250.8, Level 3 Extra heavy duty.

- e. Interior Frames: Comply with requirements of ANSI A250.8, Level 2 Heavy duty (minimum 16 gage).
- f. Fire Rated Door Frames: Provide permanently affixed UL or Warnock-Hersey label indicating that frames have been successfully tested in accordance with ASTM E 152, NFPA 252, or UL 10B, and successfully tested in accordance with CBC 7-2 or UL 10C for positive pressure ("S") rating.
- 2. Doors:
 - a. Exterior Doors: Comply with requirements of ANSI A250.8, Level 2 Heavy duty (minimum 18 gage).
 - b. Interior Doors: Comply with requirements of ANSI A250.8, Level 2 Heavy duty (minimum 18 gage).
 - c. Fire Doors: Provide permanently affixed UL or Warnock-Hersey label indicating that doors have been successfully tested in accordance with ASTM E 152, NFPA 252, or UL 10B, and successfully tested in accordance with CBC 7-2 or UL 10C for positive pressure ("S") rating. Indicate on label applicable fire test rating for door construction finished.
 - d. Prepare and reinforce door for hardware in accordance with ANSI A 250.6 and ANSI A 115.
 - e. Do not use knock-down (KD) type frames.
 - f. Size exit doors requiring continuous hinges to frame.
 - g. Cores: As required for fire, thermal or acoustic requirements.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Paints, Adhesives and Sealants: Do not exceed applicable VOC limits. [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1].
 - b. Recycled content shall meet or exceed specific thresholds:
 - 1) LEED NC v2.2 MR Credit 4.1: 10 percent¹ post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent¹ post-consumer materials, (including 1/2-percent pre-consumer materials).
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Service life span of minimum 15 years for fixed and operable parts. [PerSpecs]
 - b. Natural Resource:

- 1) Core materials for metal doors vary widely, including fiberglass and plastic forms (polystyrene and polyurethane) for insulating doors, steel ribs, honeycomb paperboard, or a fire-resistive core for fire rated doors. HFC-free, HCFC-free expanded styrene is the preferable insulating core.
- 2) Where field finishing is required, specify high-solids, low-VOC durable coating such as high-performance water-based acrylic paint. Avoid alkyd enamel paint, a solvent-based paint that emits large quantities of VOCs.

08 11 19 STAINLESS STEEL DOORS AND FRAMES

A. SUMMARY

1. Stainless steel doors and frames are primarily used for high visibility applications in passenger areas, club room entry doors, jet bridge entry doors, and executive office entry doors and are often part of the branding and color schemes of resident tenants.
2. As stainless steel is usually left exposed with only a clear finish, pay special attention to grain direction and finish sheen to provide desired appearance.
3. The added expense of stainless steel doors may warrant use of heavy duty continuous hinges to avoid damage from regular use.
4. When including requirements for door installation, field verify doors equipped with continuous hinges properly fit in each corresponding frame to ensure smooth operation.

B. MANUFACTURERS

1. No preferred manufacturers identified.

C. PRODUCTS

1. Frames:
 - a. Exterior Frames: Comply with the requirements of ANSI A250.8, Level 3 Extra heavy duty (minimum 16 gage).
 - b. Interior Frames: Comply with the requirements of ANSI A250.8, Level 2 Heavy duty (minimum 16 gage).
 - c. Fire Rated Door Frames: Provide permanently affixed UL or Warnock-Hersey label indicating that frames have been successfully tested in accordance with ASTM E 152, NFPA 252, or UL 10B, and successfully tested in accordance with CBC 7-2 or UL 10C for positive pressure ("S") rating.
 - d. Meet requirements of SDI 100.
 - e. Mitered, full (continuously) welded, and ground smooth.
 - f. Factory prepared for applicable door hardware.
2. Doors:
 - a. Exterior Doors: Comply with requirements of ANSI A250.8, Level 2 Heavy duty (minimum 18 gage).
 - b. Interior Doors: Comply with requirements of ANSI A250.8, Level 2 Heavy duty (minimum 18 gage).
 - c. Fire Doors: Provide permanently affixed UL or Warnock-Hersey label indicating that doors have been successfully tested in accordance with ASTM E 152, NFPA 252, or UL 10B, and successfully tested in accordance with CBC 7-2 or UL 10C for

- positive pressure ("S") rating. Indicate on label applicable fire test rating for door construction finished.
- d. Factory-prepare and reinforce for hardware in accordance with ANSI A250.6 and ANSI A115.
- e. Knock-down (KD) type frames will not be acceptable.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Paints, Adhesives and sealants shall not exceed applicable VOC limits. [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1]
 - b. Recycled content shall meet or exceed specific thresholds:
 - 1) LEED NC v2.2 MR Credit 4.1: 10 percent¹ post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent¹ post-consumer materials, (including 1/2-percent pre-consumer materials).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Natural Resource: Core materials for metal doors vary widely, including fiberglass and plastic forms (polystyrene and polyurethane) for insulating doors, steel ribs, honeycomb paperboard, or a fire-resistive core for fire rated doors. HFC-free, HCFC-free expanded styrene is the preferable insulating core.

08 14 16 FLUSH WOOD DOORS

A. SUMMARY

1. Provide flush wood doors at executive and private office suites and similar locations. Use solid core doors in fully welded steel frames. Provide sidelights at offices and conference rooms. Wood doors cannot withstand intense use typical for most doors at the Airport.

B. MANUFACTURERS

1. No preferred manufacturers identified.

C. PRODUCTS

1. No preferred products identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives and sealants shall not exceed VOC limit of 100 g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1].
 - b. Extraction, Process and Manufacture of wood doors may contribute to LEED v2.2 MR Credit 5.1 and 5.2 credits, Regional Materials.
 - c. For Credit EQ 4.4 (Low Emitting Materials: Composite Wood & Agrifiber Products): Provide documentation indicating that bonding agent contains no added urea formaldehyde.
 - d. Encourage environmentally responsible forest management and use minimum of 50 percent of wood-based materials and products, which are certified in accordance with Forest Stewardship Council's (FSC) principles and criteria. Contributes to LEED v2.2 MR Credit 7.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's warranty in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within 15-year or similar specified warranty period. Warranty shall include installation and finishing that may be required due to repair or replacement of defective doors.
 - b. Operational: Maintenance requirements for finish and associated hardware for flush wood doors may prove costly.
 - c. Natural Resource: Doors fabricated from sustainably harvested wood are available. Specify doors that are certified under FSC (Forest

Stewardship Council) principles and provide chain of custody documents accordingly.

08 41 13 ALUMINUM FRAMED ENTRANCES AND STOREFRONTS

A. SUMMARY

1. This section includes:
 - a. Exterior and interior storefront framing.
 - b. Storefront framing for window walls.
 - c. Storefront framing for ribbon walls.
 - d. Storefront framing for punched openings.
 - e. Exterior and interior manual-swing entrance doors and door-frame units.
2. Aluminum framed entrances as well as storefront glazing systems are widely used, with some in conjunction with automatic entryways. These systems provide ample light to public access spaces and add visual connection between exterior and interior.
3. Exercise care when implementing glazing and entry systems into future designs with respect to damage potential from jet blast and collision with ground service equipment (GSE).
4. Tempered dual glazing provides thermal, impact, and sound resistance necessary for application at an airport. Combined with bollards or similar adequate protection equipment at exterior traffic areas, these systems are an effective and flexible way to clad building exterior.

B. MANUFACTURERS

1. No preferred manufacturers identified.

C. PRODUCTS

1. Aluminum doors with wide stiles (over 5 inches).
2. Jetbridges: Aluminum and glass doors and mag locks.
3. Do not use Alumatec pull type sliding doors at Security Checkpoint. Prefer Cookson grill doors, 18'-0" maximum width.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: For Credit EQ 4.1 (Low Emitting Materials: Adhesives & Sealants): For adhesives and sealants used inside weatherproofing system, comply with VOC limits indicated set by South Coast Air Quality Management District (Rule #1168).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's warranty in which manufacturer agrees to repair or replace aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within 15 years or other specified

warranty period. Failures include, but are not limited, to the following:

- 1) Structural failures including, but not limited to, excessive deflection.
- 2) Noise or vibration caused by thermal movements
- 3) Deterioration of metals, metal finishes and other materials beyond normal weathering.
- 4) Adhesive or cohesive sealant failures.
- 5) Water leakage through fixed glazing and framing areas.
- 6) Failure of operating components.

08 42 29 AUTOMATIC ENTRANCES

A. SUMMARY

1. Section includes:
 - a. Exterior and interior, sliding, power-operated automatic entrances.
 - b. Exterior and interior, swinging, power-operated automatic entrances.
 - c. Exterior and interior, low-energy automatic entrances.
2. Aluminum sliding entrance doors are used throughout terminal areas as the primary entry system for passengers and baggage. These doors are integrated into overall curtain wall systems along south facades of Terminals 1 and 2 as well as between interior spaces within all of these buildings.
3. Doors shall be motion activated with key overrides to control passenger entry/exit points during lower use periods of the day.
4. Sliding entry doors currently in Airport installations are subject to many thousands of cycles each day. Consider heaviest duty rating available in terms of life span and cycles. Rails and stiles that frame doors shall measure no less than 5 inches (10 inches at base) in width in order to maintain overall door system stiffness given the tremendous use load.
5. Specify tempered dual glazing to provide thermal and sound transmission resistance necessary for such applications.
6. Final coating applied to aluminum door system parts shall resist effects of prolonged exposure to salt air.

B. MANUFACTURERS

1. Sliding Entrance Door: Stanley, Inc.
2. Norton will not be acceptable.

C. PRODUCTS

1. Sliding Entrance Door: Stanley, "Model 2000" or "Model 3000".

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: For Credit EQ 4.1 (Low Emitting Materials: Adhesives & Sealants): For adhesives and sealants used inside the weatherproofing system, comply with the VOC limits indicated set by South Coast Air Quality Management District (Rule #1168),
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's form in which manufacturer agrees to repair or replace

components of automatic entrances that fail in materials or workmanship within 15 years or other specified warranty period. Failures include, but are not limited to:

- 1) Structural failures including but not limited to, excessive deflection.
- 2) Faulty operation of operators, controls and hardware.
- 3) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

08 71 00 DOOR HARDWARE

A. SUMMARY

1. Section includes commercial door hardware for swinging doors.
2. Coordinate door hardware at identified locations with ACAMS/card swipe/keypad security system in use at SDIA.
3. Coordinate with Department of Facilities Management. Door hardware preferences have been established and shall be observed to allow in-house maintenance to manage replacement stock and keying standards.
4. Kickplates: Leaf type or box type bumpers that maintain a gap between the bumper and the door (subject to impact damage by luggage/supply carts).
5. Provide panic devices of either the type with "interior" actuating rods (inside the door body) or no actuating rods (bar only). Exterior rods have proven to be constant maintenance problem due to damage from impact by luggage/supply carts.

B. MANUFACTURERS

1. Hinges: Hager Companies – no substitutions.
2. Lock Sets and Latch Sets: Schlage – no substitutions.
3. Exit Devices: Von Duprin – no substitutions.
4. Closers: LCN.
5. Plates and Guards: Trimco.
6. Miscellaneous Hardware: Floor stops, wall bumpers, door holders, push-pull units, protection plates, silencers and other miscellaneous hardware:
 - a. Builders Brass Works.
 - b. Pemko Mfg. Co.
 - c. National Guard Products.
 - d. Reese Enterprises, Inc.
 - e. Trimco.
7. Weatherstripping and seals:
 - a. National Guard Products, Inc.
 - b. Pemko Mfg. Co.
 - c. Reese Enterprises, Inc.

C. PRODUCTS

1. Keying Requirements:
 - a. Coordinate keying of cylinder locks with Airport Authority. Keying system shall be approved in writing by the Authority. Furnish construction key system in accordance with lock manufacturer's standard. Where interchangeable core systems are used, use temporary cores for construction keying. Permanently inscribe each key with number that

- identifies cylinder manufacturer key symbol, and notation "Do Not Duplicate".
 - b. Integrate with Airport Authority's existing master-keying system.
 - c. Equip locks with manufacturer's standard [6] pin tumbler cylinders.
 - d. Key Quantity: Furnish five construction keys. Deliver keys to Airport Authority.
 - e. Locks and cylinders shall be of the same manufacturer. Ensure contractor provides permanent cores with FG keyway to Airport Authority. Airport Authority locksmith will perform final keying of permanent cores and keyways.
- 2. Hinges: no substitutions.
 - a. Emergency Doors and SAN Badge Access Points:
 - 1) Hager Companies continuous geared Roton fully concealed, heavy-duty hinge "780-112HD".
 - 2) Provide hinge leaf cutout to accommodate Von Duprin "EPT-10" power transfer device.
 - b. Other: Hager "H-2 Full Mortise Ball Bearing HW BB2168". Provide minimum of three butt hinges for each door except for doors over 7'-6" high, provide one extra hinge for each additional 30 inches of height or fraction thereof.
 - c. Size hinges to keep door leaf clear of walls, casings, jambs or reveals in door openings; furnish wide throw hinges where necessary.
- 3. Lock Sets and Latch Sets series "ND" and "L". Schlage brand is proprietary.
- 4. Locksets: Heavy duty, mortise type. Provide lock and latch sets with not less than 3/4-inch throw for latchbolts and 1 inch throw for dead bolts. Comply with CCR Title 24, Part 2 requirements for throw of bolts and latch bolts on fire-rated openings.
- 5. Strikes: 16 gage curved steel, bronze or brass with 2 inch deep box construction, and lips of sufficient length to clear trim and protect clothing.
- 6. Trim: Provide lever type trim. Levers shall be supported by gun type spring housed within case to prevent sagging. Auxiliary spring mounted in the rose will not be acceptable.
- 7. Exit Devices:
 - a. UL-listed for life safety.
 - b. Conform to NFPA 80 and NFPA 101 requirements.
 - c. Heavy duty, chassis mounting design, with one piece removable covers, eliminating necessity of removing device from door for standard maintenance.
 - d. Trim: Thru-bolted to lock stile case.
 - e. Lever Trim: same as specified with locksets.

- f. Rail Assemblies: Brass or bronze base material, plated to standard architectural finishes, or solid stainless steel.
 - g. Comply with UBC Std.-10-4 and CBC 1003.1.9.
- 8. Closers:
 - a. Model: LCN "4041".
 - b. Specify product of single manufacturer continuity of design and consideration of warranty.
 - c. Heavy duty, surface mounted, hydraulic type, with high strength cast case. Full rack and pinion constructed of heavy steel.
 - d. Size in accordance with manufacturer's recommendations at work site and respective openings.
 - e. Provide adjustable spring power which allows for closer sizing.
 - f. Provide separate tamper resistant, non-critical regulating screw valves for closing speed, latching speed and backcheck control as standard features.
 - g. Closer Arms: Forged steel, interchangeable with all closers specified on a given project; provides for simplification of future Owner maintenance considerations.
 - h. Supply appropriate arm assembly for each closer so that closer body and arm are mounted on non-public side of door opening and on interior side of exterior openings.
 - i. Furnish closers with special application and heavy-duty arms where necessary to provide proper operating, long-lasting opening.
 - j. Provide rectangular, full cover type closers, adjustable power, of non-ferrous, non-corrosive material painted to match lockset finish.
- 9. Plates and Guards:
 - a. Plates: Type 304 stainless steel with No. 4 brushed finish, grain running horizontal direction, and beveled sides. [FMD]
 - b. Kickplates for Doors with Louvers or Narrow Bottom Rails: Provide kick plate height 1 inch less than dimension from door bottom to bottom of louver or glass.
 - c. Kick plates: 10 inches high; mop plates 6 inches high, both by 2 inches or 1 inch less than door width.
 - d. Provide armor plates, edge guards and protective hardware in hard usage areas.
- 10. Miscellaneous Hardware:
 - a. Bumpers, Stops, and Holders: Brass or bronze castings.
 - b. Silencers: Gray rubber of type for use with metal frames.

11. Thresholds:
 - a. Weatherstripping and Seals:
 - 1) National Guard Products, Inc. "Model 99VA".
 - 2) Pemko "Model 217AV".
 - 3) Reese "Model DB596A".
 - 4) Do not use moving sweeps.
 - b. Metal Thresholds: Extruded from 6063-T5 or 6463-T5 alloy and temper aluminum, modified to receive projecting bolts of flush bolts and exit devices.
 - c. Thresholds for Handicapped Accessible Doors: Beveled with slopes not exceeding 1:2 and with heights not exceeding 1/2 inch.
12. Hardware Finishes:
 - a. Satin Stainless Steel 630.
 - b. Provide matching finishes for hardware units at each door or opening, to the greatest extent possible. In general, match items to the manufacturer's standard finish for the latch and lock set (or push-pull units if no latch-lock sets) for color and texture.
 - c. Provide protective lacquer coating on all exposed hardware finishes of brass, bronze, and aluminum.
13. Provide welded joints, butt joints will not be acceptable.
14. Bolts from China will not be acceptable.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Some reuse of door frames may be possible but not to the extent to warrant LEED criteria satisfaction.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

09 30 00 TILING

A. SUMMARY

1. Section includes tile for floor and wall applications.
2. Tiling is used extensively throughout airport facility.
3. Ceramic tiles, including porcelain mosaic, quarry, paver, and wall tiles are used in public areas including concourses, restrooms, concession spaces and exterior walk areas.
4. The majority of tiled areas utilize a full mortar bed with only wall tiling using thin set systems. Full mortar bedding on floors is preferred from a maintenance and safety perspective as it allows for a smoother surface and lessens the potential for cracking.
5. Large expanses of floor and wall tiles may require use of crack isolation hardware including sheet isolators and control joints.
6. Tile types and colors are primarily dependent on desired color scheme.
7. Paver tiles and tiles installed on walkway surfaces exposed to damp conditions including exterior applications and restrooms shall provide adequate, code-required slip resistance for pedestrian safety.
8. Use stain proof epoxy grout that is neutral, darker color (not black) complementary to the tile. [IDS]
9. Specify penetrating sealer for floor installations. [IDS]
10. Specify anti-fracture and waterproof membrane below tile at existing floor control joints and cracks for floor installations. [IDS]
11. Joints shall be no more than 1/4-inch for floor installations. [IDS]
12. For wall installations in public restrooms, specify full height on every wall and specify cove base. [IDS]
13. For wall installations in employee restrooms, wall tile shall extend to minimum height of 6 feet. [Perf Specs]
14. Ensure there are no pores or ridges that will collect dirt and make maintenance difficult. [IDS]

B. MANUFACTURERS

1. Porcelain Tile: Daltile Corporation.
2. Epoxy Grout: Custom Building Products.
3. Grout Sealer:
 - a. DuPont.
 - b. Ashland Chemical Co.
 - c. Porter Paints.

C. PRODUCTS

1. Ensure products comply with applicable American National Standards Institute (ANSI) and Tile Council of America (TCA) standards.

2. Porcelain Tile: ANSI A137.1, and as follows:
 - a. Size: Minimum 8 inches by 8 inches on all main field tile; restrooms shall not be smaller than 6 inches by 6 inches.
 - b. Surface Finish at Walls: Glazed and/or unglazed.
 - c. Surface Finish at Floors: Unglazed and slip-resistant with Static Coefficient of Friction equal to or exceeding 0.6 wet at level surfaces as determined by testing identical products, ASTM C 1028.
 - d. Edges: Cushioned at walls and square at floors.
 - e. Trim Units: Coordinated with size and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile.
 - f. Trim Unit Shapes: Select from manufacturer's standard shapes:
 - 1) Base for Portland Mortar Installations: Coved.
 - 2) External Corners for Portland Mortar Installations: Bullnose shape with radius of at least 3/4-inch.
 - 3) Internal Corners: Field-butt square corners, except with coved base and cap angle pieces designated to member with stretcher shapes.
3. Do not use mosaic tiles less than 2 inches in size (on floors or walls). [FMD].

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives and sealants shall not exceed the VOC limit of 65 g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1].
 - b. Recycled content shall meet or exceed specific thresholds:
 - 1) LEED NC v2.2 MR Credit 4.1: 10 percent post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent post-consumer materials, (including 1/2 percent pre-consumer materials).
 - c. Extraction, processing and manufacture of tile may contribute to LEED v2.2 MR Credit 5.1 and 5.2 credits, Regional Materials.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Tile is extremely durable and requires little maintenance.

- 2) Porcelain floor shall have minimum of 30 years functional service life. [Perf Specs]
- b. Operational:
 - 1) Maintenance: If installed properly and sealed thoroughly with high traffic grade sealant, maintenance for tile floors will be limited to regular cleaning and waxing. Consider more resilient surfaces in areas subject to excessively heavy cart loads as such areas are prone to cracking. Develop program that uses sustainable cleaning agents.
 - 2) Extra Materials: Specify extra materials of each type, composition, color, pattern, and size of tile and grout be delivered at completion of a project. Coordinate desired quantities with Authority's Facilities Management Department.
- c. Natural Resource: Mining raw materials (clay, silica, talc, feldspar, and limestone) for tile produces soil erosion, pollutant runoff, and habitat loss.

09 30 33 STONE TILING

A. SUMMARY

1. Section includes stone tiling for floor installations.
2. Stone tiles and natural stone flooring are used in public areas including concourses and exterior walk areas. However, natural stone should not be placed in areas subject to heavy foot traffic.
3. The majority of stone tiled areas utilize full mortar bed with only wall tiling using thin set systems. Full mortar bedding on floors is preferred from maintenance and safety perspectives as it allows for a smoother surface and lessens the potential for cracking.
4. Natural stone should not be used in areas that are subject to impact damage and heavy loads as replacement is significantly more difficult than with ceramic tiling products. These areas may be better served by a more resilient surface or a ceramic tile product.
5. Large expanses of floor tiles may require crack isolation hardware including sheet isolators and control joints.
6. Tile types and colors will be dependent on desired color scheme.
7. Typical natural stone choices include granite, limestone, and marble.
8. Consider texture with stone finishing. When used in passenger areas, smoother finishes may be preferable to avoid catching clothing and to facilitate easier cleaning.
9. Stone flooring shall have minimum compression strength of 16,000 psi., with minimum abrasion resistance index of 30 in heavy traffic, open area public spaces. [IDS]
10. Stone paver tiles exposed to damp conditions including exterior applications shall provide adequate, code-required slip resistance for pedestrian safety. Do not use polished surfaces in areas exposed to wet conditions such as food courts, beverage service areas and building entrances. [IDS]
11. Specify specialized techniques for natural stone flooring installation such as orientation detailing and color variation tolerances.
12. Coordinate joint layout and location of expansion joints with adjacent finishes. [IDS]
13. Joints shall no greater than 1/8-inch thick nominal maximum, equal in all directions, if possible. [IDS]
14. Specify penetrating sealer for floor installations. [IDS]
15. Specify anti-fracture membrane below tile at existing floor control joints and cracks for floor installations. [IDS]
16. Ensure there are no pores or ridges that will collect dirt and make maintenance difficult. [IDS]

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. Specify products in accordance with applicable American National Standards Institute (ANSI) and Tile Council of America (TCA) standards.
2. Granite: ASTM C 615.
3. Finish: Provide Static Coefficient of Friction equal to or exceeding 0.6 wet at level surfaces as determined by testing identical products per ASTM C 1028.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives and sealants shall not exceed the VOC limit of 65 g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1].
 - b. Extraction, processing and manufacture of stone if possible may contribute to LEED v2.2 MR Credit 5.1 and 5.2 credits, Regional Materials.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Tile is extremely durable and requires little maintenance.
 - b. Operational
 - 1) Maintenance: If installed properly and sealed thoroughly with high traffic grade sealant, maintenance for tile floors will be limited to regular cleaning and waxing. Consider more resilient surfaces in areas subject to excessively heavy cart loads as such areas are prone to cracking. Develop program that uses sustainable cleaning agents.
 - 2) Extra Materials: Specify extra materials of each type, composition, color, pattern, and size of tile and grout be delivered at completion of a project. Coordinate desired quantities with Facilities Management Department.
 - c. Natural Resource: Mining raw materials (clay, silica, talc, feldspar, and limestone) for tile produces soil erosion, pollutant runoff, and habitat loss.

09 51 13 ACOUSTICAL CEILINGS

A. SUMMARY

1. Acoustical ceiling panels and grids provide decorative and sound absorption elements and can be widely used in terminals and other public areas. Metal or fabric acoustical panels are beneficial in high ceiling spaces to control ambient noise levels and are useful in concealing mechanical ductwork and in mitigating air flow noise.
2. Suspended metal ceilings and decorative grids can effectively, visually “shrink” a space to provide sense of enclosure without the need for walls in a large space such as food service areas in a larger concourse space (e.g., Terminal 2 West). The ceiling shall be aesthetically complementary to the ceilings in the existing Terminal 2 West. [Perf Specs]
3. Linear metal ceilings are an alternative to panels or grids and provide visual interest as well as conceal mechanical and lighting equipment. Unlike acoustical options, metal ceilings do not provide significant sound dampening unless used in conjunction with other systems. Metal ceilings may require special finish coatings in high humidity areas to prevent discoloration and rusting.
4. Metal ceiling panels shall have continuous acoustical backing. [IDS]
5. Metal ceiling panels shall not be reflective or have a mirrored surface. [IDS]
6. Regardless of suspended ceiling system type, provide structural analysis to verify load being carried and capacity of supporting structure to support that load.
7. Fabric panels shall comply with minimum fire spread and smoke standards.
8. Provide ceilings that are easily accessible without use of special tools or without damage to the ceiling system or finish. [Perf Specs]

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. No preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Paints, Adhesives and sealants shall not exceed applicable VOC limits. [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1].
 - b. Recycled content shall meet or exceed specific thresholds:

- 1) LEED NC v2.2 MR Credit 4.1: 10 percent post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent¹ post-consumer materials, (including 1/2-percent pre-consumer materials).
 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Minimum service life span of 15 years. [PerfSpecs]
 - b. Operational:
 - 1) Maintenance: Consider cleaning and maintenance requirements (dusting, fading), as such panel systems are often suspended in locations that limit access.
 - 2) Extra Materials: Provide each type, composition, color, pattern and size of product for stock at the completion of the project. Coordinate desired quantities with Authority's Facilities Management Department.
 - c. Natural Resource:
 - 1) Reclamation: Manufacturer shall provide reclamation program for used product, potentially including zero contributions to landfills.
 - 2) Steel framing and panels containing recycled steel content is available.

09 51 23 ACOUSTICAL PANEL CEILINGS

A. SUMMARY

1. Section includes acoustical ceiling panels and exposed suspension systems for ceilings.
2. Suspended acoustical tile ceilings are used extensively in public areas, office suites, ticketing areas, low ceiling areas including soffits, ramp support spaces, baggage claim areas, corridors, and similar.
3. The established standard at the Airport is a 24-inch by 24-inch tile; style will be dependent on aesthetic design scheme proposed for each individual project.
4. Acoustic ceilings require special cleanable finish coatings when located in food service areas as required by health department guidelines. Comply with minimum fire spread and smoke standards.
5. Supporting grid system installation shall observe structural guidelines for vertical load bearing capacity and seismic restraint criteria. Ceiling tiles may be directly applied to ceiling substrate with adhesives.

B. MANUFACTURERS

1. Armstrong, Inc.
2. Chicago Metallic, Inc.
3. USG Corporation.

C. PRODUCTS

1. Suspension System: ASTM C 635, Heavy Duty, electro-galvanized or bonderized steel, 1-11/16-inch deep runners and cross tees, nominal 15/16-inch face, manufacturer's standard white enamel finish; with minimum 10 percent¹ pre-consumer recycled content or 40 percent post-consumer recycled content.
2. Acoustical Panels:
 - a. Recycled Content of Acoustical Panels: Minimum 10 percent pre-consumer recycled content or 40 percent post-consumer recycled content.
 - b. Type 1: USG "Millennia ClimaPlus 96907, 24-inch by 24-inch by 3/4-inch mineral fiberboard complying with ASTM E 1264, Type III, Form 1, Pattern E, G; UL Class A, flame spread rating 25 or less; NRC: .70; color: white; and shadowline tapered (SLT) edges.
 - c. Type 2: 24-inch by 48-inch by 3/4-inch mineral base with membrane-faced overlay: Type IV, Form 1; flame spread rating 25 or less; LR: 0.65; color: white; with washable vinyl-film overlay and square edges.
 - d. Type 3: 24-inch by 48-inch by 3/4-inch mineral fiber board complying with ASTM E 1264, UL Class A,

flame spread rating 25 or less; NRC: .70; color: white.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives and sealants shall not exceed applicable VOC limits. [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1]
 - b. Recycled content shall meet or exceed specific thresholds:
 - 1) LEED NC v2.2 MR Credit 4.1: 10 percent post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent post-consumer materials, (including 1/2-percent pre-consumer materials).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Minimum service life span of 15 years. [Perf Specs]
 - b. Operational:
 - 1) Maintenance: Consider cleaning and maintenance requirements (dusting, fading), as such panel systems are often suspended in locations that limit access.
 - 2) Extra Materials: Provide each type of acoustical panels and suspension components, composition, color, pattern and size of tile and grout for stock at completion of the project. Coordinate desired quantities with Authority's Facilities Management Department.

09 64 00 WOOD FLOORING

A. SUMMARY

1. Wood flooring is in use primarily in club rooms, food service areas, and concession spaces.
2. Wood flooring can be labor intensive in terms of maintenance, depending on traffic loads. Consider solid wood strip or plank flooring in hardwood varieties for wear and damage resistance, however limit to areas not directly part of the main path of pedestrian travel.
3. Provide field finished flooring as it will prove to be a better performing product as opposed to factory-finished or engineered products as the latter are not intended for extra heavy use and will not accept field applied protective coatings.
4. Specify vapor barriers for installations of wood flooring on top of concrete substrates, to prevent water damage.
5. Wood flooring installation requires specialized techniques such as orientation detailing and color variation tolerances that shall be included in the specifications.

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. No preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives and sealants shall not exceed the VOC limit of 100 g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1].
 - b. Extraction, processing and manufacture of wood if possible may contribute to LEED v2.2 MR Credit 5.1 and 5.2 credits, Regional Materials.
 - c. For composite wood products, provide documentation indicating that bonding agent contains no added urea formaldehyde.
 - d. Encourage environmentally responsible forest management and use minimum of 50 percent of wood-based materials and products, which are certified in accordance with the Forest Stewardship Council's (FSC) principles and criteria. Contributes to LEED v2.2 MR Credit 7.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Minimum service life span of 30 years [PerfSpecs]
 - b. Operational:

- 1) Specify adequate amounts of extra material for future repairs as color matching will be an issue.
 - 2) Avoid wood floor finishes that are solvent-based polyurethanes. Water-based polyurethanes contain mostly aliphatic hydrocarbons instead of the mostly carcinogenic aromatic hydrocarbons found in solvent-based finishes. Other alternatives include waxes and citrus-based finishes.
- c. Natural Resource: Wood flooring manufactured from reclaimed lumber from alternative species is available. Bamboo, for example, is a fast-growing grass that can be finished into hardwood flooring.

09 65 00 RESILIENT FLOORING

A. SUMMARY

1. Section includes:
 - a. Resilient base.
 - b. Resilient stair accessories.
 - c. Resilient molding accessories.
 - d. Vinyl sheet floor covering.
 - e. Rubber sheet floor covering.
 - f. Solid vinyl floor tile.
 - g. Rubber floor tile.
 - h. Vinyl composition floor tile.
2. Resilient flooring is used extensively in office areas, maintenance and storage areas, food service areas, ramp support spaces, maintenance shops, mechanical rooms, and jet bridge areas. Resilient flooring requires relatively little maintenance and is easily repaired in the event of tears from furniture, impact, and other damage.
3. Sheet vinyl products are used in wet areas and food service areas as they are effective in controlling liquid spills and are easily cleaned.
4. Vinyl composition floor tile, like sheet type flooring, shall be adhesive applied to allow for simple installation, easy repair or replacement, and low maintenance requirements.
5. Resilient wall base is used in virtually every space of the airport in conjunction with a wide variety of floor finishes including carpet, vinyl flooring, and bare concrete. Resilient flooring materials, particularly rubber, can be used on stair treads and will provide code-required tactile warning features.
6. Developed for use in electronics and computer rooms, static control resilient flooring is made of specially formulated vinyl or rubber that retards the buildup of static electricity and limits electrical resistance to within an established range. This system can employ static dissipative or conductive wiring below the flooring that connects to a grounding point. The FAA requires such flooring, including static dissipative carpeting, in all ATC data and electronics rooms including control tower cabs. Such use in Airport IT and electronics rooms is recommended.

B. MANUFACTURERS

1. Jet Bridges: Nora Systems Inc.
2. No other preferred manufacturers have been identified.

C. PRODUCTS

1. Do not use linoleum.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives, adhesive primers and sealants shall have no VOC or shall not exceed the VOC limit of 60g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED NC v2.2 EQ Credit 4.1]
 - b. Recycled content shall meet or exceed specific thresholds:
 - 1) LEED NC v2.2 MR Credit 4.1: 10 percent post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent post-consumer materials, (including 1/2-percent pre-consumer materials).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Minimum service life span of 30 years functional life span [PerfSpecs]
 - 2) Rubber flooring is extremely hard-wearing and flame-retardant.
 - b. Operational:
 - 1) No waxes are required to maintain rubber floors.
 - 2) Antistatic and chemically resistant rubber flooring is available.
 - c. Natural Resource: Natural rubber is a renewable raw material that is extracted from tropical rubber plant sap and is recyclable product.

09 66 00 TERRAZZO FLOORING

A. SUMMARY

1. Terrazzo flooring may be fluid applied or precast units and is desirable for use in concourses, baggage claim areas, and other high traffic areas.
2. Fluid applied flooring provides large expanses of seamless flooring which may be preferable in large open spaces where joint repetition and seams are not desired.
3. Provide colored admixtures and solid color chips to achieve particular colors or visual depth.
4. Lay precast units in mortar bed similar to traditional tile.
5. In high profile areas, pre-fabricated logos and graphics can be cast into the floor when poured in the field.
6. Terrazzo flooring systems require a structural concrete underbed. Coordinate design of the underbed with structural engineers.

B. MANUFACTURERS

1. DalTile.
2. Wausau Tile.

C. PRODUCTS

1. Finish: No wax shall be used. [FMD]

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Recycled content shall meet or exceed specific thresholds:
 - a. LEED NC v2.2 MR Credit 4.1: 10 percent¹ post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2-percent pre-consumer materials).
 - b. LEED NC v2.2 MR Credit 4.2: 20 percent¹ post-consumer materials, (including 1/2-percent pre-consumer materials).
 - c. Floor coatings and sealers applied to interior elements shall not exceed VOC content limit established by in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, in effect on January 1, 2004. (Floor coatings: 100g/L; Waterproofing sealers: 250 g/L; All other Sealers: 200 g/L).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Minimum service life span of 30 years [PerfSpecs]
 - 2) Terrazzo flooring is very durable and has a long life span under heavy traffic but may be labor intensive with respect to maintenance.

- b. Operational: Specify extra material for future repairs as color matching will be an issue. Coordinate desired quantities with Authority's Facilities Management Department.
- c. Natural Resource:
 - 1) Mining raw materials (marble, granite, quartzite, quartz, silica pebbles, sand, and components of Portland cement) produces soil erosion, pollutant runoff, and habitat loss.
 - 2) Terrazzo aggregate can contain recycled glass stone and glass aggregate.

09 67 23 RESINOUS FLOORING

A. SUMMARY

1. Section includes decorative resinous flooring systems.
2. Resinous flooring is a fluid applied, viscous material, for use in a variety of spaces including concourses, baggage claim areas, and other high traffic areas, storage and maintenance rooms, restrooms, and areas subject to heavy loads, impacts, and chemical spills.
3. Resinous flooring provides large expanses of seamless flooring which may be preferable in large open spaces where joint repetition and seams are not desired.
4. Adjust constituent components of flooring mix to provide varying degrees of hardness and flexibility characteristics.
5. Provide colored admixtures and solid color chips to achieve any particular color or visual depth.
6. Resinous flooring systems require a clean concrete underbed. Design of resinous flooring systems requires coordination with structural engineer if located on an upper floor and not on a slab on grade.

B. MANUFACTURERS

1. Arizona Polymer Flooring, Inc.
2. Atlas Minerals & Chemicals, Inc., Polymer Flooring Division.
3. ChemMasters.
4. Crawford Laboratories, Inc.
5. Crossfield Products Corp., Dex-O-Tex.
6. Dur-A-Flex Inc.
7. General Polymers Corporation, division of the Sherwin-Williams Company.
8. Key Resin Company.
9. Pacific Polymers, Inc.
10. Tamms Industries, Inc.

C. PRODUCTS

1. Abrasion-, impact- and chemical-resistant, decorative-aggregate-filled, epoxy-resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base.
2. Characteristics:
 - a. Color and Pattern: to be selected from manufacturer's full range; match existing unless otherwise directed.
 - b. Wearing surface: provide slip coefficient of 0.6 minimum for anticipated life of product.
 - c. Integral cove base: 6 inches high.
 - d. Overall system thickness: match existing unless otherwise directed; provide maximum depth possible.

3. System components:
 - a. Provide resinous flooring system using manufacturer's standard compatible components.
 - b. Body coat: epoxy-resin; formulation shall match existing; self-leveling slurry with broadcast aggregates.
 - c. Primer: Type recommended by manufacturer for substrate and body coats indicated.
 - d. Waterproofing Membrane: Type recommended by manufacturer for substrate and body coats indicated.
 - e. Reinforcing Membrane: Manufacturer-recommended flexible resin formulation for substrate and primer and body coats that prevent substrate cracks from reflecting through resinous flooring. Provide fiberglass scrim embedded in reinforcing membrane.
 - f. Topcoat: Two coats minimum epoxy-resin product; formulation, type and finish shall match existing; UV resistant. Provide antimicrobial formulation if in food preparation area.
4. Accessories:
 - a. Patch and Fill material: resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
 - b. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Although resinous epoxy flooring is not specifically identified in LEED NC v2.2 as a material, this system could potentially qualify under EQ Credit 4.2, Low-Emitting Materials Paints and Coatings, as a floor coating.
 - b. Floor coatings and sealers applied to interior elements shall not exceed the VOC content limit established by in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, in effect on January 1, 2004. (Floor coatings: 100g/L; Waterproofing sealers: 250 g/L; All other Sealers: 200 g/L.)
 - c. Provide documentation of VOC content and chemical components for resinous flooring system [LEED NC v2.2 EQ Credit 4.2]. Include cut sheets, material safety data sheets (MSD sheets), certificates and test reports.
 - d. Provide documentation of VOC content for floor sealers and other related installation accessories

- [LEED NC v2.2 EQ Credit 4.2]. Include cut sheets, material safety data sheets (MSD sheets), certificates and test reports.
 - e. EPA: Resinous flooring system components and related installation accessories shall not exceed VOC content limit of 100g/L (less water) [when calculated according to 40 CFR 59, Subpart D (EPA Method 24)].
 - 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Minimum service life span of 30 years. [PerfSpecs]
 - 2) Extremely durable for high traffic installations such as hold rooms and concourses.
 - b. Operational:
 - 1) Maintenance: Develop and document cleaning program that identifies regular cleaning intervals and appropriate cleaning methods and sustainable cleaning agents.
 - 2) Develop, document, and provide training, including manuals, for in-house staff or contract out for cleaning and repair services.

09 68 00 CARPETING

A. SUMMARY

1. Section includes heavy duty commercial grade:
 - a. Broadloom carpet (also known as rolled carpet).
 - b. Modular carpet (also known as carpet tile).
 - c. Carpet backing.
2. Carpet is installed throughout the Airport in gate holdrooms, club rooms, offices, administration areas, and concession spaces.
3. Carpet is installed to provide sound dampening, to define spaces within a larger area, and to reflect tenants' corporate color schemes and branding.
4. Broadloom carpet is preferred form in public spaces and can cover large expanses of floor with minimal seaming. Damage primarily occurs from abrasion at seams and from staining.
5. Modular carpet performs best in smaller spaces and in non-public "back-of-house" spaces where damage primarily occurs from impact and from staining. Carpet tiles can be repaired one tile at a time.
6. Scuff Daddy preferred at checkpoints [confirm with SDIA]

B. MANUFACTURERS

1. Carpet:
 - a. Mohawk.
 - b. Milliken.
 - c. Shaw.
2. Carpet backing: Dow Chemical Company
3. Carpet fibers: Invista
4. Edge strips:
 - a. Mercer Plastics Company, Inc.
 - b. Johnson Rubber Company.
 - c. Flexco Corporation.

C. PRODUCTS

1. Broadloom carpet: 12-foot rolls
2. Modular carpet: 36-inch square tiles
3. Carpet fibers: 100 percent nylon 6,6 (with cylindrical construction); stain resistant
4. Carpet backing: Polyurethane; with replacement anticipated every 8 to 12 years.
 - a. Dow Polyurethane Attached Cushion Technology in modular or broadloom.
 - b. Moisture barrier – pass British Spill Test
 - c. Edge ravel – minimal
 - d. Breathability – open cell construction required
 - e. Delamination – none; use of Dow Enhancer Technology to eliminate delamination.
 - f. Do not use:

- 1) PVC backing due to off-gassing, smoke density, tendency to breakdown, closed cell structure causing lack of breathability, adhesive problems, moisture problems.
 - 2) Latex backing due to lack of moisture barrier, water solubility, difficulty removing stains entirely; replacement anticipated to be required every 3 to 5 years.
 - 3) Shaw Ecobacking until industry use indicated durability.
5. Adhesives: Premium, multipurpose, water-resistant, mildew resistant, non-staining, pressure sensitive, recommended by carpet tile manufacturer for releasable installation.
6. Edge strips: solid vinyl from standard products and colors.
7. Trowelable leveling and patching compound: premix latex provided by or recommended by carpet manufacturer.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives, adhesive primers and sealants shall have no VOC or shall not exceed the VOC limit of 50g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED NC v2.2 EQ Credit 4.1]
 - b. Carpet shall be certified to meet or exceed testing and product requirements of Carpet and Rug Institute's (CRI) Green Label Plus Program [LEED NC v2.2 EQ Credit 4.3]; independent test report showing compliance is acceptable in lieu of labeled product.
 - c. Carpet cushion shall be certified to meet or exceed testing and product requirements of CRI's Green Label Program [LEED NC v2.2 EQ Credit 4.3]
 - d. Recycled content shall meet or exceed specific thresholds:
 - 1) LEED NC v2.2 MR Credit 4.1: 10 percent post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2 percent pre-consumer materials)
 - 2) LEED NC v2.2 MR Credit 4.2: 20 percent post-consumer materials, (including 1/2 percent pre-consumer materials)
 - e. Certification by NSF/ANSI STANDARD 140-2007: a system with varying levels of certification to define sustainable carpet, certification level TBD (Silver, Gold/EPP, or Platinum/EPP levels); establishes performance requirements for public health and environment, and economic-environmental-social considerations throughout the

- supply chain, focused on multiple attributes over the entire life cycle of the product.
 - f. Smoke density to meet CRI standards and NSF/ANSI 140-2007e.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) Minimum service life span of 15 years. [PerfSpecs]
 - 2) In high traffic installations such as hold rooms and concourses, carpet is anticipated to have a shorter than normal useful life, every 5 years. However, polyurethane backing and nylon fibers have the longest life expectancy when compared to other carpet products.
 - b. Operational:
 - 1) Warranties: Warranties vary. Installation partnering improves warranty and longevity of carpet.
 - 2) Maintenance: Regular and appropriate cleaning. Hot extraction cleaning can be used on carpet with polyurethane backing.
 - 3) Training: Provide training for in-house staff or contract out for cleaning and repair services. Develop program that uses sustainable cleaning agents.
 - 4) Extra Materials: Provide materials of each type of carpet for stock at completion of project. Coordinate desired quantities with Authority's Facilities Management Department.
 - c. Natural Resource: Carpet mill shall provide reclamation program for used carpet, potentially including zero contributions to landfills.

09 69 00 ACCESS FLOORING

A. SUMMARY

1. Provide access flooring for use in data and server rooms as well as communications centers to allow cabling to run below finished floor and avoid runs of cable across floors and down through ceilings. Access flooring allows cabling to be organized and secured within a hidden area below the floor and provides a plenum for ventilation and cooling of sensitive electronic equipment.
2. Often raised above floor level of surrounding floors in adjacent areas, access flooring systems employ a ramp and stair system to provide access to the finished floor height.
3. Finished floor materials applied to access floors can vary from carpeting tiles, resilient flooring such as vinyl or rubber, or static dissipative materials.
4. Access flooring requires load analysis by designing structural engineers. Calculations derived from this analysis are normally required by local building authorities.

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. No preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. VOC ratings of adhesives and sealants used for pedestals and finish tiles.
 - b. For particleboard used in steel-encapsulated, wood core panels, provide documentation indicating that particleboard contains no urea formaldehyde.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Minimum service life span of 30 years [PerfSpecs]
 - b. Operational: Specify extra material for future repairs as color matching will be an issue. Coordinate desired quantities with Authority's Facilities Management Department.

09 72 00 WALL COVERINGS

A. SUMMARY

1. Section includes:
 - a. Vinyl wall covering.
 - b. Woven glass-fiber wall covering..
 - c. Textile wall covering.
 - d. Wallpaper.
2. Wall coverings are generally not preferred because of the tendency to peel, discolor, and require more frequent repair/replacement when compared to painting such surfaces.
3. Concession areas and food courts may employ wall coverings as part of tenants' branding and color schemes.
4. Paint has proven to be a more durable wall finish.

B. MANUFACTURERS

1. Vinyl wall covering: No preferred manufacturers have been identified.
2. Woven glass-fiber wall covering: No preferred manufacturers have been identified.
3. Textile wall covering: Carnegie. [IDS]
4. Wallpaper: No preferred manufacturers have been identified.

C. PRODUCTS

1. Vinyl wall covering: No preferred products have been identified.
2. Woven glass-fiber wall covering: No preferred products have been identified.
3. Textile wall covering:
 - a. Carnegie: Xorel [IDS].
 - b. Xorel is woven from polyethylene and contains no chlorine, plasticizers, heavy metals, harmful dyes, or ozone depleting chemicals.
 - c. Fabrics are easily maintained, flame retardant, stain resistant, odorless, safely disposable, and contain extremely low VOCs.
 - d. Xorel achieved MBDC Cradle to Cradle Silver certification, earned SCS Indoor Air Advantage certification, and is GreenSpec Listed.
 - e. Other polyethylene products may be used but must be approved prior. [IDS]
4. Wallpaper: No preferred products have been identified.
5. Do Not Use Acrovyn, by Construction Specialties; this is not an acceptable material for public areas. [IDS]

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Adhesives, sealants and sealant primers shall not exceed following VOC

content limits [established per South Coast Air Quality Management District (SCAQMD) Rule #1168, as replicated in LEED NC v2.2 EQ Credit 4.1].

- a. Multipurpose Construction Adhesives: 70g/L (less water)
 - b. Porous Material (except wood): 50g/L (less water)
 - c. Contact Adhesive: 80g/L (less water)
 - d. Special Purpose Contact Adhesive: 250g/L (less water)
 - e. Top & Trim Adhesive: 250g/L (less water)
 - f. Architectural Sealants: 250g/L (less water)
 - g. Other Sealants: 420g/L (less water)
 - h. Architectural Non Porous Sealant Primers: 250g/L (less water)
 - i. Architectural Porous Sealant Primers: 775g/L (less water)
 - j. Other Sealant Primers: 750g/L (less water)
 - k. General Purpose Mist Spray Aerosol Adhesives: 65 percent VOCs by weight (g/L minus water)
 - l. General Purpose Web Spray Aerosol Adhesives: 55 percent VOCs by weight (g/L minus water)
 - m. Special Purpose Aerosol Adhesives (all types): 70 percent VOCs by weight (g/L minus water)
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
- a. Economic:
 - 1) Warranties: Seven year performance warranty.
 - 2) Life Span: 15 years
 - b. Operational:
 - 1) Maintenance: Use cleaning methods per manufacturer.
 - 2) Extra Materials: Specify adequate amount of extra material for future repairs as color matching will be an issue. Coordinate desired quantities with Authority's Facilities Management Department.
 - c. Natural Resource:
 - 1) Reclamation: When Carnegie's Xorel Fabrics are ready for disposal, they can be incinerated without emitting hazardous gases and are an energy producing source in waste burning plants. If placed in a landfill, Xorel will not harm groundwater.
 - 2) Wall Coverings manufactured from cotton, sustainably harvested wood, and natural materials such as sisal, jute, straw, and wool are available.
 - d. Natural Resources – Fabrics, plastics, and paper wall coverings all have unique potential chemical content and emission characteristics. Avoid vinyl

wall coverings due to the PVC (polyvinyl chloride) content.

09 75 00 STONE FACING

A. SUMMARY

1. This section includes:
 - a. Wall paneling.
 - b. Wainscot paneling.
 - c. Column facing.
 - d. Window stools.
 - e. Base.
 - f. Trim.
 - g. Benches.
2. Stone wall facing commonly includes varieties of granite, cut stone, marble, travertine, slate, and often locally originated materials unique to a given area.
3. Stone is a very durable material and can provide dramatic effects for public spaces as evidenced in Terminal 2 West in the main hall and ticketing areas.
4. Similar stone facing may well be a future key design component continuing the already established visual theme.
5. Due to its inherent weight, stone facing usually demands that engineered bearing walls be erected as a mounting substrate.
6. Installation and repair of stone facing may require specialized contractors.
7. Only polished granite natural stone or other stone of equal hardness shall be acceptable at walls subject to impact from pedestrian traffic and baggage carts. The durable finish shall extend to a wainscot height of 4 feet or it shall be carried to a height of 8 feet. [Perf Specs] For wall installations in restrooms, provide full height on every wall. [IDS]
8. Large expanses wall tiles may require crack isolation hardware including sheet isolators and control joints.
9. Joint layout and location of all expansion joints shall be coordinated with all adjacent finishes. [IDS]
10. Joints shall no greater than 1/8" thick nominal maximum, equal in all directions, if possible. [IDS]
11. Shall not have pores or ridges that collect dirt and make maintenance difficult. [IDS]
12. Installation and repair of stone facing requires specialized contractors.

B. MANUFACTURERS

1. No preferred manufacturers or quarries have been identified.

C. PRODUCTS

1. Granite, complying with ASTM C 615.

2. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
3. Finish: Flamed or polished.
4. Description: Uniform, fine to medium-grained stone with only slight veining.
5. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Adhesives and sealants shall not exceed VOC limit of 65 g/L (less water). [South Coast Air Quality Management District (SCAQMD) Rule #1168 as replicated in LEED v2.2 EQ Credit 4.1]
 - b. Extraction, processing and manufacture of stone if possible may contribute to LEED v2.2 MR Credit 5.1 and 5.2 credits, Regional Materials.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Maintenance: While quite labor intensive during installation, stone facing requires little regular care over its life span. Develop program that uses sustainable cleaning agents.
 - 2) Extra Materials: Provide extra materials of each type, composition, color, pattern and size of stone tile and grout for stock at the completion of the project. Coordinate desired quantities with Authority's Facilities Management Department.
 - 3) Specify installer qualifications as well as sourcing limitations of stone material to maintain consistent color and stone type.
 - b. Natural Resource: Mining raw materials (clay, silica, talc, feldspar, and limestone) for tile produces soil erosion, pollutant runoff, and habitat loss.

09 77 23 FABRIC WRAPPED PANELS

A. SUMMARY

1. Section includes:
 - a. Stretched fabric wall systems.
 - b. Stretched fabric ceiling systems.
2. Fabric panel systems represent a flexible, functional option to traditional wall covering types. Fabric panels are stretched material on a sound absorptive or tack able substrate that are often used in auditoriums, conference rooms, office suites, and training classrooms. Manipulating the amount of wall covered as well as the panel thickness will allow for a significant sound dampening quality in spaces where low noise levels are critical.
3. When incorporating special high density backer boards, fabric wrapped panels serve a dual role as tack boards in presentation and training areas and are well suited in administrative office suites, conference rooms, and similar applications in training rooms.
4. These panels are not well suited in areas prone to damage or areas serving the public.
5. As a ceiling mounted feature, mount fabric panels in high ceiling areas as a sound dampening or purely aesthetic device. Suspended rigid frames will conceal mechanical or electrical equipment in exposed ceiling areas and help deaden air noise in ductwork.
6. Use suspended panels to direct airflow across large open volumes reducing the amount of expensive ductwork required to adequately condition a large space.
7. Installation and repair of fabric wall systems requires specialized contractors. Ensure specifications include provisions for installer qualifications.

B. MANUFACTURERS

1. Stretched fabric wall systems:
 - a. Knoll.
 - b. Walltalkers.
 - c. Carnegie. [IDS]
 - d. Snap-Tex International. [IDS]
2. Stretch fabric ceiling systems: Snap-Tex International. [IDS]

C. PRODUCTS

1. Stretched fabric wall systems:
 - a. Knoll: No identified product.
 - b. Walltalkers: No identified product.
 - c. Carnegie: Xorel [IDS] – Xorel is woven from polyethylene and contains no chlorine, plasticizers, heavy metals, harmful dyes, or ozone depleting

- chemicals. Fabrics are easily maintained, flame retardant, stain resistant, odorless, safely disposable, and contain extremely low VOCs. Furthermore, Xorel achieved MBDC Cradle to Cradle Silver certification, earned SCS Indoor Air Advantage certification, and is GreenSpec Listed.
- d. Snap-Tex International: Snap-Tex Stretched Fabric, Acoustical Panel System [IDS] – Site fabricated, stretched fabric acoustical wall panel system consists of rigid, noncombustible PVC fabric mounting and tensioning tracks. Snap-Tex system accepts virtually any fabric type and color, including extra wide Ameri-Span Fabrics, with a few suggested restrictions. Fabric is stretched under high tension, not glued to substrate. Track can easily be re-opened for fabric cleaning or fabric replacement. Acoustical panel core typical materials (accessories) include semi-rigid fiberglass, tackable rigid fiberglass, tackable rigid fiberboard, fire retardant compressible polyester batt, reflective substrate, and diffusive substrate.
 2. Stretch fabric ceiling systems: Snap-Tex International: Snap-Tex Stretched Fabric, Acoustical Ceiling System [IDS] – Site fabricated, stretched fabric acoustical ceiling system consists of rigid, noncombustible PVC fabric mounting and tensioning tracks (rigid wood or metal frame work if suspended). Snap-Tex system accepts virtually any fabric type and color, including Special Snap-Span Fabric, with a few suggested restrictions and must be approved by manufacturer. Fabric is stretched under high tension, not glued to substrate. Track can easily be re-opened for fabric cleaning or fabric replacement. Acoustical panel core typical materials (accessories) include semi-rigid fiberglass, reflective substrate, and diffusive substrate.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. All adhesives, sealants and sealant primers shall not exceed the following VOC content limits [established per South Coast Air Quality Management District (SCAQMD) Rule #1168, as replicated in LEED NC v2.2 EQ Credit 4.1]
 - 1) Multipurpose Construction Adhesives: 70g/L (less water)
 - 2) Porous Material (except wood): 50g/L (less water)
 - 3) Contact Adhesive: 80g/L (less water)
 - 4) Special Purpose Contact Adhesive: 250g/L (less water)
 - 5) Top & Trim Adhesive: 250g/L (less water)

- 6) Architectural Sealants: 250g/L (less water)
 - 7) Other Sealants: 420g/L (less water)
 - 8) Architectural Non Porous Sealant Primers: 250g/L (less water)
 - 9) Architectural Porous Sealant Primers: 775g/L (less water)
 - 10) Other Sealant Primers: 750g/L (less water)
 - 11) General Purpose Mist Spray Aerosol Adhesives: 65 percent VOCs by weight (g/L minus water)
 - 12) General Purpose Web Spray Aerosol Adhesives: 55 percent VOCs by weight (g/L minus water)
 - 13) Special Purpose Aerosol Adhesives (all types): 70 percent VOCs by weight (g/L minus water)
 - b. Composite wood and agrifiber products used on building interior shall contain no added urea-formaldehyde resins [established in LEED NC v2.2 EQ Credit 4.4]. Agrifiber board is a composite panel product derived from recovered agricultural waste fiber from sources including, but not limited to, cereal straw, sugarcane bagasse, sunflower husk, walnut shells, coconut husks, and agricultural prunings.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
- a. Economic: 15 years functional service life.
 - b. Operational:
 - 1) Warranties:
 - Carnegie: Xorel – 7 year performance warranty.
 - Snap-Tex International: Snap-Tex Stretched Fabric, Acoustical Panel System – 5 year warranty against material defects when installed by a certified installer.
 - Snap-Tex International: Snap-Tex Stretched Fabric, Acoustical Ceiling System – 10 year warranty against panel core or fabric material defects when installed by a certified installer.
 - 2) Maintenance: Use cleaning methods per manufacturer.
 - 3) Extra Materials: Specify extra material for future repairs as color matching will be an issue. Coordinate desired quantities with Authority's Facilities Management Department.

- c. Natural Resource:
 - 1) Reclamation: When Carnegie's Xorel Fabrics are ready for disposal, they can be incinerated without emitting hazardous gases and are an energy producing source in waste burning plants. If placed in a landfill, Xorel will not harm groundwater.
 - 2) Wall Coverings manufactured from cotton, sustainably harvested wood, and natural materials such as sisal, jute, straw, and wool are available.
 - 3) Fabrics, plastics, and paper wall coverings all have unique potential chemical content and emission characteristics. Avoid vinyl wall coverings due to the PVC (polyvinyl chloride) content.

09 91 13 EXTERIOR PAINTING

A. SUMMARY

1. Section includes field painting for exposed exterior items and surfaces to include piping identification.
2. California state requirements have changed to reduce the amount of volatile organic compounds (VOCs) in paints and San Diego International Airport has progressively changed from oil to water based acrylic enamel paint types.
3. Paint and primer types vary with substrate being painted that include metals, drywall, wood, concrete, masonry, and stucco.
4. All paint specifications and products need to be confirmed and approved by the Authority Lead Painter prior to any paint application.

B. MANUFACTURERS

1. Obtain primers and undercoat materials for each coating system from manufacturer product that is compatible with selected finish coats.
2. Acceptable Manufacturers:
 - a. PROline.
 - b. Dunn Edwards.
 - c. Frazee.
 - d. Glidden.
 - e. Sherwin Williams.
 - f. Vista.
3. Primers, Fillers, and Undercoats:
 - a. Exterior Primer/Sealer: Dunn-Edwards, Xim, or Zinsser.
 - b. Exterior Metal Primer (Ferrous): Dunn-Edwards.
 - c. Exterior Metal Primer (Non-Ferrous): Dunn-Edwards.
 - d. PROline.

C. PRODUCTS

1. Latex Acrylic Enamel:
 - a. Provide block fillers, primers, undercoats and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - b. Provide manufacturer's best-quality paint material of various coating types. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
2. Oxide Paint: Required for exposed steel. [FMD]
3. Bollards: PROline gloss paint. [FMD]

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria; Primers: Proper disposal system for paint products.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: California state requirements have changed to reduce the amount of volatile compounds (VOCs) in paints and San Diego International Airport has progressively changed from oil to water based acrylic enamel paint types when used in interior applications. Because of California state regulatory requirements, application and cleaning is easier, but interior paint wear life is appreciably less.
 - b. Operational:
 - 1) Extra Materials: Furnish extra materials from same production run as materials applied. Coordinate desired quantities with Authority's Facilities Management Department. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents and location where material was applied within the project. Deliver extra material to FMD. Significant quantities of paint products are currently kept by FMD and are regularly replenished.
 - 2) Paint Formula: In lieu of furnishing additional material, ensure that the paint formulas for each material and color applied is provided during project closeout submittals.

09 91 23 INTERIOR PAINTING

A. SUMMARY

1. Section includes field-applied interior paints, to include piping identification.
2. Paint and primer types vary with substrate being painted such as metals, drywall, wood, concrete, masonry, and stucco. Provide materials for use within each paint system that are compatible with one another and the substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
3. For each coat in paint system, provide products recommended by manufacturers of topcoat for use in paint system and on the intended substrate.
4. Provide manufacturer's best-quality paint material of various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.
5. Where a specific name is not given for a product or ingredient, provide item that meets best quality of approved manufacturer and product that is normally used for intended purpose.

B. MANUFACTURERS

1. Obtain primers and undercoat materials for each coating system from manufacturer product that is compatible with selected finish coats.
2. Primers:
 - a. Dunn Edwards. [FMD]
 - b. Sherwin Williams.
 - c. Xim.
 - d. Zinsser. [FMD]
3. Paint:
 - a. Benjamin Moore.
 - b. Dunn Edwards. [FMD]
 - c. Frazee (for high profile). [FMD]
 - d. Glidden.
 - e. Sherwin Williams.
 - f. Vista Paint.

C. PRODUCTS

1. Primers:
 - a. Gypsum Wallboard: Water-based, factory-formulated, for interior application.
 - 1) Dunn-Edwards Corp: Zero or low VOC Primer.
 - 2) Sherwin Williams Co.
 - b. Plaster: Factory-formulated latex-based.

- c. Concrete and Masonry: Factory-formulated alkali-resistant acrylic-latex.
- d. Ferrous Metal: Factory-formulated quick-drying rust-inhibitive.
 - 1) Dunn-Edwards Corp.
 - 2) Sherwin Williams Co.
- e. Non-Ferrous Metal: Factory-formulated quick-drying rust-inhibitive.
 - 1) Dunn-Edwards Corp.
- f. Textured Paint: By same manufacturer as textured paint.
- 2. Finish Coats:
 - a. Low Sheen Acrylic Enamel: Factory-formulated low sheen acrylic-latex enamel.
 - 1) Dunn-Edwards Corp.
 - b. Acrylic Eggshell Enamel: Factory-formulated eggshell acrylic-latex enamel.
 - 1) Dunn-Edwards Corp.: California Formula
 - c. Acrylic Semi-Gloss Enamel: Factory-formulated semi-gloss acrylic-latex enamel.
 - 1) Dunn Edwards Corp.: California Formula
 - d. Acrylic Gloss Enamel: Factory-formulated gloss acrylic-latex enamel.
 - 1) Dunn Edwards Corp.: California
 - e. Acrylic Semi-Gloss on Metal Only: Water-base rust-preventative, for ferrous and non-ferrous metals:
 - 1) Dunn-Edwards Corp.
 - f. Acrylic Gloss on Metal Only: Water-base rust-preventative for ferrous and non-ferrous metals:
 - 1) Dunn-Edwards Corp.
- 3. Volatile Organic Compounds VOC Content: Products with a high VOC content (greater than 50 gl) will not be accepted for use in interior painting.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Provide proper disposal system for paint products.
 - b. Paints shall have no VOC or shall not exceed the following VOC content limits [established in Green Seal Standard GS-11, Paints, First Edition, May 20, 1993, as replicated in LEED NC v2.2 EQ Credit 4.2]
 - 1) Flat paint: 50g/L (less water)
 - 2) Non-Flat paint: 150g/L (less water)
 - c. Primers and undercoats shall meet VOC content limit stated above for non-flat paint.
 - d. Anti-corrosive and anti-rust paints applied to exterior ferrous metal substrates shall not exceed the following VOC content limit: 250 g/L [established in Green Seal Standard GS-03, Anticorrosive Paints, Second Edition, January 7, 1997, as replicated in LEED NC v2.2 EQ Credit 4.2]

- e. Regional Materials MR Credit 5.1 and 5.2.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Minimum functional service life span for interior wall finishes of 15 years. [Perf Specs]
 - b. Operational:
 - 1) Relative to service life span, durability and maintenance, interior painting has proven to require constant attention at the airport. In high traffic spaces, such as passenger areas and maintenance rooms adjacent to the ramp, the effective life span of painted surfaces has been from four to twelve months.
 - 2) Maintenance: Provide alternatives in lieu of painted walls in the “impact zone” (under 4 feet).
 - 3) Maintenance: Regular and appropriate cleaning. Provide training for in-house staff or contract out for cleaning services. Develop and document cleaning program that uses sustainable cleaning agents.
 - 4) Extra Materials: Furnish extra materials from same production run as materials applied. Coordinate desired quantities with Authority’s Facilities Management Department. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents and location where material was applied with the project. Deliver extra material to FMD. Significant quantities of paint products are currently kept by FMD and are regularly replenished.
 - 5) Paint Formula: In lieu of furnishing additional material, ensure that the paint formulas for each material and colort applied is provided during project closeout submittals.
 - c. Natural Resource:
 - 1) California state requirements have changed to reduce the amount of volatile compounds (VOCs) in paints and San Diego International Airport has progressively changed from oil to water based acrylic enamel paint types. Because of California state regulatory requirements, application and cleaning is easier, but interior paint wear life is appreciably less.
 - 2) Reclamation: Develop and document disposal procedures for demolition and waste management as appropriate for products, systems, and/or processes. Prioritize products with Cradle to Cradle.

09 93 00 STAINING AND TRANSPARENT FINISHING

A. SUMMARY

1. Primarily wood trim in concourses, concession areas, and club areas are stained. Office areas with wood doors may also require staining.

B. MANUFACTURERS

1. Benjamin Moore.
2. Dunn Edwards.
3. Frazee.
4. Glidden.
5. Sherwin Williams.
6. Vista.
7. General Finishes.

C. PRODUCTS

1. No preferred products have been identified.
2. Water based products are preferred.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Comply with the VOC limits stated in Credit 4.2 (Low-Emitting Materials) and established by South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings & Green Seal Standard for Commercial Adhesives (GS-11).
 - b. Proper disposal system for stains and staining waste.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Stained areas require regular maintenance.
 - 2) Significant quantities of paint products are kept by the Authority's Department of Facilities Management and are regularly replenished.

09 96 00 EXTERIOR HIGH PERFORMANCE COATINGS

A. SUMMARY

1. High performance coatings are used primarily on airside or landside spaces where high traffic and weather accelerate wear and tear on exposed surfaces.
2. High performance coatings can be used on concrete vertical and horizontal surfaces.
3. High performance paints and stains are fortified with either epoxy or polyurethane bases that greatly increase durability.
4. For particular substrates including metals and masonry, specify these paints in a multi-coat system with sealers that shield color layer from wear and inhibit rust.
5. High temperature coatings see limited use in mechanical and electrical areas on heat generating machinery including transformers, generators, and heat pumps.
6. These coatings are formulated for use on aluminum where standard paints do not perform well.
7. Zinc rich paints are commonly used for high temperature applications.

B. MANUFACTURERS

1. Acceptable Manufacturers:
 - a. Benjamin Moore.
 - b. Dunn Edwards.
 - c. Frazee.
 - d. Glidden.
 - e. Sherwin Williams.
 - f. Vista.
2. Concrete Floor Coatings:
 - a. Concrete Solutions, Inc.
 - b. Proline.
 - c. Rustoleum.
 - d. Sherwin Williams.
 - e. Vista Paint.

C. PRODUCTS

1. Concrete Floor Coatings: Sherwin Williams, "Pro-Line".
2. No other preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Comply with the VOC limits stated in Credit 4.2 (Low-Emitting Materials) and established by South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings & Green Seal Standard for Commercial Adhesives (GS-11).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):

- a. Economic:
 - 1) Application is more labor intensive than standard paints but life span is increased.
 - 2) Provide 15-year warranty.
- b. Operational:
 - 1) Significant quantities of paint products are kept by the Department of Facilities Management and are regularly replenished.
 - 2) As machinery is mission critical for the Authority, maintaining protective coatings on these items of equipment is a priority.

09 96 46 INTUMESCENT PAINTING

A. SUMMARY

1. Intumescent painting is a specialty product used for coating exposed structural steel with fire retardant protective treatment in areas where fire codes do not require spray-on cementitious fireproofing.
2. Require installation performed by a certified installer.

B. MANUFACTURERS

1. Albi Manufacturing.
2. Flame Control Coatings.
3. Magna Coatings Technology Inc.
4. NoFire Technologies, Inc.

C. PRODUCTS

1. No preferred products have been identified.
2. Volatile Organic Compounds (VOC) content of selected products are not to exceed 50 gl.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Comply with the VOC limits stated in Credit 4.2 (Low-Emitting Materials) and established by South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings & Green Seal Standard for Commercial Adhesives (GS-11).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Maintenance requirements are usually low as areas requiring intumescent coatings are typically hidden and not subject to damage. Fresh coats will be necessary over the life span of product use.
 - b. Provide 15-year warranty.

09 96 53 ELASTOMERIC COATINGS

A. SUMMARY

1. Elastomeric coatings are specialty products used for coating exposed concrete, masonry, and stucco.
2. These coatings will waterproof porous structures as well as seal hairline cracks on above grade walls caused by the settling of the building or earthquakes.
3. In ramp areas subject to jet blast and other high wind conditions, these coatings can protect exterior walls from wind blown water and debris.
4. Elastomeric coatings can be sprayed applied as an undercoat substrate for standard or high performance paints.
5. Specify requirements for coordination between elastomeric undercoat and subsequent paint finish, ensure compatibility.

B. MANUFACTURERS

1. Benjamin Moore.
2. Dunn Edwards.
3. Frazee.
4. Sherwin Williams.
5. Vista.

C. PRODUCTS

1. No preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Adhesives, sealants and sealant primers shall not exceed the following VOC content limits [established per South Coast Air Quality Management District (SCAQMD) Rule #1168, as replicated in LEED NC v2.2 EQ Credit 4.1]
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Manufacturer's standard warranty in which manufacturer agrees to repair or replace elastomeric coatings that fail within 15 years or other specified warranty period.
 - b. Operational:
 - 1) Elastomeric coatings contribute to water penetration prevention.
 - 2) Federal VOC content limits include 350 grams per liter for concrete-curing compounds and 700 grams per liter for concrete curing and sealing compounds.

09 97 26 CEMENTITIOUS COATINGS

A. SUMMARY

1. Cementitious coatings are specialty products used for coating and resurfacing exposed concrete, masonry, and brick at the Airport.
2. These coatings waterproof porous structures and seal hairline cracks on above grade walls caused by building settling or earthquakes.
3. In ramp areas subject to jet blast and other high wind conditions, these coatings can protect exterior walls from wind blown water and debris.
4. When used as an undercoat substrate, cementitious coatings can be brushed or sprayed applied for standard or high performance paints. Ensure compatibility when specifying requirements for cementitious undercoat and subsequent paint finish.

B. MANUFACTURERS

1. Benjamin Moore.
2. Concrete Solutions, Inc.
3. Dunn Edwards.
4. Frazee.
5. Glidden.
6. PROline
7. Sherwin Williams.
8. Vista.

C. PRODUCTS

1. No preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Adhesives, sealants and sealant primers shall not exceed following VOC content limits [established per South Coast Air Quality Management District (SCAQMD) Rule #1168, as replicated in LEED NC v2.2 EQ Credit 4.1]
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Five-year warranty.
 - b. Operational:
 - 1) Cementitious coatings contribute to water penetration prevention.
 - 2) Federal VOC content limits include 350 grams per liter for concrete-curing compounds and 700 grams per liter for concrete curing and sealing compounds.

10 14 00 SIGNAGE

A. SUMMARY

1. Section includes panel signs, otherwise known as photopolymer signs.
2. Photoluminescent Signs: Refer to Comprehensive Sign Program requirements.
3. Signage plays crucial role in the smooth operation and flow of pedestrian and vehicular traffic through an airport. The responsibility for signage is borne by the Airport as well as airlines, concessions, and government agency tenants who are all responsible for signage in their lease spaces.
4. While numerous copies of each type of signage may be needed, more often than not standardized, pre-manufactured signage is not used. Instead custom templates that are part of a branding and company logo program are fabricated by local signage firms.
5. Specifications will generally include material standards, finishes, colors, and mounting requirements.
6. Shop drawings must be required in the specifications for review by the architect, SDCRAA, and the building authority as necessary.
7. ADA requirements account for much of the plaque type signage in public facilities.
8. Restroom, path of travel, and fire egress signs are mandatory by code and may be a pre-manufactured variety.
9. Post and panel signage includes illuminated and non-illuminated signage for airport and tenant branding and identification. The majority of this type of signage falls under the responsibility of the individual tenants who must comply with SDCRAA standards for dimensions and mounting.
10. Like tenant signage, signs that are fabricated are custom designs based on the current color and graphics schemes that the facility observes. Manufacturers generally contract to construct and install the signage required.
11. Specify deep post trenching (sitework), structural calculations for sign support, and electrical requirements if the signage is to be illuminated.

B. MANUFACTURERS

1. Panel/photopolymer signs:
 - a. Andco Industries Corp.
 - b. ASI Sign Systems, Inc.
 - c. Best Manufacturing Company
 - d. Mohawk Sign Systems
 - e. Poblocki & Sons, Inc.
 - f. Spanjer Brothers, Inc.

- g. The Supersine Company
 - h. Vomar Products, Inc.
- 2. Other sign types shall be custom fabricated by signage companies.

C. PRODUCTS

- 1. For all sign types, refer to the San Diego International Airport, Comprehensive Sign Program.
- 2. Recommendations in addition to Sign Program requirements:
 - a. Tactile (ADA) signs - Numbers and letters to be raised 0.794 mm (.0312-inch) from background surface.
 - b. The draft of the letters and numbers to be tapered, vertical and clean.
 - c. Contracted Grade 2 Braille shall conform to California code requirements.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Illumination sources may assist with energy efficiency requirement credits.
 - b. Electrical Recommendations for future interior illuminated channel letters and interior illuminated sign cabinets:
 - 1) Low voltage system, Sloan ChanneLED4.
 - 2) LED light sources, Sloan ChanneLED4 modules.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational: Besides identification or directional signage, there can be significant value in signs that interpret green building features – explaining how a low flow toilet operates.
 - b. Natural Resource:
 - 1) Products exist with a high percentage of recycled content and energy-conserving (if powered) capabilities.
 - 2) Recommend specifying vinyl products that follows sustainable theory in their manufacturing process (such as Arlon vinyl).

10 21 13 TOILET COMPARTMENTS

A. SUMMARY

1. This section includes public-use and non-public-use toilet partitions.
2. Public restroom design suggestion: Include pocket-type door to serve maintenance when they close a restroom for routine maintenance work.

B. MANUFACTURERS

1. Public-use toilet partitions: Hadrian Manufacturing, Inc. [strong preference]
2. Non-Public-use toilet partitions: No preferred manufacturers have been identified.

C. PRODUCTS

1. Public-use toilet partitions:
 - a. Basis of Design Product: Elite Plus.
 - b. Stainless steel partitions will be Authority standard; other material options will be considered in some areas.
 - c. Wall mounted with floor pedestals, overhead or head-rail braced.
 - d. Use high grade hardware.
 - e. Do not use continuous hinges on partition doors.
2. Non-public-use toilet partitions:
 - a. Laminate will be replaced upon failure.
 - b. Solid core in some non-public or selected public areas.
 - c. Minimum 3/4-inch thick doors and panels.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Recycled content shall meet or exceed specific thresholds:
 - a. LEED NC v2.2 MR Credit 4.1: 10 percent post-consumer materials as identified in accordance with ISO 14021 Environmental, (including 1/2 percent pre-consumer materials).
 - b. LEED NC v2.2 MR Credit 4.2: 20 percent post-consumer materials, (including 1/2 percent pre-consumer materials).
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational – Maintenance: Use cleaning methods per manufacturer.
 - b. Operational: Toilet compartments should be cleanable, moisture-resistant, and unable to support mold growth.
 - c. Natural Resources and Social: Recycled plastic (typically HDPE) is an excellent material for toilet

compartments; other lightweight, durable materials may also be appropriate.

10 26 00 WALL AND DOOR PROTECTION

A. SUMMARY

1. This section includes:
 - a. Wall guards.
 - b. Impact-resistant handrails.
 - c. Corner guards.
 - d. Impact-resistant wall coverings.
 - e. Door protection systems.
2. Wall and door finish protection devices are widely used in public and back of house areas.
3. Stainless steel corner guards serve in the concourse, baggage claim, security, holdroom areas to protect drywall from damage and wear, and in back room areas prone to regular impact by equipment.
4. Fiberglass reinforced paneling (FRP) is a durable and easy to clean material, either as a wainscot or a full height finish for non-public areas only.
5. Stainless steel can be used as a protective wall covering and is available in a variety of patterns and thickness depending on installation location's potential for damage.
6. If large panel type wall protection does not fit well with an aesthetic scheme, rails can be located at pre-determined heights on a wall such as chair or cart level and will allow for a smaller profile device to be used.
7. Stainless steel with embossed texture installed at T-1 baggage claim is manufactured by Rimex Corporation and can be sourced locally at I.M.S. [FMD]

B. MANUFACTURERS

1. American Floor Products Company, Inc.
2. ARDEN Architectural Specialties, Inc.
3. Boston Retail Products.
4. Construction Specialties, Inc.
5. IPC Door and Wall Protection Systems; Division of InPro Corporation.
6. Korogard Wall Protection Systems; Division of RJF International Corporation.
7. Pawling Corporation.
8. Tepromark International, Inc.
9. WallGuard.com.

C. PRODUCTS

1. Wall guards: No preferred products have been identified.
2. Impact-resistant handrails: No preferred products have been identified.
3. Corner guards: Type 304 stainless steel, 16 gage; 14 gage in heavy usage areas; No. 4 brushed finish.
 - a. Small corner guards, run grain vertically.

- b. Large corner guards, grain may run horizontally. [FMD].
- c. Use surface-mounted, metal corner guards, fabricated from 1-piece, formed or extruded metal with formed edges, with 90 or 135 degree turn to match wall condition.
- d. Use stainless steel bumpers on lower wall surfaces and column surrounds in high traffic areas where excessive damage could occur. [IDS]

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. VOC ratings of adhesives.
 - b. Chain-of-custody certificates certifying that wood rails comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by FSC-accredited certification body. LEED NC v2.2 Credit EQ 4.4.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Liberal use of wall and door protection devices can significantly reduce maintenance costs and extend the useful life of wall finishes.
 - b. Operational:
 - 1) Maintenance: Use cleaning methods per manufacturer.
 - 2) Extra Materials: Specify extra materials for future repairs as color matching will be an issue. Coordinate desired quantities with Authority's Facilities Management Department.

10 28 00 TOILET, BATH, AND LAUNDRY ACCESSORIES

A. SUMMARY

1. This section includes:
 - a. Public-use washroom accessories.
 - b. Non-public-use bathroom accessories.
 - c. Laundry and custodial accessories.
2. Of primary importance when specifying these items is their durability in public and back of house applications.
3. Toilet accessories are subject to repetitive use as well as vandalism which result in the need for regular repairs and maintenance beyond the normal restocking requirements. Consider requirements of staff shower rooms, industrial laundry rooms for cleaning towels and rags, and janitorial rooms.
4. Accessibility codes require installation of under the counter pipe guards at restroom lavatories to protect disabled patrons from hot water piping.
5. Specify electric hand dryers, diaper changing stations, and similar accessories in accordance with Airport policy for passenger and maintenance staff convenience.
6. Include criteria for capacities (numbers of paper towels, liners, etc.) as well lockset type and finish type.
7. Commonly specified finishes include stainless steel or high impact ABS plastic.
8. Specify dispensed materials associated with respective accessories (powder or liquid soap, fold pattern of paper towels, etc).

B. MANUFACTURERS

1. Public-use washroom accessories:
 - a. Bobrick Washroom Equipment, Inc.
 - b. Georgia-Pacific Corporation.
 - c. Koala Kare Products.
 - d. Technical Concepts, LLC.
2. Non-public-use washroom accessories: Bobrick Washroom Equipment, Inc.
3. Laundry and custodial accessories: No preferred manufacturers have been identified.

C. PRODUCTS

1. Public-use washroom accessories:
 - a. Waste receptacle: Bobrick B-2280; 21-gallon, square, approximately 30 inches high.
 - b. Circular waste chute ADA compliant: Bobrick B-529.
 - c. Recessed toilet paper, seat cover dispenser and sanitary napkin disposal ADA compliant: Bobrick B-357.

- d. Partition mounted toilet paper, seat cover dispenser and sanitary napkin disposal ADA compliant: Bobrick B-3571.
- e. Recessed toilet paper and seat cover dispenser ADA compliant: Bobrick B-3474.
- f. Partition mounted toilet paper and seat cover dispenser ADA compliant: Bobrick B-3471.
- g. Recessed sanitary napkin/tampon vendor ADA compliant: Bobrick B-43500X2.
- h. Stainless steel folding shelf: Bobrick B-287.
- i. Mount stainless steel shelf above urinals. [IDS]
- j. Clothes hook and bumper; ADA compliant, door-mounted, bright polished:
 - 1) Office/Administrative Areas: Bobrick B-212.
 - 2) Public Areas: B-671.
- k. Grab bar with concealed mounting and snap flange: Bobrick B-6806x36".
- l. Grab bar with concealed mounting and snap flange: Bobrick B-6806x42".
- m. Soap dispenser: Sloan "300", chrome color, hard wired with transformer.
- n. Surface mounted toilet seat cover dispenser: Bobrick B-221.
- o. Partition mounted toilet paper dispenser: Bobrick B-27460.
- p. Surface mounted automated paper towel dispenser: Georgia Pacific "enMotion" touchless towel dispenser; color "translucent smoke".
- q. Horizontal baby changing table to be located in both men's and women's restrooms: Koala Kare Products, KB200-05; color "white granite".
- r. Mirrors: 24"x36", full length in all restrooms [IDS], baby changing mirror [IDS], and custom mirror sizes over entire length of main wash area and separate vanity counter areas in all restrooms [IDS]
- s. Built-in diaper dispensing unit located adjacent to baby changing station.
- t. Cover exposed pipes with pipe boots under each basin (no skirt is preferred). [IDS]
- u. Surface-mounted door bumper: Bobrick B-687.
- 2. Materials:
 - a. Stainless steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312 inch minimum nominal thickness, unless otherwise indicated.
 - b. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.
 - c. Sheet steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359 inch minimum nominal

- thickness; surface preparation and metal pretreatment as required for applied finish.
- d. Galvanized steel sheet: ASTM A 653/A 653M, G60.
- e. Chromium plating: ASTM B 456, service condition number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
- f. Mirror glass: ASTM C 1036, type 1, class 1, quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
- g. Galvanized steel mounting devices: ASTM A 153, hot-dip galvanized after fabrication.
- h. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: Specify requirement for written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty. Minimum warranty period 10 years from date of Substantial Completion.
 - b. Operational: Use cleaning methods per manufacturer.

12 20 00 WINDOW TREATMENTS

A. SUMMARY

1. This section includes blinds, drapes, and window tinting.
2. Window treatments including blinds and drapes are primarily found in office suites and club rooms and the responsibility for specifying will be the individual tenants.
3. Blinds can serve as sun shades at exterior windows as well as privacy screens for offices and conference rooms.
4. In public areas, achieve more effective means of sun control with a combination of window tinting and exterior shade structures.

B. MANUFACTURERS

1. Hunter Douglas.
2. Levelor.
3. Mark Window Products.

C. PRODUCTS

1. No preferred products have been identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Specify extra material for future repairs as color matching will be an issue. Coordinate desired quantities with Authority's Facilities Management Department.
 - 2) Blinds can be maintenance problems if not used with care.

12 36 61 SIMULATED STONE COUNTERTOPS

A. SUMMARY

1. This section includes horizontal and trim quartz and similar solid-surfacing material for:
 - a. Countertops with or without undermount bowls.
 - b. Tabletops.
 - c. Bar tops.
 - d. Cafeteria surfaces.
2. Construction and installation quality of components is governed by various trade associations that establish material grades, manufacturing standards, and installation standards that tradesmen will observe.
3. Manufacturer's warranty against defects in materials.

B. MANUFACTURERS

1. Solid Surfacing Materials:
 - a. Public and Administrative Spaces: DuPont Zodiac or similar homogeneous quartz solid material.
 - b. Non-Public or "Back-of-House" Spaces: Subject to compliance with requirements, provide products by one of the following:
 - 1) ABA Industries.
 - 2) Avonite, Inc.
 - 3) E. I. du Pont de Nemours and Company.
 - 4) Formica Corporation.
 - 5) LG Chemical, Ltd.
 - 6) Meganite Inc.; a division of the Pyrochem Group.
 - 7) Nevamar Company, LLC; Decorative Products Div.
 - 8) Samsung; Cheil Industries Inc.
 - 9) Swan Corporation (The).
 - 10) Transolid, Inc.
 - 11) Wilsonart International; Div. of Premark International, Inc.

C. PRODUCTS

1. Solid-Surfacing-Material Thickness: 3/4-inch or 1-1/8-inch dependent upon the application; thicker material will be more costly.
2. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material, as selected by Authority from manufacturer's full range.
3. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

- a. Fabricate tops with shop-applied edges of materials and configuration indicated.
 - b. Fabricate tops with loose backsplashes for field application.
- 4. Drill holes in countertops for plumbing fittings and soap dispensers in shop; sink bowls will be under-counter mounted.
- 5. Adhesives: Do not use adhesives that contain urea formaldehyde. Use manufacturer-approved adhesive that will create color matched seam, where required.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. VOC ratings of adhesives, no urea formaldehyde.
 - b. Recycled content, include statement of costs for each product having such recycled content.
 - c. Easy to repair, refinish, renew thus minimizing need to replace or dispose of material.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: 10-year warranted life span.
 - b. Operational:
 - 1) Durability: Minimum 10 years functional service life.
 - 2) Maintenance: Use manufacturer recommended cleaning methods.
 - c. Natural Resource:
 - 1) Salvagable for reuse, long life-cycle with reduced waste.
 - d. Social:
 - 1) Nontoxic, non-allergenic to humans.
 - 2) Solid surfacing materials and sealants provide acceptable indoor air quality.

12 48 13 ENTRANCE FLOOR MATS AND FRAMES

A. SUMMARY

1. Entry floor mats are of primary importance at San Diego International Airport.
2. Entry mats significantly reduce the amount of dirt tracked into a building.
3. Made with extremely durable products such as rubber (often recycled car tires), olefin polyester, or even aluminum, entry mats can be either surface mounted or set into a recessed frame flush with the surrounding walk area.
4. Consider large heavy cart traffic that will roll across entry mats. Even though most materials are load tested, use only the most resilient and durable options.
5. Ensure the type of mat to be used is considered during the design phase of new projects as flush mats will require flooring at building entrances to be recessed.

B. MANUFACTURERS

1. American Floor Products Company.
2. Balco, Inc.
3. C/S Group.

C. PRODUCTS

1. Carpet floor mat:
 - a. Carpet, backing and edges shall be extremely durable and appropriate for high-volume of pedestrian traffic with rolling bags.
 - b. Carpet, backing and edges shall not buckle, warp, shrink, curl or pose a trip hazard.
2. Recessed entrance floor mat and frame:
 - a. System shall be sturdy, extremely durable, non-clattering and heel-proof. System shall be appropriate for high-volume of pedestrian traffic with rolling bags.
 - b. In new construction, frame shall be recessed such that a mat and frame are flush with the surrounding floor. [IDS]
 - c. Size: extending a minimum of 7'-0" and maximum of 8'-0" toward the interior of the space from the doors; extending 6" on either side of the door opening. [IDS]

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: For carpet mat and carpet backing, refer to LEED criteria in Section 09 68 00 CARPET of the Facilities Criteria Document.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):

- a. Economic: Minimum service life span of 15 years functional service life.
- b. Operational:
 - 1) Warranties: Warranties vary.
 - 2) Maintenance: Entry floor mats require maintenance and cleaning to remove dirt buildup. The purpose of entrance mats is to remove dirt and water from shoes in order to extend the useful life of the primary carpeted areas by reducing deterioration due to dirt.
 - 3) Extra Materials: For replaceable treads, provide extra materials of each type for stock at the completion of project. Coordinate desired quantities with Authority's Facilities Management Department.
- c. Natural Resource: Carpet mill shall provide reclamation program for used carpet, potentially including zero contributions to landfills. The frame, if made of aluminum, would be 100 percent recyclable.
- d. Social:
 - 1) Dust and dirt can be carried into buildings on footwear, contributing to Indoor Air Quality (IAQ) problems and reducing the life of indoor floor finishes.
 - 2) Inclement weather increases risk of personal

14 00 00 CONVEYING EQUIPMENT

A. SUMMARY

1. Elevator and escalator installations, whether in new or existing hoistways, are a multidisciplinary effort and involve coordination of architectural, structural, mechanical, electrical, and fire protection input.
2. The type, brand, and size must be chosen early in the design phase such that designers can get information specific to any given manufacturer's product. Similarly, the chosen product must be ordered early in the construction phase to avoid delays with manufacturing times.
3. Traction elevators are typically used in applications over three stories in height.
4. Hydraulic actuated elevators rely on a central plunger that pushes the elevator cab up. This mechanism is very effective but to only plus or minus 30 feet, or three stories.
5. Moving walks should provide ample width for standing and walking riders as well as intermittent breaks to allow for exiting along the procession past gates. Ensure adequate pedestrian traffic space exists around the moving walkway.
6. Specify following criteria, as a minimum:
 - a. Elevator cab, door frame, and outer door finishes.
 - b. Finishes and configurations of elevator controls and indicator lighting.
 - c. Escalator sidewalls finish (metal, clear glass, translucent glass, etc.).
 - d. Pit ladders.
 - e. Separation fencing, if more than one elevator car will be in a hoistway.
 - f. Required fire rating.
 - g. Elevator, escalator, or moving walk speed.
 - h. Fire/Emergency operation settings/dispatching.
 - i. Electrical requirements including power source voltage.
 - j. Security/passcard requirements.
 - k. Elevator car capacity.
 - l. Number of flat steps at top and bottom of escalator.
 - m. High traffic designation of escalators (requires heavy duty parts, increased support structure).
 - n. Elevator manufacturer shop drawing requirements for architect and owner approval.

B. MANUFACTURERS

1. Fujitec, Inc.
2. Kone.
3. Otis.
4. Thyssen Krupp.

C. PRODUCTS

1. No products identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No significant compatibility issues. Proper disposal of hydraulic and lubricating fluids may have impact on USCBC LEED credits.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
3. Operational: Specify comprehensive description of desired maintenance and service program from manufacturer including scope of responsibility and service/warranty terms.

22 11 16 DOMESTIC WATER PIPING

A. SUMMARY

1. This section includes under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Piping materials shall bear label, stamp, or other markings of specified testing agency.
3. Comply with NSF 61 for potable domestic water piping and components.
4. Aboveground domestic water piping shall be Type L copper.
5. Underground domestic water piping shall be Type K copper.
6. Install copper tubing underground in PE encasement in accordance with ASTM A 674.

B. MANUFACTURERS

1. Elkhart Corporation.
2. Mueller.
3. NIBCO Inc.
4. Viega.

C. PRODUCTS

1. Copper Tube and Fittings:
 - a. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1) Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2) Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - b. Hard Copper Tube: ASTM B 88 Type K Water Tube, Drawn Temper.
 - 1) Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2) Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - c. Soft Copper Tube: ASTM B 88 Type K Water Tube, Drawn Temper.
 - 1) Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2) Wrought-Copper Solder-Joint Fittings: ASME B16.22 wrought-copper pressure fittings.
 - d. Aboveground Fittings: Pro Press.
2. Piping Joining Materials
 - a. Meta, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 - b. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- c. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system cleaning and flushing.
 - 3) Repair and Replacement: Specify extra material for future repairs. Coordinate desired quantities with Authority's Facilities Management Department.

22 13 16 SANITARY WASTE AND VENT PIPING

A. SUMMARY

1. This section includes pipe, tube, and fittings and special pipe fittings.
2. Components and installation shall be capable of withstanding the following minimum working pressure, unless other indicated:
3. Soil, Waste, and Vent Piping: 10-foot head of water.
4. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
5. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. MANUFACTURERS

1. ANACO-Husky.
2. Fernco Inc.
3. Tyler Pipe.

C. PRODUCTS

1. Hub-And-Spigot, Cast-Iron Soil Pipe and Fittings:
 - a. Pipe and Fittings: ASTM A 74, Service class.
 - b. Gaskets: ASTM C 564, rubber.
 - c. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.
2. Hubless Cast-Iron Soil Pipe and Fittings:
 - a. Pipe and Fittings: ASTM A 888 or CISPI 301.
 - b. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - c. Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands, and tightening devices; and ASTM C 564, rubber sleeve.
3. PVC Pipe and Fittings for Underground Applications:
 - a. Cellular Core PVC Pipe: ASTM F 891, Schedule 40.
 - b. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns to fit Schedule 40 pipe.
4. Encasement for Underground Metal Piping:
 - a. ASTM A 674 or AWWA C105, high-density, cross-laminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.
 - b. Form: Sheet or tube.
 - c. Color: Black or natural.

5. Piping Applications:
 - a. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
 - b. Aboveground, soil and waste piping shall be the following:
 - 1) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2) Hubless cast-iron soil pipe and fittings standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - 3) Copper DWV tube, copper drainage fittings, and soldered joints.
 - c. Aboveground, vent piping shall be as follows:
 - 1) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2) Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - d. Underground, soil, waste, and vent piping:
 - 1) Service class, cast-iron soil piping; gaskets; and gasketed calking materials; and calked joints.
 - 2) Solid-wall ABS, Piping, ABS Socket Fittings, and Solvent-Cemented joints.
 - 3) Schedule 40 PVC.
 - e. Sanitary cross sewer connection on urinals shall be as follows:
 - 1) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2) Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: LEED Submittal of Product Data for Credit EQ4.1: For solvent cements and adhesive primers, documentation included printed statement of VOC content.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system cleaning and flushing.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

22 13 29 SANITARY SEWAGE EJECTOR PUMPS

A. SUMMARY

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and - 0application.
2. UL Compliance: Comply with UL 778 for motor-operated water pumps.
3. Aboveground pump stations will be preferred.

B. MANUFACTURERS

1. Aurora Pumps.
2. Bell & Gossett Pumps.
3. Grundfos Pumps.
4. JDL Systems, Inc.

C. PRODUCTS

1. Duplex Sewage Lift Station complete with Stainless Steel Submersible Chopper Pump.
2. Lift Station shall include:
 - a. Pump Casing, End Bell and Motor Shell: Type 316 stainless steel.
 - b. Impeller: Open-Type, Type 316 stainless steel.
 - c. Shaft: Type 316 stainless steel.
 - d. Chopper System: Chopping/maceration of solids shall be accomplished by the action of two rotating knives moving across one fixed knife alternatively three fixed mounted by the pump inlet external of the pump casing. The chopping system shall be designed to prevent the pump inlet from clogging. Rotating and fixed knives shall be easily replaceable without the use of special tools or requirement of pump disassembly. Fixed and rotating knives shall be stainless steel heat treated to 60 Rockwell C Hardness.
 - e. Bearings: Pre-lubricated ball bearing. L-10 Bearing Life rating of 100,000 Hours.
 - f. Seal: Double opposed mechanical seal operating in an in an oil filled seal chamber. The oil seal chamber shall be designed to prevent over-filling and include as antivortexing vane to insure proper lubrication of both seals. Lower seal faces shall be silicon carbide running against silicon carbide, Upper side: shall be carbon/ceramic.
 - g. Motor: FM Approved Air-filled, Insulated Class F, 4 Pole, rated for continuous duty and 10 starts per hour. Built-in Thermal Detector Overload Protection. Built-in mechanical seal leak detector. External seal probes will not be considered equal or

- approved. Motor shall be non-overloading at design point and across the entire curve.
3. Guide Rail and Coupling System:
 - a. For permanent installation and ease of inspection a guide rail and coupling system shall be used to mount each pump. The system shall consist of a floor-mounted assembly with foot, discharge elbow and a coupling device for the pump. A guide rail shall ensure the pump is guided to the discharge elbow and correctly located in position to give a leak-free connection.
 - b. The bottom assembly shall be bolted to the floor of the tank and provide support for the guide rail.
 - c. An upper guide holder assembly shall secure the system to the tank wall, platform, or under a manhole/hatch cover. It shall also provide the lateral support for the guide rail. The assembly shall contain a location to secure the electrical motor cable holder.
 - d. Guide Rail shall be stainless steel. The Coupling System shall be stainless steel.
 4. Crane Arm Assembly: Provide assembly to raise and lower the unit for installation and service, consisting of crane arm and winch with stainless steel wire. Crane arm assembly shall be stainless steel, suitable for swinging pump over tank wall, platform, or manhole and shall place it safely on platform or on the ground outside the tank.
 5. Control Panel and Pump Level Controls:
 - a. Industrial grade UL listed, 508A control panel with NEMA 3R enclosure. Panel shall be factory wired in accordance with UL 508A procedures. All control switches, test buttons; alarm-silencing switches shall be mounted on interior door and shall include the following:
 - 1) Individual disconnects switches with lockout handles.
 - 2) Fused motor protection.
 - 3) Two magnetic starters with three leg overload protection.
 - 4) Two reverse magnetic contactors.
 - 5) Reverse Start programmer with Fault Detection programming.
 - 6) Two Test – Off – Automatic selector switches.
 - 7) Two manual reverse override switches.
 - 8) Electric duplex alternator.
 - 9) Control circuit transformers.
 - 10) Two green pump running lights.
 - 11) Two yellow reverse pump run lights.
 - 12) Current sensing fault relays.
 - 13) Thermal sensors relays with cut-out and pilot lights.

- 14) Seal failure relays with pilot lights
- 15) Pump Failure Alarm circuit.
- 16) High Water Alarm circuit.
- 17) Alarm horn mounted and beacon on panel.
- 18) Alarm horn silencing switch.
- 19) Dry contacts for remote alarm.
- b. Level Controls: Provide four UL-listed mechanically activated float switches complete with stainless steel float mounting support pole. The cables shall be secured to the support pole in accordance with the manufacturer installation instructions.
- c. Sewage Basin:
 - 1) Pre-fabricated fiberglass or poured-in-place concrete.
 - 2) Provide manufacturer's service weight frame and cover plate (Gas Tight) with single door hinged pump access door complete with hold open device suitable for removal of pumping equipment. Frame, cover plate, and hardware shall be minimum 1/2-inch thick, Type 304 stainless steel.
 - 3) Provide embed crane hoist socket.
 - 4) Coordinate in field for location and installation.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

22 34 00 FUEL-FIRED DOMESTIC WATER HEATERS

A. SUMMARY

1. This section includes commercial, power-vent, storage, gas water heaters.
2. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Where ASME-code construction is indicated, fabricated and label commercial water heater storage tanks shall comply with ASME Boiler and Pressure Vessel Code Section VIII. Division 1.
5. Where ASME-code construction is indicated, fabricated and label commercial, finned-tube water heaters shall comply with ASME Boiler and Pressure Vessel Code Section IV.
6. Comply with NSF 61, "Drinking Water System Components – Health Effects; Sections 1 through 9" for components that will be in contact with potable water.

B. MANUFACTURERS

1. A.O. Smith.
2. Lochinvar.
3. Patterson Kelly Co.

C. PRODUCTS

1. Commercial, Power Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
2. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.
3. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
4. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
5. Special Requirements: NSF 5 construction.
6. Power-Vent System: Exhaust fan, interlocked with burner.
7. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Minimum energy performance, LEED NC V2.2 EA Prerequisite 2.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:

- 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
- 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
- 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

22 40 00 PLUMBING FIXTURES

A. SUMMARY

1. Section includes:
 - a. Water closets.
 - b. Urinals.
 - c. Lavatories.
 - d. Sinks.
 - e. Toilet Seats.
 - f. Flush valves.
 - g. Faucets.
 - h. Sensor operated faucet, and devices.
2. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from single manufacturer.
3. Regulatory Requirements:
 - a. Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.
 - b. Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
 - c. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
4. Lavatory tempered supply water shall have circulating pump at end of pipe run to maintain hot water at fixture.
5. Install lavatory fixtures with removable trap arm.
6. Provide following clearances for plumbing chases:
 - a. Back to back water closet: 48 inches.
 - b. Back to back lavatory: 36 inches.
 - c. Single water closet: 30 inches.
7. Provide floor drains, hose bibs, lights and electrical outlets in chases.

B. MANUFACTURERS

1. Water Closets: American Standard, Kohler.
2. Urinals: Zurn.
3. Lavatories: American Standard, Kohler.
4. Sinks: American Standard, Kohler.
5. Service Sinks: American Standard, Kohler.
6. Toilet Seats: Bemis Co. (1995c)
7. Flush Valves:
 - a. Water Closet: Sloan.
 - b. Urinal: Zurn.
8. Faucets: Zurn.

9. Sensor operated faucet and devices: Zurn.

C. PRODUCTS

1. Select compatible combinations of fixtures and trim, faucets, fittings, and other components.
2. Comply with following applicable standards and other requirements specified for plumbing fixtures:
 - a. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - b. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 - c. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - d. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 - e. Vitreous-China Fixtures: ASME A112.19.2M.
 - f. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
3. Comply with following applicable standards and other requirements specified for lavatory and sink faucets:
 - a. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - b. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - c. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - d. Faucets: ASME A112.18.1.
 - e. Hose-Connection Vacuum Breakers: ASSE 1011.
 - f. Hose-Coupling Threads: ASME B1.20.7.
 - g. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - h. NSF Potable-Water Materials: NSF 61.
 - i. Pipe Threads: ASME B1.20.1.
 - j. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - k. Supply Fittings: ASME A112.18.1.
 - l. Brass Waste Fittings: ASME A112.18.2.
4. Comply with following applicable standards and other requirements specified for miscellaneous fittings:
 - a. Atmospheric Vacuum Breakers: ASSE 1001.
 - b. Brass and Copper Supplies: ASME A112.18.1.
 - c. Dishwasher Air-Gap Fittings: ASSE 1021.
 - d. Manual-Operation Flushometers: ASSE 1037.
 - e. Brass Waste Fittings: ASME A112.18.2.
 - f. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
5. Comply with following applicable standards and other requirements specified for miscellaneous components:
 - a. Disposers: ASSE 1008 and UL 430.
 - b. Dishwasher Air-Gap Fittings: ASSE 1021.
 - c. Flexible Water Connectors: ASME A112.18.6.
 - d. Floor Drains: ASME A112.6.3.

- e. Grab Bars: ASTM F 446.
- f. Hose-Coupling Threads: ASME B1.20.7.
- g. Hot-Water Dispensers: ASSE 1023 and UL 499.
- h. Off-Floor Fixture Supports: ASME A112.6.1M.
- i. Pipe Threads: ASME B1.20.1.
- j. Plastic Shower Receptors: ANSI Z124.2.
- k. Plastic Toilet Seats: ANSI Z124.5.
- l. Supply and Drain Protective Shielding Guards: ICC A117.1.
- m. Whirlpool Bathtub Equipment: UL 1795.
- 6. Faucets:
 - a. Polished chrome finish.
 - b. Provide hard-wired type at lavatories.
 - c. Zurn, "Model Z6913."
- 7. Urinals: 1/8-gallon flush.
- 8. Water Closet Flushometer: Sloan or Zurn; hard-wired, automatic operation type; 1.28 gallon flush.
- 9. Flush Valve Automatic Sensor:
 - a. Provide at lavatories
 - b. Converted fixtures: Zurn, "ZERL-CPM".
- 10. Water Closets: Wall hung, Kohler, "Kingston."
- 11. Silicone Sealants: 100% silicone rubber, clear, intended for use with toilet and restroom fixtures:
 - a. Silicone sealant to be waterproof, non-shrinking and mold/mildew resistant.
 - b. Apply continuous sealant joint between all fixtures and adjacent surface, such as lavatory tops, finish floor material and finish wall material.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Water use reduction, LEED, NC V2.2, WE 3.1.
 - b. Water use reduction, LEED, NC V2.2, WE 3.2.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

22 47 00 DRINKING FOUNTAINS AND WATER COOLERS

A. SUMMARY

1. Section includes electric water coolers.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
4. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
5. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
6. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

B. MANUFACTURERS

1. Halsey Taylor.
2. Elkay Manufacturing Co.
3. Haws Corporation.

C. PRODUCTS

1. Use carrier off-floor supports for wall-mounting fixtures.
2. Use mounting frames for recessed water coolers.
3. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.
4. All new water coolers are to be a water cooler/bottle filling station combination unit.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Select refrigerants that minimize or eliminate emissions of compounds that contribute to ozone depletion and global warming.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.

- 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
- 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 05 19 METERS AND GAUGES FOR HVAC PIPING

A. SUMMARY

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.
2. Section includes:
 - a. Liquid in-glass thermometers
 - b. Thermowells
 - c. Dial-type pressure gauges
 - d. Gauge attachments
 - e. Test plugs
 - f. Test-plug kits
 - g. Flow meters
3. Submittal Requirements:
 - a. Product Data: For each product indicated
 - b. Wiring Diagrams: For power, signal and control wiring
 - c. Product Certificates: For each type of meter and gauge, from manufacturer
 - d. Operation and Maintenance Data: For meters and gauges, to include in operation and maintenance manuals.

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. Liquid In-Glass Thermometers
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
 - 1) Flo Fab Inc.
 - 2) Miljoco Corporation
 - 3) Palmer Wahl Instrumentation Group
 - 4) Tel-Tru Manufacturing Company
 - 5) Trerice H.O. Co.
 - 6) Weiss Instruments Inc.
 - 7) Winters Instruments – US
 - b. Standard: ASME B40-200
 - c. Case: Cast aluminum, 7-inch nominal size unless otherwise indicated.
 - d. Case Form: Adjustable angle unless otherwise indicated.
 - e. Tube: Glass with magnifying lens and red organic liquid.

- f. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F and degree C.
 - g. Window: Glass
 - h. Stem: Aluminum and of length to suit installation
 - 1) Design for air-duct installation: With ventilated shroud.
 - 2) Design for Thermowell installation: Bare stem.
 - i. Connector: 1-1/4 inches with ASME B1.1 screw threads.
 - j. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
 - 2. Thermowells
 - a. Thermowells:
 - 1) Standard: ASME B40:200
 - 2) Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3) Material for use with copper tubing: CNR or CUNI.
 - 4) Material for use with steel piping: CRES CSA.
 - 5) Type: Stepped shank unless straight or tapered shank is indicated.
 - 6) External Threads: NPS 3/4, ASME B1.20.1 pipe threads.
 - 7) Internal Threads: 3/4, with ASME B1.1 screw threads.
 - 8) Bore: Diameter required to match thermometer bulb or stem.
 - 9) Insertion Length: Length required to match thermometer bulb or stem.
 - 10) Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 11) Bushings: For converting size of thermowell's internal screw head to size of thermometer connection.
 - b. Heat-Transfer Medium: Mixture of graphite and glycerin.
 - 3. Pressure Gauges
 - a. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges
 - b. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
 - 1) AMETEK Inc; U.S. Gauge
 - 2) Ashcroft Inc.
 - 3) Ernst Flow Industries
 - 4) Flo Fab Inc.
 - 5) Marsh Bellofram
 - 6) Noshok

- 7) Palmer Wahl Instrumentation Group
- 8) REOTEMP Instrument Corporation
- 9) Tel-Tru Manufacturing Company
- 10) Trerice H.O. Co.
- 11) Watts Regulator Co.; A Division of Watts Water Technologies Inc.
- 12) Weiss Instruments Inc.
- 13) WIKA Instrument Corporation – USA
- 14) Winters Instruments – U.S.
- c. Standard: ASME B40-100
- d. Case: Sealed type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
- e. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- f. Pressure Connection: Brass, with NPS ¼ or NPS ½, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- g. Movement: Mechanical, with link to pressure element and connection to pointer.
- h. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi and kPa.
- i. Pointer: Dark-colored metal.
- j. Window: Glass
- k. Ring: Stainless Steel
- l. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- 4. Gauge Attachments
 - a. Snubbers: ASME B40,100, brass; with NPS ¼ or NPS ½, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
 - b. Siphons: Loop-shaped section of stainless-steel pipe with NPS ¼ or NPS ½ pipe threads.
 - c. Valves: Brass or stainless-steel needle, with NPS ¼ or NPS ½, ASME B1.20.1 pipe threads.
- 5. Test Plugs
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
 - 1) Flow Design Inc.
 - 2) Miljoco Corporation
 - 3) National Meter Inc.
 - 4) Peterson Equipment Co. Inc.
 - 5) Sisco Manufacturing Company Inc.
 - 6) Trerice H.O. Co.
 - 7) Watts Regulator Co.; a Division of Watts Water Technologies Inc.
 - 8) Weiss Instruments Inc.
 - b. Description: Test-station fitting made for insertion into piping tee fitting.

- c. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
 - d. Thread Size: NPS ¼ or NPS ½, ASME B1.20.1 pipe thread.
 - e. Minimum Pressure and Temperature rating: 500 psig at 200 deg F.
 - f. Core Inserts: EPDM self-sealing rubber.
- 6. Test-Plug Kits
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
 - 1) Flow Design Inc.
 - 2) Miljoco Corporation
 - 3) National Meter Inc.
 - 4) Peterson Equipment Co. Inc.
 - 5) Sisco Manufacturing Company Inc.
 - 6) Trerice H.O. Co.
 - 7) Watts Regulator Co.; a Division of Watts Water Technologies Inc.
 - 8) Weiss Instruments Inc.
 - b. Furnish one test-plug kit containing two thermometers, one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
 - c. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
 - d. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
 - e. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 deg psig.
 - f. Carrying Case: Metal or plastic, with formed instrument padding.
- 7. Venturi Flowmeters
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
 - 1) Armstrong Pumps Inc.
 - 2) Badger Meter Inc.; Industrial Division
 - 3) Bailey-Fischer and Porter Co.
 - 4) Flow Design Inc.
 - 5) Gerand Engineering Co.

- 6) Hyspan Precision Products Inc.
 - 7) Leeds and Northrup
 - 8) McCrometer Inc.
 - 9) Preso Meters Corporation
 - 10) Vitaulic Co. of America
 - b. Description: Differential-pressure design for installation in piping: with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter and system fluid.
 - c. Construction: Bronze, brass or factory-primed steel, as noted below; with brass fittings and attached tag with flow conversion data.
 - 1) NPS ½ through NPS 2: Bronze or brass.
 - 2) NPS 2 ½ through NPS 80: Factory primed cast steel.
 - 3) NPS 10 and larger: Factory primed fabricated steel
 - d. Pressure rating: 250 psig
 - e. Temperature Rating: 250 deg
 - f. End Connections for NPS 2 and Smaller: Threaded
 - g. End Connections for NPS 2-1/2 and Larger: Flanged
 - h. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
 - i. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - 1) Scale: Gallons per minute
 - 2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.
 - j. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
 - 1) Scale: Gallons per minute
 - 2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.
 - k. Operating Instructions: Include complete instructions with each flowmeter.
- 8. Pitot-Tube Flowmeters
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
 - 1) Dieterich Standard Inc.
 - 2) Meriam Instruments Division; Scott Fetzer Co.
 - 3) Preso Meters Corporation

- 4) Taco Inc.
- 5) Veris Industries
- b. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.
- c. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.
- d. Pressure rating: 150 psig minimum.
- e. Temperature rating: 250 deg F minimum.
- f. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.
- g. Integral Transformer: For low-voltage power connection.
- h. Accuracy: Plus or minus 1 percent for liquids and gases.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. No currently identified EONS criteria.

E. EXECUTION

- 1. Installation
 - a. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.
 - b. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
 - c. Install thermowells with extension on insulated piping.
 - d. Fill thermowells with heat-transfer medium.
 - e. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
 - f. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
 - g. Install test plugs in piping tees.
 - h. Install flow indicators in piping systems in accessible positions for easy viewing.
 - i. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
 - j. Install flowmeter elements in accessible positions in piping systems.
 - k. Install wafer-orifice flowmeter elements between pipe flanges.

- I. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
 - m. Install connection fittings in accessible locations for attachment to portable indicators.
 - n. Install thermometers in the following locations:
 - 1) Inlet and outlet of each hydronic coil in air-handling units.
 - o. Install pressure gauges in the following locations:
 - 1) Discharge of each pressure-reducing valve.
 - 2) Suction and discharge of each pump.
2. Connections
 - a. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines and equipment.
3. Adjusting
 - a. After installation, calibrate meters according to manufacturer's written instructions
 - b. Adjust faces of meters and gauges to proper angle for best visibility
4. Thermometer Schedule
 - a. Thermometers at inlet and outlet of each hydronic coil in air-handling units shall be the following:
 - 1) Industrial style, liquid-in-glass type.
 - 2) Test plug with EPDM self-sealing rubber inserts.
 - b. Thermometers at inlets and outlets of each hydronic heat exchanger shall be the following at AHU only:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Test plug with EPDM self-sealing rubber inserts.
 - c. Thermometer stems shall be of length to match thermowell insertion length.
5. Thermometer Scale-Range Schedule
 - a. Scale Range for Chilled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.
 - b. Scale Range for Heating, Hot-Water piping: 0 to 250 deg F and 0 to 150 deg C.
6. Pressure-Gauge Schedule
 - a. Pressure gauges at discharge of each pressure-reducing valve shall be one of the following:
 - 1) Sealed, metal case.
 - b. Pressure gauges at inlet and outlet of each air handling unit hydronic coil chilled-water and condenser-water connection shall be the following:
 - 1) Sealed, metal case.
 - c. Pressure gauges at suction and discharge of each pump shall be the following:
 - 1) Sealed, metal case.

7. Pressure-Gauge Scale-Range Schedule
 - a. Scale Range for Chilled-Water Piping: 0 to 200 psi and 0 to 1400 kPa
 - b. Scale Range for Heating, Hot-Water Piping: 30 in. Hg to 15 psi and minus 100 to 0 kPa.

23 05 48 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

A. SUMMARY

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.
 - b. Division 07 Section "Roof Accessories"
 - c. Division 22 Section "Hydronic Piping"
2. Section includes the following:
 - a. Isolation pads.
 - b. Isolation mounts.
 - c. Restrained elastomeric isolation mounts.
 - d. Freestanding and restrained spring isolators.
 - e. Housed spring mounts.
 - f. Elastomeric hangers.
 - g. Spring hangers.
 - h. Spring hangers with vertical-limit stops.
 - i. Pipe riser resilient supports.
 - j. Resilient pipe guides.
 - k. Seismic snubbers.
 - l. Restraining braces and cables.
 - m. Steel and inertia, vibration isolation equipment bases.
3. Definitions:
 - a. IBC: International Building Code
 - b. ICC-ES: ICC Evaluation Service
4. Performance Requirements
 - a. Wind-Restraint Loading:
 - 1) Basic Wind Speed: 85 mph
 - 2) Building Classification Category: Occupancy Category 1.25.
 - 3) Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
 - b. Seismic-Restraint Loading:
 - 1) Site Class as Defined in the CMC 07.
 - 2) Assigned Seismic Use Group or Building Category as Defined in the IBC: Occupancy Category 1.25:
 - Component Importance Factor: 1.0 or 1.5 if it is a system that has to operate after an earthquake event or if it contains hazardous materials.
 - Component Response Modification Factor: per CMC.07.

- Component Amplification Factor: Refer to CMC 07, Table 13.6-1.

5. Quality Assurance
 - a. Comply with seismic-restraint requirements in the CMC unless requirements in this Section are more stringent.
 - b. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and may bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. Vibration Isolators
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1) Ace Mountings Co., Inc.
 - 2) Amber/Booth Company, Inc.
 - 3) California Dynamics Corporation.
 - 4) Isolation Technology, Inc.
 - 5) Kinetics Noise Control.
 - 6) M.W. Sausse
 - 7) Mason Industries.
 - 8) Vibration Eliminator Co., Inc.
 - 9) Vibration Isolation.
 - 10) Vibration Mountings & Controls, Inc.
 - b. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - c. Resilient Material: Oil- and water-resistant neoprene.
 - d. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

- e. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - f. Neoprene: Shock-absorbing materials compounded according to the standard for bridge- bearing neoprene as defined by AASHTO.
- 2. Restrained Mounts: All-directional mountings with seismic restraint.
 - a. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - b. Neoprene: Shock-absorbing materials compounded according to the standard for bridge- bearing neoprene.
- 3. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - a. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - b. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - c. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - e. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- 4. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - b. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 - c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

- d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - e. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 5. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
 - a. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 - b. Base: Factory drilled for bolting to structure.
 - c. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- 6. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- 7. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- 8. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

- b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- 9. Vibration Isolation Equipment Bases (where applicable)
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1) Amber/Booth Company, Inc.
 - 2) California Dynamics Corporation.
 - 3) Isolation Technology, Inc.
 - 4) Kinetics Noise Control.
 - 5) Mason Industries.
 - 6) Vibration Eliminator Co., Inc.
 - 7) Vibration Isolation.
 - 8) Vibration Mountings & Controls, Inc.
- 10. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
 - a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - 1) Include supports for suction and discharge elbows for pumps.
 - b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - c. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- 11. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

- 1) Include supports for suction and discharge elbows for pumps.
 - b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - c. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - d. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
12. Seismic-Restraint Devices
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1) Amber/Booth Company, Inc.
 - 2) California Dynamics Corporation.
 - 3) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 4) Hilti, Inc.
 - 5) Kinetics Noise Control.
 - 6) Loos & Co.; Cableware Division.
 - 7) Mason Industries.
 - 8) TOLCO Incorporated; a brand of NIBCO INC.
 - 9) Unistrut; Tyco International, Ltd.
13. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
14. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - a. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - b. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - c. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.
15. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with

- corrosion-resistant coating; and rated in tension, compression, and torsion forces.
16. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
 17. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
 18. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
 19. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
 20. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
 21. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
 22. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
 23. Factory Finishes
 - a. Finish: Manufacturer's standard prime-coat finish ready for field painting.
 - b. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1) Powder coating on springs and housings.
 - 2) All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3) Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED criteria: No currently identified USGBC LEED criteria.

2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. No currently identified EONS criteria.

E. EXECUTION

1. Examination
 - a. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
 - b. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
 - c. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Applications
 - a. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
 - b. Strength of Support and Seismic-restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
3. Vibration-Control and Seismic-Restraint Device Installation
 - a. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports and roof penetrations.
 - b. Equipment Restraints:
 - 1) Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2) Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3) Install seismic-restraint devices using methods approved by an agency acceptable to Authorities Having Jurisdiction, providing required submittals for component.
 - c. Piping Restraints:
 - 1) Comply with requirements in MSS SP-127.
 - 2) Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3) Brace a change of direction longer than 12 feet.

- d. Install cables so they do not bend across edges of adjacent equipment or building structure.
- e. Install seismic-restraint devices using methods approved by an agency acceptable to Authorities Having Jurisdiction, providing required submittals for component.
- f. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- g. Drilled-in Anchors:
 - 1) Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2) Do not drill holes in concrete or masonry until concrete or masonry until concrete, mortar or grout has achieved full design strength.
 - 3) Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4) Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5) Set anchors to manufacturer's recommended torque.
 - 6) Install zinc-coated steel anchors for interior and stain-steel anchors for exterior applications.
- 4. Accommodation of Differential Seismic Motion
 - a. Install flexible connections in piping where they cross seismic joints. Comply with requirements in Division 22 Section "Hydronic Piping", for piping flexible connections.
- 5. Adjusting
 - a. Adjust isolators after piping system is at operating weight.
 - b. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit

stops so they are out of contact during normal operation.

- c. Adjust active height of spring isolators.
- d. Adjust restraints to permit free movement of equipment within normal mode of operation.

23 05 53 IDENTIFICATION FOR HVAC PIPING

A. SUMMARY

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.
 - b. Division 09 Section "Interior Painting"
2. Section includes:
 - a. Equipment labels
 - b. Warning signs and labels
 - c. Pipe labels
 - d. Duct labels
 - e. Stencils
 - f. Valve tags
 - g. Warning tags
3. Submittals:
 - a. Product Data and Samples: For each type of product indicated
 - b. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
 - c. Valve numbering scheme
 - d. Valve Schedules: For each piping system to include in maintenance manuals.
4. Coordination:
 - a. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
 - a. Coordinate installation of identifying devices with locations of access panels and doors.
 - b. Install identifying devices before installing acoustical ceilings and similar concealment.

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
3. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
4. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

5. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
6. Lettering Size: Minimum 1-1/2 inches high or proportionally larger based on pipe diameter.
 - a. Valve tags if required.
 - b. Warning signs and labels if required.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

E. EXECUTION

1. Preparation
 - a. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil grease, release agents and incompatible primers, paints and encapsulants.
2. Equipment Label Installation
 - a. Install or permanently fasten labels on each major item of mechanical equipment.
 - b. Locate equipment labels where accessible and visible
3. Pipe Label Installation
 - a. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting".
 - b. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
 - 1) Stencil Paint: Use for pipe marking.
 - c. Locate pipe labels where piping is exposed or above accessible ceiling in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1) Near each valve and control device
 - 2) Near each branch connection, excluding short takeoffs for fixtures and terminal units.
 - 3) Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4) At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5) Near major equipment items and other points of origination and termination.

- 6) All straight pipe runs shall be labeled every 20 feet maximum with system description, i.e., chilled water, and with direction of flow. Each shut off valve, piece of equipment and branch take off shall be labeled as well.
 - 7) On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 - d. Pipe Label Color Schedule
 - 1) Chilled Water Piping:
 - Background Color: Blue
 - Letter Color: White
 - 2) Heating Water Piping:
 - Background Color: Orange
 - Letter Color: White
 - 3) Refrigerant Piping:
 - Background Color: Black
 - Letter Color: White
- 4. Valve-Tag Installation
 - a. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shut-off valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
 - b. Valve-tag Application Schedule: Tag valves according to size, shape and color scheme, and with captions similar to those indicated in the following subparagraphs:
 - 1) Chilled Water Piping:
 - Background Color: Blue
 - Letter Color: White
 - c. Write required message on, and attach warning tags to (if required), equipment and other items where required.

23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

A. SUMMARY

1. Section includes balancing of air and hydronic piping systems.
2. Specify yearly system testing for five years from date of contract closeout.
3. TAB Contractor Qualification:
 - a. Engage TAB entity certified by AABC.
 - b. TAB Field Supervisor: Employee of TAB contractor and certified by AABC.
 - c. TAB Technician: Employee of TAB contractor and certified by AABC as a TAB technician.
4. Instrumentation Type Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
5. General Procedures for Balancing Air Systems:
 - a. Prepare test reports for fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck summation of required outlet volumes with required fan volumes.
 - b. Prepare schematic diagrams of systems' "as-built" duct layouts.
 - c. Require development of plan to simulate diversity for variable air volume systems.
 - d. Determine best locations in main and branch ducts for accurate duct-airflow measurements.
 - e. Check airflow patterns from outdoor-air louvers and dampers and return- and exhaust-air dampers through 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.

B. MANUFACTURERS

1. American Air Balance Co.
2. Penn Air Control Inc.
3. San Diego Air Balance Co.

C. PRODUCTS

1. No preferred products identified.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Fundamental commissioning of the building energy system, LEED NC V2.2, EA Prerequisite 1.
 - b. Enhanced commissioning, LEED NC V2.2, EA Credit 3.
 - c. Minimum IAQ Performance, LEED NC V2.2, EQ Prerequisite 1.
 - d. Thermal comfort, LEED NC V2.2, EQ Credit 7.1
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 09 00 HVAC INSTRUMENTATION AND CONTROL

A. SUMMARY

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.
2. General Requirements:
 - a. Section includes Building Automation System (BAS).
 - b. BAS system shall be designed and installed, commissioned and serviced by manufacturer employed personnel.
 - c. Manufacturer shall have in-place support facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.
 - d. Distributors, wholesalers, or licensed installing mechanical contractors will not be acceptable.
 - e. Manufacturer shall provide experienced project manager for this work, responsible for direct supervision of the design, installation, and start up and commissioning of the BAS.
 - f. Manufacturer shall be regularly engaged in manufacturing, installation, and maintenance of BAS systems with minimum of ten years of demonstrated technical expertise and experience in manufacture, installation and maintenance of BAS systems similar in size and complexity to this project, a maintained service organization consisting of at least ten competent servicemen for a period of not less than ten years and to provide list of 10 projects, similar in size and scope to the current project, completed within last five years.
 - g. Materials and equipment shall be catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with specified requirements.
 - h. BAS shall be listed under UL 916 PAZX and 864 UDTZ, UUKL, and other subsystem listings as applicable, and as required by Authority at time of project.
 - i. Electronic equipment shall conform to requirements of FCC Regulation, Part 15, Section 15, and Governing Radio Frequency Electromagnetic Interference and be so labeled.

- j. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.
- 3. Submittal Requirements
 - a. Product Submittal Requirements: Provide six copies of shop drawings and other submittals on hardware, software and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2010 compatible files on optical disk (file format: .dwg, .dxf, .vsd or comparable) or hard copies of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawings on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. All wall-mounted hardware shall be coordinated with the Architect before submittal.
 - b. Submittal data shall consist of the following:
 - 1) Direct Digital Control System hardware:
 - Complete bill of materials indicating quantity, manufacturer, model number and relevant technical data of equipment to be used.
 - Manufacturer's description and technical data, such as product specification sheets, installation and maintenance instructions for items listed below and for relevant items not listed below:
 - Direct Digital Controllers (controller panels)
 - Transducers and transmitters
 - Sensors (including accuracy data)
 - Valves
 - Dampers
 - Relays and Switches
 - Control Panels
 - Power Supplies
 - Operator Interface Equipment
 - Wiring diagrams and layouts for each control panel. Show all termination numbers.

- Floor plan schematic diagrams indicating control panel and space temperature sensor locations.
- c. Central System hardware and Software:
 - 1) Complete bill of material indicating quantity, manufacturer, model number and relevant technical data of equipment used.
 - 2) Manufacturer's description and technical data such as product specifications for items listed below, and for relevant items furnished under this contract not listed below:
 - Central Processing Unit (CPU)
 - Monitors
 - Keyboards
 - Power Supply
 - Battery backup
 - Interface Equipment Between CPU and Control Panels
 - Operating System Software
 - Operator Interface Software
 - Color Graphic Software
 - Third-Party Software
 - 3) Schematic diagrams of all control, communication and power wiring for central system installation. Show interface wiring to control system.
 - 4) Provide sample color graphics prints for each typical system indicating conceptual layout of pictures and data for each graphic. List of color graphics to be provided, showing or explaining which other graphics can be directly accessed.
 - 5) Provide a list of ATC point naming convention. Indicate the format, structure and standards of typical point names. The naming convention shall follow the "Global Campus Building Area Equipment Function" format. Provide a list of point names for typical equipment and functions with specific examples.
- d. Controlled Systems:
 - 1) Riser diagrams showing control network layout, communication protocol, and wire types.
 - 2) Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of controlled elements.
 - 3) Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic use the same name.

- 4) Instrumentation list for each controlled system. List control system element in a table. Show element name, type of device, manufacturer, model number and product data sheet number.
- 5) Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system.
- 6) Point list for each system controller, including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point and location of I/O device.
- e. Description of process, report formats and checklists to be in used in Part E "Control System Demonstration and Acceptance"
- f. Contractor shall submit documentation in the following phased delivery schedule:
 - 1) Valve and damper schedules
 - 2) Point Naming Convention
 - 3) Sample Graphics
 - 4) System schematics, including:
 - System Riser Diagrams
 - Sequence of Operations
 - Mechanical Control Schematics
 - Electrical Wiring Diagrams
 - Control Panel Layouts
 - Product Specification Sheets
 - As-Built Drawings
- g. Schedules:
 - 1) Schedule of work provided within one month of contract award indicating:
 - Intended sequence of work item.
 - Start dates of each work item.
 - Duration of each work item.
 - Planned delivery dates for ordered material and equipment and expected lead times.
 - Milestones indicating possible restraints on work by other trades or situations.
 - 2) Monthly written status reports indicating work completed and revisions to expected delivery. Include updated schedule of work.
- h. Project Record Documents: Submit three copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
 - 1) Project Record Drawings: As-built versions of the submittal of the submittal shop drawings provided as AutoCAD 2008 (or newer) compatible files on optical media and as 11" x 17" hardcopy prints.

- 2) Testing and Commissioning Reports and Checklists: Completed versions of reports, checklists and trend logs used to meet requirements of part E "Control System Demonstration and Acceptance".
- 3) Operation and maintenance (O&M) manual:
 - As-Built versions of the submittal product data.
 - Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and charging set points and variables.
 - Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations use, of point database creation and modification, of program creation and modification and of editor use.
 - Engineering, installation and maintenance manual or set of manuals that explains how to design and install new points, panels and other hardware; how to perform preventative maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - Documentation of all programs created using custom programming language, including set points, tuning parameters and object database.
 - Graphic files, programs and database on magnetic or optical media.
 - List of recommended spare parts with part numbers and suppliers.
 - Complete original-issue documentation, installation and maintenance information for furnished third-party hardware, including computer equipment and sensors.
 - Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator

- workstation software and graphics software.
 - Licenses, guarantees and warranty documents for equipment and systems.
- i. Training Manuals: Provide course outline and manuals at least six weeks before training.

B. MANUFACTURERS

1. Siemens Building Technologies; no substitutions.

C. PRODUCTS

1. DDC Controller Floor Level Network:
 - a. This level communication shall support a family of application specific controllers and shall communicate with peer-to-peer network through DDC Controllers for transmission of global data.
 - b. Floor level network controllers will be connected with 22 gage twisted pair.
2. DDC and HVAC Mechanical Equipment Controllers:
 - a. DDC and HVAC Mechanical Equipment Controllers shall reside on Building Level Network.
 - b. DDC and HVAC Mechanical Equipment Controllers shall use same programming language and tools.
 - c. DDC and HVAC Mechanical Equipment controllers, which require different programming language or tools, will not be acceptable.
3. HVAC Mechanical Equipment Controllers (MEC):
 - a. HVAC MEC shall be 12-bit stand-alone, multi-tasking, multi-user; real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
 - b. Each HVAC MEC shall have sufficient memory to support its own operating system and databases, including:
 - 1) Control processes.
 - 2) Energy management applications.
 - 3) Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - 4) Historical/trend data for points specified.
 - 5) Maintenance support applications.
 - 6) Custom processes.
 - 7) Operator I/O.
 - 8) Dial-up communications.
 - c. Each HVAC MEC shall support firmware upgrades without need to replace hardware.
 - d. HVAC MEC shall provide RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers,

- operator terminals, modems and portable laptop operator's terminals.
 - e. HVAC MEC shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without need for operator I/O device.
 - f. Each HVAC MEC shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all components.
 - g. HVAC MEC shall provide local and remote annunciation of detected component failures, low battery conditions or repeated failure to establish communication.
 - h. Provide isolation at all peer-to-peer network terminations, and field point terminations to suppress induced voltage transients consistent with IEEE 587 (ANSI/IEEE C62.41).
 - i. In the event of the loss of normal power, ensure there will be an orderly shutdown of HVAC MEC to prevent loss of database or operating system software. Incorporate non-volatile memory for critical controller configuration data. Provide battery backup to support real-time clock and volatile memory for a minimum of 72 hours.
 - 1) Upon restoration of normal power, ensure HVAC MEC automatically resumes full operation without manual intervention.
 - 2) Should HVAC MEC memory be lost, ensure user will have capability of reloading HVAC MEC via local RS-232C port, via telephone line dial-in,, or from network workstation PC.
- 4. DDC and HVAC MEC Resident Software Features:
 - a. Specify software programs as an integral part of DDC and HVAC MEC, not dependent upon any higher-level computer for execution.
 - b. Identify points by up to 30-character point name and 16-character point descriptor.
 - c. Digital points shall have user defined two-state status indication (descriptors with minimum of eight characters allowed per state (i.e. summer/winter)).
 - d. DDC and HVAC MEC shall have ability to perform following pre-tested control algorithms:
Two-position control; Proportional control; Proportional plus integral control; Proportional, integral, plus derivative control; and Automatic tuning of control loops.
- 5. DDC and HVAC MEC Energy Management Routines: Provide to optimize energy consumption while maintaining occupant comfort.
 - a. Start-Stop Time Optimization (SSTO):

- 1) SSTO shall automatically be coordinated with event scheduling. SSTO program shall start HVAC equipment at latest possible time that will allow equipment to achieve desired zone condition by time of occupancy.
- 2) SSTO program shall shut down HVAC equipment at earliest possible time before end of occupancy period and still maintain desired comfort conditions.
- 3) SSTO program shall operate in heating and cooling seasons. Ensure that it will be possible to apply SSTO program to individual fan systems. SSTO program shall operate on outside weather conditions and inside zone conditions and empirical factors.
- 4) SSTO program shall meet local code requirements for minimum outside air while building is occupied.
- b. Event Scheduling:
 - 1) Provide comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
 - 2) It shall be possible to individually command a point or group of points.
 - 3) For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
 - 4) Operator shall be able to define: Time, day; Commands such as on, off, auto, and so forth; and Time delays between successive commands.
 - 5) There shall be provisions for manual overriding of each schedule by an appropriate operator.
 - 6) It shall be possible to schedule events up to one year in advance.
 - 7) Scheduling shall be calendar based.
 - 8) Holidays shall allow for different schedules.
- c. Enthalpy switchover (economizer):
 - 1) EMCS will control position of air handler relief, return, and outside air dampers.
 - 2) If outside air-dry bulb temperature falls below changeover set point, EMCS will modulate dampers to provide 100 percent outside air.
 - 3) User will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override economizer cycle and return to minimum outside air operation at any time.

- d. Temperature-compensated duty cycling:
 - 1) DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
 - 2) Loads shall be cycled such that there is a net reduction in electrical demands and energy consumed.
- e. Automatic Daylight Savings Time Switchover: System shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- f. Night setback control: System shall provide ability to automatically adjust set points for night control.
- 6. DDC and HVAC MEC Processes:
 - a. MEC shall be able to execute custom, job-specific, user-defined processes, to automatically perform calculations and special control routines.
 - b. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC MEC on network.
 - c. A single process shall be able to issue commands to points in all other DDC and HVAC MEC on the network.
 - d. Database shall support 30 characters, English language point names, structured for searching and logs.
 - e. Processes shall be able to generate operator messages and advisories to operator I/O devices.
 - f. A process shall be able to directly send a message to a specified device or cause execution of a dial-up connection to a remote device such as a printer or pager.
 - g. DDC and HVAC MEC shall provide HELP function key, providing enhanced context sensitive on-line help with task-orientated information from the user manual.
 - h. DDC and HVAC MEC shall be capable of comment lines for sequence of operation explanation.
- 7. Alarm Management:
 - a. Provide system to monitor and direct alarm information to operator devices.
 - b. Each DDC and HVAC MEC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost.
 - c. At no time shall DDC and HVAC MEC ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device, or communications with other panels on the network.

- d. All alarm or point change reports shall include point's English language description and time and date of occurrence.
 - e. User shall be able to define specific system reaction for each point.
 - f. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms.
 - g. Provide minimum of six priority levels for each point.
 - h. Combine point priority levels with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining handling of system alarms.
 - i. Each DDC and HVAC MEC shall automatically inhibit reporting of selected alarms during system shutdown and start-up.
 - j. Users shall have ability to manually inhibit alarm reporting for each point.
 - k. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) or based on priority.
 - l. In addition to point's descriptor and time and date, user shall be able to print, display or store a 200 character alarm message to more fully describe alarm condition or direct operator response.
8. Historical Data Collection:
- a. Provide variety of historical data collection utilities to manually or automatically sample, store and display system data for points as specified in I/O summary.
 - b. Any point, physical or calculated may be designated for trending.
 - c. Any point, regardless of physical location in network, may be collected and stored in each DDC and HVAC MEC point group.
 - d. Two methods of collection shall be allowed: by a pre-defined time interval or upon a pre-defined change of value.
 - e. Provide sample intervals of one minute to seven days.
 - f. Each DDC and HVAC MEC shall have dedicated RAM-based buffer for trend data and shall be capable of storing a data samples.
 - g. DDC and HVAC MEC shall provide high-resolution sampling capability for verification of control loop performance.
 - h. Provide operator-initiated automatic and manual loop tuning algorithms for operator-selected PID control loops as identified in point I/O summary.

- i. Loop tuning shall be capable of being initiated either locally at DDC and HVAC MEC, from network workstation or remotely using dial-in modems.
 - j. For loop-tuning functions, access shall be limited to authorized personnel through password protection.
9. DDC and HVAC MEC shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points.
10. DDC and HVAC MEC shall automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog and digital pulse input type points.
 - a. Tantalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., KWH, gallons, BTU, tons, etc.).
 - b. Totalization routine shall have sampling resolution of one minute or less.
 - c. User shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when limit is reached.
11. DDC and HVAC MEC shall have the ability to count events such as the number of times a pump or fan system is cycled on and off.
 - a. Event totalization shall be performed on a daily, weekly, or monthly basis for points as specified in the point I/O summary.
 - b. Event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.
 - c. User shall have ability to define a warning limit. Unique, user-specified messages shall be generated when limit is reached.
12. Peer-to-peer network shall allow DDC and HVAC MEC to access any data from or send control commands and alarm reports directly to other DDC and HVAC MEC or combination of controllers.
13. Peer-to-peer network shall allow DDC and HVAC MEC to assign minimum of 50 passwords access and control priorities to each point individually. Logon password shall enable operator to monitor, adjust, and control points that the operator is authorized for.
14. Floor Level Network Application Specific Controllers (ASC):
 - a. Each DDC Controller shall be able to extend its performance and capacity through use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.

- b. Each ASC shall operate as a stand-alone controller capable of performing its specific control responsibilities independently of other controllers in the network.
 - c. Each ASC shall be microprocessor-based, multi-tasking, and real-time digital control processor.
 - d. Provide following types of ASCs as a minimum:
 - 1) Central System Controllers;
 - 2) Terminal Equipment Controllers; and
 - 3) Package Unit.
 - e. Each ASC shall be capable of controlling the terminal device independent of manufacturer of terminal device.
15. Central System Controllers:
- a. Controllers shall include point inputs and outputs necessary to perform specified control sequence.
 - b. Ensure that 20 percent of point inputs and outputs are of the Universal type, allowing for additional system flexibility. In lieu of Universal inputs and outputs, provide minimum of 20 percent spare points of each type via additional point termination boards or controllers.
 - c. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in event communication with DDC Controller is lost and to ensure protection during power outages.
 - d. Programs shall be field-customizable to meet user's exact control strategy requirements. Central System controllers utilizing pre-packaged or canned programs will not be acceptable. As an alternative, provide DDC Controllers for central equipment in order to meet custom control strategy requirements.
 - e. Programming of central system controllers shall utilize same language and code as used by DDC Controllers to maximize system flexibility and ease of use. Should system controller utilize different control language, provide DDC Controller to meet required functionality.
 - f. Each controller shall have connection provisions for portable operator's terminal and will allow user to display, generate, or modify point databases and operating programs.
 - g. Provide door-mounted portable interface terminal or laptop to allow for direct-user access to controller.
 - h. Terminal shall provide user with following functionality as a minimum:
 - 1) View and set date and time;
 - 2) Modify and override time-of-day schedules;
 - 3) View points and alarms;

- 4) Monitor points;
 - 5) Command and modify set points.
 - i. Should system controller be unable to interface to door-mounted terminal, provide laptop or similar terminal at controller or provide DDC Controller with door-mounted or local terminal in lieu of system controller in order to meet minimum required functionality.
- 16. Terminal Equipment Controllers:
 - a. Provide for control of each piece of equipment, including, but not limited to, the following:
 - 1) Variable Air Volume (VAV) boxes;
 - 2) Constant Air Volume (CAV) boxes;
 - 3) Split Units;
 - 4) Fan powered boxes;
 - 5) Chillers;
 - 6) Pumps;
 - 7) Towers; and
 - 8) Boilers.
 - b. Controllers shall include point inputs and outputs necessary to perform specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 0-10v, allowing for interface to variety of modulating actuators. System shall monitor following points:
 - 1) Air Handlers:
 - On-off status;
 - Entering air temperature;
 - Leaving air temperature;
 - Entering chilled water temperature;
 - Leaving chilled water temperature;
 - Entering heating water temperature;
 - Leaving heating water temperature;
 - Supply fan airflow;
 - Return fan airflow;
 - Exhaust fan airflow;
 - Outside airflow;
 - Filter static pressure.
 - 2) Chillers:
 - On-off status;
 - Entering chilled water temperature;
 - Leaving chilled water temperature;
 - Entering condenser water temperature;
 - Leaving condenser water temperature;
 - Percent of full load;
 - Chilled water flow;
 - Condenser water flow;
 - Safety controls.
 - 3) Boilers:
 - On-off status;
 - Hot water temperature supply;

- Hot water temperature return;
 - Percent of full load;
 - Safety controls.
 - 4) Cooling Towers:
 - On-off status;
 - Entering condenser water temperature;
 - Leaving condenser water temperature;
 - Percent of full load;
 - Fan status;
 - Condenser water flow;
 - Freeze protection status.
 - 5) Computer room air-conditioning units.
 - 6) Fan coil units.
 - 7) Pumps:
 - VFD on-off status;
 - VFD speed;
 - VFD safety controls;
 - Entering water pressure;
 - Leaving water pressure.
 - 8) High temperature alarm from IT rooms: Safety controls.
 - c. Ensure controller sequences and operation provide closed loop control of intended application. Closing control loops over the FLN, BLN or MLN will not be acceptable.
- 17. Field Devices:
 - a. Provide instrumentation as required for monitoring, control or optimization functions.
 - b. Temperature Sensors:
 - 1) Digital room sensors shall have LCD display, day / night override button, and set point slide adjustment override options. Set point slide adjustment can be software limited by automation system to limit amount of room adjustment.
 - Temperature monitoring range: plus 20 degrees F to 120 degrees F (minus 13 degrees to 49 degrees C).
 - Output signal changing resistance.
 - Accuracy at Calibration point: Plus 0.5 degree F (plus or minus 0.3 degree C.)
 - Set Point and Display Range: 55 degrees F to 95 degrees F (13 degrees C to 35 degrees C.)
 - 2) Liquid immersion temperature:
 - Temperature monitoring range: Plus 30 degrees F to 250 degrees F (minus 1 degree C to 121 degrees C.)
 - Output signal changing resistance.
 - Accuracy at Calibration Point: Plus 0.5 degree F (plus or minus 0.3 degree C.)

- 3) Duct (single point) temperature:
 - Temperature monitoring range: Plus 20 degrees F to 120 degrees F (minus 7 degrees C to 49 degrees C.)
 - Output signal changing resistance.
 - Accuracy at Calibration Point: Plus 0.5 degree F (plus or minus 0.3 degree C.)
- 4) Duct Average temperature:
 - Temperature monitoring range: Plus 20 degrees F to 120 degrees F (minus 7 degrees C to plus 49 degrees C.)
 - Output signal: 4 – 20 ma DC.
 - Accuracy at Calibration Point: Plus 0.5 degree F (plus 0.3 degree C.)
 - Sensor Probe Length: 25 feet (7.3m).
- 5) Outside air temperature:
 - Temperature monitoring range: 58 degrees F to 122 degrees F (minus 50 degrees C to plus 50 degrees C.)
 - Output signal: 4 – 20 ma DC.
 - Accuracy at Calibration Point: Plus 0.5 degree F (plus or minus 0.3 degree C.)
- c. Liquid Differential Pressure Transmitter:
 - 1) Ranges
 - 0-5/30 inches H2O
 - 0-25/150 inches H2O
 - 0-125/750 inches H2O
 - 2) Output 4 – 20 ma DC
 - 3) Calibration Adjustments Zero and span
 - 4) Accuracy: Plus or minus 0.2 percent of span
 - 5) Linearity: Plus or minus 0.1 percent of span
 - 6) Hysteresis: Plus or minus 0.05 percent of span
- d. Differential pressure:
 - 1) Unit for fluid flow proof: Penn P74.
 - Range: 8 to 70 psi
 - Differential: 3 psi
 - Maximum differential pressure: 200 psi
 - Maximum pressure: 325 psi
 - 2) Unit for airflow: Siemens Building Technologies SW141:
 - Set point ranges: 0.5" WG to 1.0" WG (124.4 to 248.8 Pa)
 - 1.0" WG to 12.0" WG (248.8 to 497.6 Pa)
- e. Static pressure sensor:
 - 1) Range:
 - 0 to .5" WG (0 to 124.4 Pa)
 - 0 to 1" WG (0 to 248.8 Pa)
 - 0 to 2" WG (0 to 497.7 Pa)
 - 0 to 5" WG (0 to 1.2 kPa)

- 0 to 10" WG (0 to 2.5 kPa)
 - 2) Output Signal 4 – 20 ma VDC
 - 3) Combined static error 0.5 percent full range
 - 4) Operating Temperature: Minus 40 degrees F to 175 degrees F (minus 40 degrees C to 79.5 degrees C).
- f. Air Pressure Sensor:
 - 1) Ranges:
 - 0 to 0.1 in. water (0 to 24.9 Pa)
 - 0 to 0.25 in. water (0 to 63.2 Pa)
 - 0 to 0.5 in. water (0 to 124.5 Pa)
 - 0 to 1.0 in. water (0 to 249 Pa)
 - 0 to 2.0 in water 90 to 498 Pa)
 - 0 to 5.0 in. water (0 to 1.25 kPa)
 - 0 to 10.0 in. water (0 to 2.49 kPa)
 - 2) Output signal 4 to 20 ma
 - 3) Accuracy: Plus 1 percent of full scale
- g. Damper Actuators:
 - 1) Automatic dampers shall have electric actuators.
 - 2) Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, metal housing, manual override, independently adjustable dual auxiliary switch.
 - 3) Actuator assembly shall include hardware and proper mounting and connection to standard 1/2-inch diameter shaft or damper blade.
 - 4) Design for mounting directly to damper shaft without need for connecting linkages.
 - 5) Actuators having more than 100 lb-in torque output shall have self-centering damper shaft clamp that guarantees concentric alignment of actuator's output coupling with damper shaft.
 - 6) Self-centering clamp shall have pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength.
 - 7) Single clamping bolt shall simultaneously drive both cradles into contact with damper shaft.
 - 8) Actuators having more than 100 lb-in torque output shall accept 1-inch diameter shaft directly, without need for auxiliary adapters.
 - 9) Designed and manufactured using ISO 9000 registered procedures, UL873 and CSA22.2 listed.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Minimum Energy Performance, LEED NC V2.2, EA Prerequisite 2.

- b. Optimize Energy Performance, LEED NC V2.2, EA Credit 1.
 - c. Measurement and Verification, LEED NC V2.2, EA Credit 5.
 - d. Outdoor Air Delivery Monitoring, LEED NC V2.2, EQ Credit 1.
 - e. Controllability of System, LEED NC V2.2, EQ Credit 6.2
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

E. EXECUTION

- 1. Examination
 - a. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
 - b. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
 - c. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.
- 2. Protection
 - a. The contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.
 - b. The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3. Coordination
 - a. Site
 - 1) The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner such as mechanical contractor, general contractor, construction manager, owner or owner's representative as applicable.
 - 2) The controls contractor shall follow prime contractor's job schedule and coordinate all project related activities through the prime contractor except otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.
 - 3) Where the work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.
 - 4) If the contractor deviates from the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other contractor shall make the necessary changes to correct the condition without extra charge.
 - 5) Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
 - b. Submittals.
 - 1) Refer to the -Submittals article in Part 1 of this specification for requirements.
 - c. Test and Balance
 - 1) The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2) The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 - 3) In addition, the contractor shall provide a qualified technician for duration of 8 hours to assist in the test and balance process.
 - 4) The tools used during the test and balance process shall be returned at the completion of the testing and balancing.
 - d. Life Safety
 - 1) Duct smoke detectors required for air handler shutdown are supplied under Division 26 of this specification. The

- contractor shall interlock smoke detectors to air handlers for shutdown as described in Part E, "Sequences of Operation".
- 2) Smoke dampers and actuators required for duct smoke isolation are provided under a Section of Division 15. The contractor shall interlock these dampers to the air handlers as described in Part E, "Sequences of Operation".
 - 3) Fire/smoke dampers and actuators required for fire rated walls are provided under another Section of Division 15. Control of these dampers shall be by Division 26.
- e. Coordination with controls specified in other sections or divisions.
- 1) Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
 - All communication media and equipment shall be provided as specified in Part C "Products" of this specification.
 - Each supplier of controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section.
 - The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 - The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 - The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is

described within the contract documents.

4. General Workmanship
 - a. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
 - b. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
 - c. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
 - d. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
 - e. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Field Quality Control
 - a. Contractor shall have a 6 Sigma certified quality manager on staff to inspect the project execution and to enforce quality standards.
 - b. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.
 - c. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
 - d. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.
6. Existing Equipment
 - a. Unless otherwise directed, the contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the engineer is to be notified immediately.
7. Wiring
 - a. All control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
 - b. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved conduit according to NEC and Division 26 requirements.
 - c. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be

- sub fused when required to meet Class 2 current limit.)
- d. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.
 - e. All wiring shall be in conduit without exceptions.
 - f. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
 - g. Do not install wiring in conduit containing tubing.
 - h. Where plenum rated cable is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
 - i. Where plenum rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.
 - j. All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.
 - k. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
 - l. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers or interposing relays.
 - m. All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.
 - n. Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.
 - o. Size and type of conduit and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
 - p. Include one pull string in each conduit 3/4 in. or larger.
 - q. Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel

- enclosures unless they also contain Class 1 starters.
- r. Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
- s. Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.
- t. Adhere to this specification's Division 26 requirements where conduit crosses building expansion joints.
- u. The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- v. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed (3 ft) in length and shall be supported at each end. Flexible metal conduit less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.
- w. Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.
- 8. Communication Wiring
 - a. The contractor shall adhere to the items listed in the "Wiring" article in Part E of the specification.
 - b. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
 - c. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
 - d. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
 - e. Contractor shall verify the integrity of the entire network following the cable installation. Use

- appropriate test measures for each particular cable.
- f. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
- g. All runs of communication wiring shall be unspliced length when that length is commercially available.
- h. All communication wiring shall be labeled to indicate origination and destination data.
- i. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding".
- 9. Installation of Sensors
 - a. General:
 - 1) Install sensors in accordance with the manufacturer's recommendations.
 - 2) Mount sensors rigidly and adequately for the environment within which the sensor operates.
 - 3) Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
 - 4) All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
 - 5) Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.
 - 6) Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.
 - 7) All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
 - 8) Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
 - b. Room Instrument Mounting
 - 1) Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted 53 inches above the finished floor unless otherwise shown.
 - c. Instrumentation Installed in Piping Systems

- 1) Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.
- 2) Gauges in piping systems subject to pulsation shall have snubbers.
- 3) Gauges for steam service shall have pigtail fittings with isolation valves.
- d. Duct Smoke Detectors
 - 1) Duct smoke detectors will be provided by the Fire Alarm System Contractor in supply and return air ducts in accordance with Division 26
 - 2) Contractor shall connect the DDC System to the auxiliary contacts provided on the Smoke Detector as required for system safeties and to provide alarms to the DDC system.
- e. Occupancy Sensors, if required
 - 1) A sufficient quantity of occupancy sensors shall be provided to provide complete coverage of the area (room or space).
 - 2) Occupancy sensors shall be installed in accordance with NFPA 70 requirements and the manufacturer's instructions.
 - 3) Occupancy sensors shall not be located within (6 feet) of HVAC outlets or heating ducts.
 - 4) PIR and dual-technology PIR/ultrasonic sensors shall not be installed where they can "see" beyond any doorway.
 - 5) Ultrasonic sensors shall not be installed in spaces containing ceiling fans.
 - 6) Sensors shall detect motion to within (2 feet) of all room entrances and shall not trigger due to motion outside the room.
 - 7) The off-delay timer shall be set to 15 minutes unless otherwise shown.
 - 8) All sensor adjustments shall be made prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc.
 - 9) Each controlled area shall have one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.
- f. Temperature Limit Switch
 - 1) A temperature limit switch (Low Temperature Detector) shall be provided to sense the temperature.

- 2) A sufficient number of temperature limit switches shall be installed to provide complete coverage of the duct section.
- 3) Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily.
- 4) The temperature limit switch sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.
- 5) Each bend shall be supported with a capillary clip. Provide 1 ft. of sensing element for each 1 ft² of coil area.
- g. Averaging Temperature Sensing Elements
 - 1) Sensing elements shall be installed in a serpentine pattern.
 - 2) Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- h. Air Flow Measuring Stations (AFMS) to be provided and installed by mechanical
 - 1) Outside Air AFMSs shall be located downstream from the Outside Air filters.
 - 2) Pitot Tube type AFMS shall not be used if the expected velocity measurement is below (700 fpm) [or for outside airflow measurements.
- i. Differential air static pressure
 - 1) Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2) Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3) Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4) The piping to the pressure ports on all pressure transducers shall contain a

- capped test port located adjacent to the transducer.
 - 5) All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork.
 - 6) Mount transducers in a location accessible for service without use of ladders or special equipment.
 - j. Water Differential pressure sensors
 - 1) Differential pressure sensors shall be installed with valved taps into the piping to ensure serviceability without draining the system
 - 2) Sensors shall be mounted with bleed valves
 - 3) After sensor installation any air shall be eliminated using the bleed valves to ensure reading accuracy
 - 4) The sensors shall be located to ensure accessibility
 - k. Relative Humidity Sensors
 - 1) Relative humidity sensors in supply air ducts shall be installed at least (10 feet) downstream of humidity injection elements.
 - l. Flowmeters
 - 1) The minimum straight unobstructed piping for the flowmeter installation shall be at least 10 pipe diameters upstream and at least 5 pipe diameters downstream and/or in accordance with the manufacturer's installation instructions.
 - m. Flow Switch
 - 1) Use correct paddle for pipe diameter.
 - 2) Adjust flow switch in accordance with manufacturer's instructions.
- 10. Flow Switch Installation by Mechanical Contractor
 - a. Use correct paddle for pipe diameter.
 - b. Adjust flow switch in accordance with manufacturer's instructions.
- 11 Actuators
 - a. Mount and link control damper actuators according to manufacturer's instructions.
 - 1) To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2) Check operation of damper/actuator combination to confirm that actuator

- modulates damper smoothly throughout stroke to both open and closed positions.
 - 3) Provide all mounting hardware and linkages for actuator installation.
 - b. Electric/Electronic
 - 1) Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
 - 2) Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.
- 12 Warning Labels and Identification Tags
 - a. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
 - 1) Labels shall use white lettering (12-point type or larger) on a red background.
 - 2) Warning labels shall read as follows:
"C A U T I O N This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing".
 - b. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1) Labels shall use white lettering (12-point type or larger) on a red background.
 - 2) Warning labels shall read as follows:
"C A U T I O N This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing".
 - c. Equipment and Device labeling
 - 1) Labels and tags shall be keyed to the unique identifiers shown on the As-Built drawings.
 - 2) All Enclosures and DDC Hardware shall be labeled.
 - 3) All sensors and actuators not in occupied areas shall be tagged.
 - 4) Airflow measurement arrays shall be tagged to show flow rate range for signal

- output range, duct size, and pitot tube AFMS flow coefficient.
 - 5) Duct static pressure taps shall be tagged at the location of the pressure tap.
 - 6) Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire.
 - 7) Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to the enclosure or DDC Hardware.
 - 8) Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.
 - 9) Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
 - 10) Identify room sensors relating to terminal box or valves with nameplates.
 - 11) Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
 - d. Identification of Tubing and Wiring
 - 1) All wiring and cabling including that within factory-fabricated panels shall be labeled at each end within (2 in.) of termination with the DDC address or termination number.
 - 2) Permanently label or code each point of field terminal strips to show the instrument or item served.
13. Identification of Hardware and Wiring
- a. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within (2 in.) of termination with the DDC address or termination number.
 - b. All pneumatic tubing shall be labeled at each end within (2 in.) of termination with a descriptive identifier.
 - c. Permanently label or code each point of field terminal strips to show the instrument or item served.
 - d. Identify control panels with minimum (½ in.) letters on laminated plastic nameplates.
 - e. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
 - f. Identify room sensors relating to terminal box or valves with nameplates.

- g. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
 - h. Identifiers shall match record documents.
 - 14. Programming
 - a. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free within the primary controller for future use.
 - b. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point Naming standard shall be agreed upon between owner and BAS contractor. Refer to Submittals section in the General Section.
 - c. Software Programming
 - 1) Provide programming for the system and adhere to the sequences of operation provided. The contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation and be of different font and color in text editor. Use the appropriate technique based on one of the following programming types:
 - Text-based
 - Must provide actions for all possible situations
 - Must be modular and structured
 - Must be commented
 - Must provide line by line programming and compilation wizard to allow for ease of editing.
 - Graphic-based
 - Must provide actions for all possible situations
 - Must provide programming and compilation wizard to allow for ease of editing
 - Must be documented
 - d. Operator Interface
 - 1) Standard graphics—Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller,

- boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
- 2) Show terminal equipment information on a graphic summary table. Provide dynamic information for each point shown.
 - 3) The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.
 - 4) Contractor shall provide necessary programming to create all reports referred to in Part C "Operator Interface Software"
- 15 Control System Checkout and Testing
- a. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Commissioning work that requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
 - b. Phase I – Field I/O Calibration and Commissioning
 - 1) Verify that each control panel has been installed according to plans, specifications and approved shop drawings. Calibrate, test, and have signed off each control sensor and device. Commissioning to include, but not be limited to:
 - Sensor accuracy at 10, 50 and 90% of range.
 - Sensor range.

- Verify analog limit and binary alarm reporting.
 - Binary alarm and switch settings.
 - Actuator and positioner spring ranges if pneumatic actuation is utilized.
 - Fail-safe operation on loss of control signal, electric power, network communications, etc.
- c. Phase II – System Commissioning
- 1) Each ATC program shall be put on-line and commissioned. The contractor shall, in the presence of the owner and construction manager, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and re-tested.
- d. Phase III - Integrated System Program Commissioning
- 1) Tests shall include, but not be limited to:
- Data communication, both normal and failure modes.
 - Fully loaded system response time.
 - Impact of component failures on system performance and system operation.
 - Time/Date changes.
 - End of month/ end of year operation.
 - Season changeover.
 - Global application programs and point sharing.
 - System backup and reloading.
 - System status displays.
 - Diagnostic functions.
 - Power failure routines.
 - Battery backup.
 - Smoke Control, ents, in concert with Fire Alarm System testing.
 - Testing of all electrical and HVAC systems with other division of work.
- 2) Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test

- procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy and the system performance does not degrade over time.
- 3) Using the commissioning test data sheets, the contractor shall demonstrate each point. The contractor shall also demonstrate 100 percent of the system functions. The contractor shall demonstrate all points and system functions until all devices and functions meet specification.
 - 4) The B.M.S. contractor shall supply all instruments for testing. Instruments shall be turned over to the owner after acceptance testing.
 - 5) All test instruments shall be submitted for approval prior to their use in commissioning.
 - 6) Test Instrument Accuracy:
 - Temperature: $\frac{1}{4}$ F or $\frac{1}{2}$ % full scale, whichever is less.
 - Pressure: High Pressure (PSI): $\frac{1}{2}$ PSI or $\frac{1}{2}$ % full scale, whichever is less.
 - Low Pressure: $\frac{1}{2}$ % of full scale (in w.c.)
 - Humidity: 2% RH
 - Electrical: $\frac{1}{4}$ % full scale
 - 7) After the above tests are complete and the system is demonstrated to be functioning as specified, a thirty-day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the owner may request that performance tests be repeated.
- e. Additional testing, debugging and fine tuning
- 1) Provide an additional 100 hours of appropriate highest labor cost category to be used at the owner's discretion to test, debug and fine tune the system during standard business hours.
- 16 Control System Demonstration and Acceptance
- a. Demonstration
 - 1) Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance

- with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
- 2) The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part E of this specification.
 - 3) The demonstration process shall follow that approved in Part A, "Submittals". The approved checklists and forms shall be completed for all systems as part of the demonstration.
 - 4) The contractor shall provide at least one person equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
 - 5) As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
 - 6) Demonstrate compliance with Part A, "System Performance".
 - 7) Demonstrate compliance with sequences of operation through all modes of operation.
 - 8) Demonstrate complete operation of operator interface.
 - 9) Additionally, the following items shall be demonstrated:
 - DDC control loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC control loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes,

depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.

- Interface to the building fire alarm system.
- Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and electronic formats.

- 10) Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

b. Acceptance

- 1) All tests described in this specification shall have been performed to the satisfaction of both the engineer and/or owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
- 2) The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part A "Submittals".
- 3) Needs Assessment/Monitoring Plan. A monitoring and analysis plan must be provided by the vendor prior to the execution of the active analysis service contract. The plan should outline total system points monitored, needs addressed, projected energy impact and

price prior to execution of service contract. The system shall be able to support needs including, but not limited to:

- System Performance Optimization Analysis
 - Reduction in Energy Consumption
 - Reduction in System Downtime
 - Reduced Tenant Complaints
 - Compliance, Regulatory support/reporting
 - Staff optimization
 - Issue Tracking/Financial Justification
- 4) The active analysis service shall have the capabilities to evaluate systems and equipment.
- 5) The analysis of system, equipment and performance must detect issues and opportunities, evaluate root cause and quantify opportunities.
- 6) Reporting: Active analysis reporting shall be provided on a monthly interval in both hardcopy and electronic formats. The reports shall include the following key sections:
- Issue/opportunity identification with date found and date corrected/implemented
 - Financial impact of issues/opportunities
 - Issue/Opportunity description and recommended action
 - Issue/Opportunity category (Based on user needs), such as compliance/code, energy, O&M
 - Detailed analysis of each issue including:
 - Graphic of data used to generate issue/opportunity
 - Detailed description of graphical data
 - Detailed description of recommended fix/optimization
 - Detailed explanation of financial impact assessment
 - Reports shall reflect updates, resolutions and system changes if implemented during the reporting period.

17 Cleaning

- a. The contractor shall clean up all debris resulting from their activities daily. The contractor shall

remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

- b. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- c. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

18 Training

- a. The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed. Factory employed/certified instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays.
- b. Provide 40 (forty) hours of site-specific training for Owner's operating personnel. Training shall include:
 - 1) Day-to-day Operators:
 - Proficiently operate the system
 - Understand control system architecture and configuration
 - Understand DDC system components
 - Understand system operation, including DDC system control and optimizing routines (algorithms)
 - Operate the workstation and peripherals
 - Log on and off the system
 - Access graphics, point reports, and logs
 - Adjust and change system set points, time schedules, and holiday schedules
 - Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - Understand system drawings and Operation

- and Maintenance manual
- Understand the job layout and location of control components
- Access data from DDC controllers and ASCs
- Operate portable operator's terminals
- 2) Advanced Operators:
 - Make and change graphics on the workstation
 - Create, delete, and modify alarms, including annunciation and routing of these
 - Create, delete, and modify point trend logs and graph or print these both on an ad- hoc basis and at user-definable time intervals
 - Create, delete, and modify reports
 - Add, remove, and modify system's physical points
 - Create, modify, and delete programming
 - Add panels when required
 - Add operator interface stations
 - Create, delete, and modify system displays, both graphical and others
 - Perform DDC system field checkout procedures
 - Perform DDC controller unit operation and maintenance procedures
 - Perform workstation and peripheral operation and maintenance procedures
 - Perform DDC system diagnostic procedures
 - Configure hardware including PC boards, switches, communication, and I/O points
 - Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - Adjust, calibrate, and replace system components
- 3) System Managers/Administrators:
 - Maintain software and prepare backups
 - Interface with job-specific, third-party operator software
 - Add new users and understand password security procedures

- c. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If such training is required by the Owner, it will be contracted at a later date. Provide description in the Technical Proposal of available local and factory customer training.
- d. Provide course outline and materials in accordance with the "Submittals" article in Part A of this specification. The instructor(s) shall provide one copy of training material per student.
- e. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

23 21 23 HYDRONIC PUMPS

A. SUMMARY

1. Section includes base mounted and inline; close coupled and separated coupled hydronic pumps; single speed or VFD application type.
2. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with UL 778 for motor-operated water pumps.

B. MANUFACTURERS

1. Aurora Pump.
2. Bell & Gossett.
3. PACO.

C. PRODUCTS

1. Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 125-psig minimum working pressure and continuous water temperature of 250 degrees F (121 degrees C).
2. Pump Casing: Cast Iron with 125 psig ANSI/PN16 flanges for working pressure below 175 psig (12 bar) at 150 degrees F (65 degrees C) and ductile Iron with 250 psig ANSI/PN25 flanges for working pressures to 375 psig (25 bar) at 150 degrees F (65 degrees C). Suction and discharge connections shall be flanged and same size; drilled and tapped for seal flush and gauge connections.
3. Impeller: Bronze, fully enclosed type; dynamically balanced; two-plane balancing is required where installed impeller diameter is less than six times impeller width.
4. Shaft: Stainless steel.
5. Coupling: Rigid spacer type of high tensile aluminum alloy; designed to be easily removed on site to reveal space between pump and motor shafts sufficient to remove mechanical seal components for servicing and to be replaced without disturbing pump or motor.
6. Mechanical Seals: Stainless steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat; Type 316 stainless steel gland plate. Provide factory installed flush line with manual vent.
7. Motor: Single speed or multi-speed compatible with variable frequency drive (VFD) where applicable; high efficiency type, with permanently lubricated ball bearings;

rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 36 00 AIR TERMINAL UNITS

A. SUMMARY

1. Section includes single-duct air terminal units (VAV box) and fan-powered air terminal units.
2. Structural Performance: Hangers and supports and seismic restraints shall withstand effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by qualified testing agency, marked for intended location and application.
4. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.

B. MANUFACTURERS

1. Carrier.
2. Krueger.
3. Titus.
4. Trane.

C. PRODUCTS

1. Series Fan-Powered Air Terminal Units:
 - a. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside protective metal shroud for installation above ceilings.
 - b. Casing: 20 gage galvanized, single wall.
 - 1) Casing Lining: Adhesive attached; 1/2-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having maximum flame-spread index of 25 and maximum smoke-developed index of 50, for insulation and adhesive, when tested according to ASTM E 84.
 - 2) Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 - 3) Air Outlet: S-slip and drive connections.
 - 4) Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 - 5) Fan: Forward-curved centrifugal.
 - c. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

- 1) Maximum Damper Leakage: ARI 880 rated, 23 percent of nominal airflow at 3-inch wg inlet static pressure.
- 2) Damper Position: Normally open.
- d. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.
- e. Motor:
 - 1) Type: Permanent-split capacitor with SCR for speed adjustment; high efficiency type, where applicable.
 - 2) Fan-Motor Assembly Isolation: Rubber isolators.
 - 3) Enclosure: Open dripproof.
 - 4) Enclosure Materials: Cast iron.
- f. Filters: Minimum arrestance according to ASHRAE 52.1 and minimum efficiency reporting value (MERV) according to ASHRAE 52.2. Provide LEED filtration requirements, if applicable.
 - 1) Material:
 - Polyurethane foam having 70 percent arrestance and 3 MERV.
 - Glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.
 - Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
 - 2) Thickness: 1 inch.
- g. Attenuator Section: 0.034-inch steel sheet.
 - 1) Lining: Adhesive attached, 3/4-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having maximum flame-spread index of 25 and maximum smoke-developed index of 50, for insulation and adhesive, when tested according to ASTM E 84.
 - Cover liner with nonporous foil.
 - Cover liner with nonporous foil and perforated metal.
 - 2) Lining: Adhesive attached, 3/4-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements and having maximum flame-spread index of 25 and maximum smoke-developed index of 50, for insulation and adhesive, when tested according to ASTM E 84.
 - 3) Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1-inch and rated for minimum working pressure of 200 psig and maximum

- entering-water temperature of 220 degrees F
Include manual air vent and rain valve.
- 4) Factory-Mounted and –Wired Controls:
Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 - Siemens ATEC Controller Pre Wired.
 - Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 - Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 - Disconnect Switch: Factory-mounted, fuse type.
- 5) Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- 6) Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor.
- 2. Single-Duct Air Terminal Units:
 - a. Configuration: Volume-damper assembly inside unit casing with control components inside protective metal shroud.
 - b. Casing: 22 gage galvanized wall.
 - 1) Casing Lining: Adhesive attached, 1/2-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, having maximum flame-spread index of 25 and maximum smoke-developed index of 50, for insulation and adhesive, when tested in accordance with ASTM E 84.
 - 2) Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3) Air Outlet: S-slip and drive connections.
 - 4) Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - c. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1) Maximum Damper Leakage: ARI 880 rated, 23 percent of nominal airflow at 3-inch wg inlet static pressure.
 - 2) Damper Position: Normally closed.

- d. Attenuator Section:
 - 1) 0.034-inch steel sheet.
 - 2) Lining: Adhesive attached, 3/4-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having maximum flame-spread index of 25 and maximum smoke-developed index of 50, for insulation and adhesive, when tested in accordance with ASTM E 84.
- e. Multioutlet Attenuator Section: With two, three or four 6-inch, 8-inch, or 10-inch-diameter collars, each with locking butterfly balancing damper.
- f. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for minimum working pressure of 200 psig and maximum entering-water temperature of 220 degrees F. Include manual air vent and drain valve.
- g. Direct Digital Controls: Single-package unitary controller and actuator.
 - 1) Damper Actuator: 24 volts, powered closed, spring return open.
 - 2) Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.
 - 3) Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 52 00 HEATING BOILERS

A. SUMMARY

1. Section includes modular packaged, factory-fabricated and-assembled, gas-fired, finned water-tube boilers, trim, and accessories for generating hot water.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
4. Specify boilers that are tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with IBR (Hydronic Institute of Boiler and Radiator Manufacturers) emblem on nameplate affixed to boiler.
5. Meet NOx and other California Air Resource Board annual permit requirements.
6. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.

B. MANUFACTURERS

1. Fulton.
2. Lochinvar Corporation.
3. Raypak.

C. PRODUCTS

1. Water containing section shall consist of two integrated heat exchangers constructed of "Fin Tube" design, with straight copper tubes having extruded integral fins spaced seven fins per inch.
2. Tubes shall be "rolled" securely into glass-lined, cast iron headers.
3. There shall be no bolts, gaskets or "O" rings in head configuration.
4. Ensure removable access plugs are provided on heat exchanger headers for purposes of inspection, cleaning or repair.
5. Boiler drains shall be provided, having external access.
6. Ensure that heat exchanger will be mounted in a stress free jacket assembly to provide a "free floating design" able to withstand effects of thermal shock.
7. Boiler shall bear ASME "H" stamp for 160 psi working pressure and shall be National Board listed.
8. Boiler shall be equipped to accept return water temperatures as low as 50 degrees F with specified minimum set point temperatures of auxiliary piping or preheat loops.

9. Boiler shall be supplied with circulating pump wired for continuous operation.
10. Installations shall require primary/secondary piping to reduce overall head loss in heating system.
11. Secondary circulators will operate intermittently to prevent radiant heat loss due to water circulation through boilers in off mode.
12. Combustion chamber shall be constructed of stainless steel, sealed for combustion.
13. Burner surface shall be constructed of high temperature aluminum/chromium alloy woven mesh and fire in vertical plane within combustion chamber.
14. Burner shall employ special perforated flame injection tube extending entire length of heat exchanger.
15. Burner must be capable of firing at complete blue flame with maximum gas and air input as well as firing infrared when gas and air are reduced.
16. Burner must be capable of firing at 100 percent of rated output when supplied with 4 inches water column of inlet gas pressure, so as to maintain service under heavy demand conditions, no exceptions.
17. Burner shall fire in full 360-degree pattern resulting in uniform heat transfer upon every inch of heating surface.
18. Provide viewing port permitting visual observation of burner operation.
19. Hot water boiler shall use combustion air blower to precisely control fuel/air mixture for maximum efficiency.
20. Ensure that all-aluminum blower will be mounted on burner and draw gas and air from premixing chamber.
21. Utilization of variable frequency drive will enable blower to infinitely vary its' speed, therefore adjusting volume of gas and air supplied for combustion.
22. Boiler shall operate between 25 percent and 100 percent of rated output.
23. Combustion air blower shall operate for pre-purge period before burner ignition and post-purge period after burner operation to clear combustion chamber.
24. Boiler shall be constructed with a 16 gage galvanized steel jacket assembly.
25. Interior of combustion chamber and flue collector shall be constructed completely of stainless steel to ensure corrosion protection.
26. Inner and outer jacket panels shall be fully gasketed and sealed.
27. Exterior of jacket assembly shall be primed and pre-painted on both sides with minimum 0.7 mil dry film thickness.
28. Models shall be certified for installation on combustible floors without additional safety provisions.
29. Boiler shall be designed to allow field installation of multiple venting options.

30. Boiler shall be vented with vertical positive draft, Category IV vent system drawing combustion air from equipment room.
31. Boiler shall be certified and listed by C.S.A. International under latest edition of harmonized ANSI Z21.13 test standard for US and Canada.
32. Boiler shall comply with energy efficiency requirements of ASHRAE 90.1.
33. Boiler shall be rated minimum 85 percent thermal efficiency.
34. Boiler shall be equipped with interface controller with microprocessor based platform, capable of full diagnostics.
35. Internal safety, operating and ignition controls shall interface with microprocessor controller.
36. Boiler interface control shall provide on/off control of gas supply to burner, operation of VFD to control variable speed combustion air blower, interface with ignition control system, on/off control of integral circulating pump, operation of floating point bypass valve, control of water temperature set points, and monitoring of safety functions.
37. Local communication, programming and display of operating and alarm status conditions shall be accessible through digital display panel.
 - a. Digital panel shall display 21 data points on each unit and be capable of monitoring up to 16 individual units.
 - b. Displayed data points include temperature, unit operation status, operational sensor location, total run time, (sequencing operation – optional), and firing rate.
 - c. Digital display panel may be optionally remote mounted and communicate with BOILER(S) via twisted pair cable connection.
38. Boiler interface control shall serve as an operating temperature control to track demand and regulate amount of heat added to the system to meet hot water demand.
39. Boiler interface control shall be capable of varying burner input from 25 percent up to 100 percent of rated input.
40. Burner input may vary in steps as small as 1 percent of input allowing up to 75 adjustable steps while tracking hot water demand.
41. Access to boiler interface controller shall be made by a wiring harness with unique multiple pin terminations for each connection point.
42. Access to boiler interface controller to adjust settings shall be limited by changeable password system entered through digital display panel.
43. Standard operating controls shall include adjustable immersion type, digital temperature controller and immersion safety, adjustable manual reset high limit to regulate boiler water temperatures.

44. Multiple air pressure switches shall be provided to prove operation of combustion air fan, monitor combustion chamber pressures and monitor operation of flue.
45. Standard control system shall include electronic ignition system with full flame monitoring capability.
46. Additional standard controls shall include low voltage transformer for control circuit, flow switch to prove water flow, inlet and outlet temperature displays, and factory installed ASME pressure relief valve.
47. Ensure that manufacturer verifies proper operation of burners, controls and heat exchanger by connection to gas, water and venting for a full factory fire test prior to shipping. Require quality test report shipped with each unit.
48. Ensure unit control panel contains lighted on/off main power switch, alarm light and audible silence switch, and high temperature alarm light.
49. Provide central monitor for boiler. Monitor shall provide digital display of 21 data points on each unit and be capable of monitoring up to 16 individual units. Displayed data points shall include temperatures, unit operation status, (outdoor air reset programming -optional), operational sensor location, total run time, and firing rate.
50. Provide 24 volts AC control circuit and components in conjunction with 24-volt circuit breaker.
51. Ensure components are easily accessible and serviceable from front and top of unit.
52. Wiring harness connections shall have multi-pin plug in type connectors to ease service, troubleshooting and reduce removal and replacement cost.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Minimum Energy Performance, LEED NC V2.2, EA Prerequisite 2.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance. Ensure that five-year warranty from boiler manufacturer will be provided.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 64 16 CENTRIFUGAL WATER CHILLERS

A. SUMMARY

1. Section includes packaged, water-cooled, electric-motor-driven centrifugal chillers and packaged, portable refrigerant recovery units.
2. Hermetic and open; direct and gear drives; water and air cooled water chillers.
3. Provide variable frequency drives on all chillers.
4. Certify chiller according to ARI 550 certification program.
5. Rate chiller performance in accordance with ARI 550/590.
6. ASHRAE Compliance Considerations:
 - a. ASHRAE 15 for safety code for mechanical refrigeration.
 - b. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage.
 - c. Applicable requirements in ASHRAE/IESNA 90.1.
7. Comply with NFPA 70.
8. Comply with requirements of UL and UL Canada, and include label by qualified testing agency showing compliance.
9. Green Seal Compliance: Signed by manufacturer certifying compliance with GS-31.
10. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.

B. MANUFACTURERS

1. Carrier.
2. Mcquay.
3. Trane.
4. Turbocore.

C. PRODUCTS

1. Manufactured Unit Characteristics:
 - a. Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.
 - b. Disassemble chiller into major assemblies as required by installation after factory testing and before packaging for shipment.
 - c. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during seismic event when chiller is anchored to field support structure.
 - d. Provide interface controller with microprocessor-based platform capable of full diagnostics.

2. Compressor-Drive Assembly
 - a. Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
 - b. Compressor:
 - 1) Casing: Cast iron, precision ground.
 - 2) Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
 - c. Compressor Motor:
 - 1) Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
 - 2) Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
 - 3) Of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
 - d. Oil Lubrication System: Consisting of pump, filtration, heater, cooler, factory-wired power connection, and controls.
3. Refrigeration:
 - a. Refrigerant: Type: R-123; ASHRAE 34, Class B1.
 - b. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying required performance requirements..
 - c. Pressure Relief Device: Comply with requirements in ASHRAE 15 and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - d. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to remote refrigerant storage and recycling system. Comply with ASHRAE 15 and ASHRAE 147.
 - e. Purge System: For chillers operating at subatmospheric pressures (using R-123 refrigerant), factory install automatic purge system for collection and return of refrigerant and lubricating oil and for removal of noncondensables including, but not limited to, water, water vapor, and noncondensable gases.
4. Evaporator:
 - a. Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell; shell separate from condenser.
 - b. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

- c. Designed to prevent liquid refrigerant carryover from entering compressor.
 - d. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
- 5. Condenser:
 - a. Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell; shell separate from evaporator.
 - b. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
- 6. Insulation:
 - a. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - b. Thickness: 3/4-inch.
- 7. Variable Frequency Controller:
 - a. Factory mounted and wired on chiller to provide single-point, field-power termination to chiller and its auxiliaries.
 - b. NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
 - c. Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Fundamental Refrigerant Management, LEED NC, V2.2, EA Prerequisite 3.
 - b. Enhanced Refrigerant Management, LEED NC, V2.2, EA Credit 4.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 65 00 COOLING TOWERS

A. SUMMARY

1. Section includes factory assembled open and closed circuit, forced draft, cross and counter-flow towers.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
5. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."
6. FMG approval and listing in the latest edition of FMG's "Approval Guide."
7. Construction: Stainless steel.
8. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.

B. MANUFACTURERS

1. Baltimore Aircoil.
2. Evapco Inc.
3. Recold.

C. PRODUCTS

1. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
2. Casing and Frame Material: Stainless steel.
3. Frame Material: Stainless steel.
 - a. Joints and Seams: Sealed watertight.
 - b. Welded Connections: Continuous and watertight.
4. Collection Basin:
 - a. Material: Stainless steel.
 - b. Strainer: Removable stainless-steel.
5. Basin Sweeper Distribution Piping and Nozzles:
 - a. Pipe Material: PVC
 - b. Nozzle Material: Plastic.
6. Fill: Materials: PVC.
7. Centrifugal Fan:
 - a. Double-width, double-inlet, forward-curved blades, and statically and dynamically balanced at factory after assembly.

- b. Each cooling tower cell shall have single fan or multiple fans connected to common shaft.
- c. Fan Wheel and Housing Materials: Stainless steel.
- d. Fan Shaft: Stainless steel.
- e. Protective Enclosure: Removable, stainless-steel, wire mesh screens complying with OSHA regulations.
- f. Fan Motor: High-efficiency type; comply with NEMA designation and temperature-rating requirements. Each motor shall be operated by Variable Frequency Drive (VFD).

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

23 73 13 CUSTOM AIR HANDLING UNITS

A. SUMMARY

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.
2. Section includes.
 - a. Agency Listing
 - b. Unit Nameplates and Labels
 - c. Casing Performance
 - d. Bases and Floors
 - e. Walls
 - f. Access Doors
 - g. Roofs
 - h. Shipping Splits
 - i. Unit Paint
 - j. Dampers
 - k. Outside and Return Airflow Measuring Stations
 - l. Air Filters
 - m. Cooling Coils
 - n. Chilled Water Coils
 - o. Primary Drain Pans
 - p. Intermediate Drain Pans
 - q. Fans
 - r. Unhoused Plenum Fans-Direct Drive
 - s. Fan Motors
 - t. Fan Airflow Measurement Systems
 - u. Trane Catalytic Cleaner System
 - v. Protection of Polymeric Materials
 - w. Safety
 - x. Vibration Isolation
 - y. Unit Acoustics
 - z. Marine Lights
 - aa. Marine Light Switches
 - bb. Variable Frequency Drives
3. Structural Calculations:
 - a. Provide structural calculations for the following:
 - 1) Structural Supports
 - 2) Structural Platforms
 - b. Calculations to include, at a minimum:
 - 1) Operational weight of new equipment
 - Equipment location relative to center of gravity.
 - Point of anchorage to the existing structure if applicable.

B. MANUFACTURERS

1. Energy Labs

2. Pace
3. Temtrol
4. Trane

C. PRODUCTS

1. Agency Listing
 - a. AHU's shall be agency listed to UL 1995 by UL or ETL
2. Unit Nameplates and Labels
 - a. Metal nameplates shall be provided on the units. All information contained on the nameplate shall be etched or burned into the surface to prevent fading. Information shall include:
 - 1) Job name, sales order number, unit tagging and service model number.
 - 2) MCA, MOP and maximum fuse/HACR circuit breaker size.
 - 3) Voltage, frequency, phase, Hp, FLA and inverter input current for all motors.
 - b. Labels for AHRI Standard 410 and the listing agency, either UL or ETL shall be provided on the units.
 - c. Labels shall be provided on the units for unit rigging and coil piping and connection instructions. Labels shall be provided on fans indicating direction of rotation. Warning labels shall be provided on appropriate components indicating hazardous voltage. For each section which must be assembled to another, matching steel identification tags shall be welded at each mating joint to ensure correct assembly order.
3. Casing Performance
 - a. Unit air leakage shall not exceed 1.0% of design cfm at +10.0" w.g. in all positive-pressure sections and -10.0" w.g. in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.
 - b. Casing deflection shall not exceed L/200 at +10.0" w.g. in all positive-pressure sections and -10.0" w.g. in all negative-pressure sections, where L is defined as the panel span.
 - c. IBC Seismic Certification
 - 1) All AHU's shall be certified for seismic applications in accordance with the following International Building Code (IBC) releases: IBC 2000, 2003, 2006, 2009.
 - 2) Seismic qualification testing and structural analysis shall be conducted in accordance with and strict adherence to the standards set forth within ASCE 7 by an independent approval agency with a complete list of

certified models, options and installation methods provided in an approved detailed report. The AHU's shall be approved for seismic applications when properly installed and used as intended. The basis of the certification shall be obtained through a combination of testing of the active and energized components per AC-156, and analysis of the main force resisting members of the unit.

- 3) The certification shall be based on a maximum Design Structural Response Acceleration at Short Period (Sds) value of 1.85 g's for IBC 2006 and 2009, and 1.93 g's for IBC 2000 and 2003. This is obtained from the Maximum Considered Earthquake Short Period Spectral Response Acceleration, Ss of 2.78 g's or 20.0 g's as determined by the ASCE 7 seismic maps for Soil Site Class B with 5 percent damping. When the site soil properties or final equipment installation location are not known, the soil site coefficient, Fa, defaults to the Soil Site Class D coefficient. Occupancy Category IV and Seismic Design Category C shall be covered under this certification, limited by the Sds value stated above. A seismic importance factor, Ip of 1.5 shall apply to the certification to include essential facility requirements and life safety applications for post event functionality.
 - 4) Structural floors, housekeeping pads, supporting curbs and supporting steel must be seismically designed and approved by the Project or Building Structural Engineer of Record to withstand the seismic anchor loads. Installation details such as special inspection, attachment to a curb, or attachment to a non-building structure must be outlined and approved by the Engineer of Record for the project or building. The installing contractor shall be responsible for the proper installation of the equipment and must observe the seismic installation requirements set forth by the Engineer of Record.
4. Bases and Floors
 - a. Base shall be constructed from welded minimum 10-gage galvanized steel channels around the perimeter and welded minimum 10-gage galvanized steel cross members. The height of each base channel shall be no less than the height

- indicated in the drawings. Each shipping section shall be provided with removable lifting lugs. Structural framework shall fully support the unit casing and all component during installation such that no section deflects more than $L/1000$ during rigging of that section, where L is defined as the distance between lifting lugs.
- b. Floor shall be constructed from 16 gage smooth galvanized steel. The floor surface shall be welded and all spaces and joints completely sealed with dams around all bottom penetrations. Floor deflection shall not exceed $L/200$ under a point load of 200 pounds, where L is defined as the floor span.
 - c. Insulation that meets a minimum R-value of 1.25 shall be provided underneath the entire unit floor. Insulation shall be closed-cell foam to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist.
 - d. Safety grates that provide a walking surface shall be provided across all bottom air openings. Safety grates shall support a minimum 300-pound load.
5. Walls
- a. Wall assemblies shall be double-wall construction with galvanized steel solid exterior and stainless steel interior. The entire unit shall have a solid wall liner on the interior. All spaces and joints of wall assemblies shall be completely sealed. Wall shall meet the casing deflection limits contained herein.
 - b. A Class "B" thermal break shall be provided throughout the entire wall assembly.
 - c. Insulation that meets a minimum R-value of 12.5 shall be provided throughout all unit wall assemblies. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist and settling of insulation is prevented. Wall assemblies shall comply with NFPA 90 A.

- d. Removable wall access panels shall be provided in coil sections for service removal of components. A Class "B" thermal break shall be provided throughout all removal wall access panels.
- 6. Access Doors
 - a. Access doors shall be provided throughout units as indicated on the schedules and drawings. Access doors shall be double-wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively.
 - b. A Class "A" thermal break shall be provided on all door assemblies downstream of the cooling coil.
 - c. Insulation that meets a minimum R-value of 12.5 shall be provided throughout all door assemblies. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long- strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long- strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist and settling of insulation is prevented. Door assemblies shall comply with NFPA 90 A.
 - d. All doors shall be a minimum of 60" high if sufficient height is available, or the maximum height allowed by the unit height. All doors shall open against pressure to ensure an airtight seal and to prevent a safety hazard.
 - e. Door hinges shall be stainless steel type. Door handles shall be Allegis design for minimized leakage and to provide a Class "A" thermal break. Handles shall fasten against the door frame with a roller cam to eliminate wear of the door frame. On indoor units, if Allegis handles are not provided, Ventlok 310 handles shall be provided on all doors to ensure positive seal of the door and to avoid wear of the door frame. All door handles shall be operable from both the unit exterior and interior.
 - f. Windows shall be provided in doors as indicated on the schedule and drawings. Windows shall be mounted in a metal frame and shall be a minimum of 8" x 8", with safety glass. For any instance where a window cannot fit in a door, a narrower window 8" tall may be provided. Windows in doors with a thermal break shall be thermal, double-pane type.

7. Roofs

- a. Roof assemblies shall be double-wall construction. Exterior roof panels and interior ceiling panels shall be of the same construction as the exterior and interior wall panels, respectively. Sections in units with perforated interior wall liners shall have perforated interior ceiling liners. For perforated liners, a triple-wall panel shall be provided. This triple-wall panel shall be constructed such that two layers of the panel are solid, with the aforementioned class of thermal break between them to isolate the supply air from contact with the outside panel. The third, inner liner shall be perforated. All spaces and joints of roof assemblies shall be completely sealed. In addition to meeting the casing deflection limits contained herein, roof deflection shall not exceed $L/200$ under a point load of 200 pounds, where L is defined as the roof panel span.
- b. A Class "B" thermal break shall be provided throughout the entire roof assembly.
- c. Insulation that meets a minimum R-value of 12.5 shall be provided throughout all roof assemblies. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist. Roof assemblies shall comply with NFPA 90 A.

8. Shipping Splits

- a. Shipping splits shall be provided as indicated on the schedule and drawings. Heavy-gage gussets shall be provided in the corners of each split on the unit interior to minimize the opportunity for racking of the section during shipping and rigging. Structural members shall be provided at the base of the unit exterior to enable pull together of each shipping split.

9. Unit Paint

- a. External surfaces of all indoor and outdoor unit casings shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 700 consecutive

hours. Paint shall be AHU manufacturer's standard color.

10. Dampers
 - a. Ultra low-leak modulating dampers shall be provided, sized, and located as indicated on the schedule and drawings. Blade arrangement (parallel or opposed) and orientation (horizontal blades or vertical blades) shall also be provided as indicated on the schedule and drawings. Damper blades shall be aluminum double-skin airfoil design for minimal pressure drop. Leakage rate shall not exceed 3 cfm/square foot at 1" w.g. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. All dampers, except external bypass and multizone dampers, shall be mounted on the AHU interior. The damper actuator/controllers shall be provided and installed by the control company (Siemens).
11. Outside and Return Airflow Measuring Stations
 - a. Airflow measurement stations shall be provided, sized, and located in the outside and/or return air paths as indicated on the schedule and drawings to measure airflow.
 - b. The airflow measurement station shall measure up to 100% of the total outside and/or return air. The airflow measuring device shall adjust for temperature variations. Output shall be provided from station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/-5%. Airflow measuring stations shall be mounted on the AHU interior.
12. Air Filters
 - a. All filters shall be 12" x 24", 24" x 24", or 24" x 12" nominal sizes to minimize the number of sizes required to be stocked by the Owner. Filters of other nominal sizes will not be acceptable.
 - b. High Efficiency Cartridge Filters
 - 1) Rigid cartridge filters 12" deep shall be provided as indicated on the schedule and drawings. The MERV rating shall be 13 when tested in accordance with ANSI/ASHRAE 52.2. Filters shall consist of high density glass fiber media enclosed in galvanized steel frames with diagonal supports on both the entering and leaving sides.
 - 2) Filters shall be UL Class 2 when tested in accordance with UL Standard 900.
 - 3) High efficiency cartridge filters shall be provided with 2" deep pleated media pre-filters, Merv rating shall be 8".. Pleated media

- pre-filters shall conform to the "Medium Efficiency Pleated Media Filters" specifications contained herein.
- 4) Filters shall be provided with side-loading frames. Filter holding frames shall be constructed of stainless steel and equipped with foam gaskets to seal filters against filter frames. Frame seams shall be sealed to eliminate air bypass. Filter holding frames shall be of a universal type to accommodate standard filters of the same nominal size as well as appropriate fasteners. Filter access shall be as indicated on the schedule and drawings.
13. Cooling Coils
- a. Coil performance shall be provided as indicated on the schedule and drawings. Coil capacities, pressure drops and selection procedures shall be certified to AHRI Standard 410.
- b. Coils shall have same-end header connections. Water coils shall have non-ferrous headers. Water coils shall have vent and drain taps and MPT connections. Connection locations (hanging) shall be as indicated on the drawings. Grommets shall be provided at coil casing penetrations around the coil piping. Grommets shall be designed to seal the opening under positive and negative pressure.
14. Chilled Water Coils
- a. Chilled water coils shall be provided as indicated on the schedule and drawings.
- b. Chilled water coils shall have 0.0045" thick copper fins. Fins shall be mechanically bonded to 5/8" OD seamless copper tubes with 0.020" thick walls. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion. Coils shall be circuited for counter-flow heat transfer. Coil casings shall be constructed of stainless steel.
- c. Chilled water coils shall be proof and leak tested under water. Proof test shall be at 300 psig and leak test shall be at 200 psig.
15. Primary Drain Pans
- a. Primary condensate drain pans shall be provided in cooling coil sections as detailed in the drawings. Drain pans in cooling coil sections shall be stainless steel. Primary drain pans shall extend under each entire coil bank, including headers and return bends. Primary drain pans shall extend downstream of the coil bank for a minimum distance as indicated in the drawings. Primary drain pans shall be sloped a minimum of 1/8" per foot,

- shall be a minimum of 2" deep, and shall be double-sloped (sloped in 2 planes) to positively drain. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum of 1-1/2" beyond the base to ensure adequate room for field piping of condensate drain traps. Drain connection locations (hanging) shall be as indicated on the schedule and drawings. Any coil support member located inside a primary drain pan shall be of the same material as the drain pan.
16. Intermediate Drain Pans
- a. For cooling coil sections requiring stacked coils, sloped intermediate drain pans constructed of stainless steel shall be provided under each upper-level coil in the coil bank and shall extend under the entire coil, including headers and return bends. Intermediate drain pans shall extend downstream of the leaving face of the coil bank for a minimum of 4". Non-corrosive pipe with a minimum diameter of 1" shall be connected to each end of all intermediate drain pans, and shall be piped to the primary drain pan of the coil section. Any coil support member located inside an intermediate drain pan shall be of the same material as the drain pan.
17. Fans
- a. All fans shall be tested, rated and certified in accordance with ANSI/AMCA Standard 210 for air delivery and in accordance with AMCA Standard 300 for sound power levels and shall bear the AMCA seal. The fan balancing process, including vibration limits and documentation, shall be performed in accordance with ANSI/AMCA Standard 204. Fan and motor performance requirements shall be as shown on the schedule and drawings. Maximum rated speed of the fans shall not exceed 75% of the first critical speed.
18. Unhoused Plenum Fans-Direct Drive
- a. Fans shall be un-housed, SWSI plenum type with high efficient AF blades as indicated on the schedule and drawings. Fans shall be direct driven. Fan wheels shall be aluminum. The Hp characteristic of the fans shall be non-overloading. Fans shall be furnished with protective enclosures around the fan wheels. Fans shall be furnished with inlet collars.
19. Fan Motors
- a. Locations of motors shall be as indicated on the schedule and drawings.
- b. All motors shall conform to ANSI/NEMA MG 1 as well as all applicable requirements of NEC and

- shall be UL Listed. Motors shall be inverter ready, ODP and of the voltage, phase, frequency, and Hp indicated on the schedule and drawings. Motors shall be premium efficient, exceeding the EPA efficiency requirements. The motor shall be provided with a heavy duty, adjustable, steel base.
- c. Nameplate motor horsepower for all fans, including dual fans, shall be at least 10% greater than design brake horsepower of each fan.
 - d. Motors shall be NEMA Design B, with Class B insulation.
20. Fan Airflow Measurement Systems
- a. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate fan airflow. The accuracy of the devices shall be no worse than +/-5% when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.
21. Trane Catalytic Cleaner System
- a. The TCACS shall be factory engineered and factory installed in the air handler by the air handler manufacturer. Field-installed fixtures shall not be allowed.
 - b. The TCACS shall be a two-part integral assembly for treatment of air by: (1) Ultraviolet Germicidal Irradiation (UVGI) using UV-C lamps and fixtures; and (2) Photocatalytic Oxidation (PCO) using titanium dioxide (TiO₂) media. Assembly shall be housed in steel casing.
 - c. The TCACS shall contain UV-C lamps and ballasts designed specifically to provide type-C ultraviolet light with a wavelength at or near 2537 Angstroms. Lamps shall be non-ozone producing. Sufficient lamps shall be provided and positioned so as to achieve a minimum coverage of 5 milliwatts per square inch of UVC light across all exposed surfaces of the PCO media.
 - d. The TCACS shall consist of six-inch non-metallic PCO media pleated at one pleat per inch (nominal), with a 40-200 nanometer TiO₂ coating. PCO media shall be placed perpendicular to the air stream in the unit casing. Maximum velocity across the PCO media shall be 500 feet per minute.

- e. Fixtures shall meet the UL drip proof design criteria. Component enclosures shall be constructed of galvanized steel or stainless steel to resist corrosion. Fixtures shall have been tested and recognized by UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards 1995.
 - f. The TCACS shall be configured to operate with the scheduled voltage at 60 Hz. For line voltage applications, the TCACS shall be provided with a UL 508 listed panel for power distribution and over-current protection. UV-C lamps and fixtures shall be positioned to provide an equal distribution of UV-C energy and to minimize shadowed areas. The fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row is a minimum of 90% of the irradiated surface's total width. The lamps shall not produce ozone.
22. Protection of Polymeric Materials
- a. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as UV-C tolerant. Any polymeric material in direct or indirect contact with UV-C light not certified as UV-C tolerant shall be completely shielded from the UV-C light using a certified UV-C tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.
23. Safety
- a. Access doors shall be provided at the location of each TCACS as indicated on the plans and schedule. All points of access to sections of the air handler where the TCACS may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door or access panel is opened.
 - b. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the TCACS. The switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the TCACS.
 - c. A viewing window shall be provided on each air handler to allow viewing of the TCACS to confirm proper operation. The viewing window shall be treated and tested to assure the UV- C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.
 - d. Units shall have a safety warning label applied to the exterior of each section containing the TCACS.

- e. Complete safety, maintenance and servicing instructions for the TCACS shall be incorporated into the air handler manufacturer's standard installation, operating and maintenance manuals.
- 24. Vibration Isolation
 - a. All fan and motor assemblies shall be mounted on vibration isolators which have a 2" deflection to isolate the assembly from the unit housing. The discharge of housed fan assemblies and the inlet of plenum fan assemblies shall be connected to the pressure- bulkhead panel (wall, floor, or roof) with flexible duct to prevent transmission of vibration to the unit casing. No metal-to-metal contact will be permitted between fixed and floating parts. Thrust restraints shall be provided as required to limit horizontal movement of fan assembly at design conditions. Fan bases shall be rigidly tied to the unit base during shipment to prevent damage from shipping vibrations. Shipping restraints shall be field removable with a common tool.
 - b. Each fan assembly shall be vibration tested prior to shipment. Measurements shall include both radial and axial displacement at each bearing using magnetic accelerometers connected to a vibration analyzer. Vibration shall not exceed limits specified herein.
- 25. Unit Acoustics
 - a. Acoustical performance (example shown below) shall be provided with final submittal data and based on AHRI Standard 260 fan in unit testing. Provide units as listed below with the following maximum sound power levels in dB, re 10-12 W. Data provided in Sones or Bels is not acceptable.

		Octave Band Center Frequency, Hz						
Unit Tag	D/I*	63	125	250	500	1000	2000	4000
AHU-#	D	#	#	#	#	#	#	#
	I	#	#	#	#	#	#	#

* D = Ducted Discharge, I = Ducted Inlet

- 26. Marine Lights
 - a. Marine lights shall be provided throughout AHUs as indicate on the schedule and drawings. Lights shall be fluorescent type to minimize amperage draw and shall produce lumens equivalent to a minimum 64 W, instant-start bulb. Lights shall be constructed of safety glass. Lights shall be suitable for wet locations.
- 27. Marine Light Switches
 - a. All lights on a unit shall be wired in the factory to a single on-off switch. On outdoor units, the light

switch shall be mounted inside the unit at the fan access door. On indoor units, the light switch shall be mounted on the casing exterior in a NEMA 1 enclosure next to the fan access door. Lighting circuit(s) shall be wired by the AHU Manufacturer to a common junction box separate from the VFD or starter so the lights can remain on when the main disconnect to the unit is on or off.

28. Variable Frequency Drives
- a. Combination VFDs (with bypass for each VFD paired to a belt-driven fan) shall be provided, mounted, and wired by the AHU manufacturer as indicated on the schedule and drawings. Combination VFDs shall be properly sized, mounted, wired to the fan motors, and commissioned by the AHU Manufacturer. Combination VFDs shall include the VFD, a circuit breaker disconnect, bypass circuitry, a Hand-Off-Bypass Auto-Bypass Hand switch, manual speed control, and a control transformer.
 - b. VFDs shall be high-performance PWM AC drives that generate a sine-code, variable voltage/frequency, three phase output for optimum speed control. VFDs shall be digitally based using a common microprocessor control logic circuit board for the Hp ratings. All programming shall be maintained in non-volatile RAM memory so the program will be maintained when power is removed.
 - c. Output current overload shall be rated at 110% of motor FLA for one minute. VFDs shall have the following minimal protective features: current limited stall prevention, auto restart after momentary power loss, speed search for starting into rotating motor, anti-windmill, phase-to-phase short circuit protection, and ground fault protection. The VFD shall have an ambient service temperature rating of -10 to 120 F, and humidity rating to 95% non- condensing. The VFD shall be UL508 listed and shall conform to applicable NEMA, NFPA, and IEC standards.
 - d. Digital operator keypads and displays shall be provided with each VFD and shall provide local control and readout for: run/stop, speed, reset, volts, amps, kilowatts, and diagnostics.
 - e. Factory-Installed Motor Wire Termination, VFD, Combination Starter/Disconnect, and Fan Disconnect Switch Enclosures.
 - 1) VFDs shall be factory-mounted on the drive-side of the fan section on the interior of the unit, accessible from the unit exterior through

- an access door, for outdoor units and on the casing exterior in a NEMA Type 12 enclosure for indoor units.
- 2) Any welds shall be properly finished with no rough edges. Enclosures shall house circuit breaker disconnects, bypass circuitry, Drive-OFF-BypassAuto-BypassHand switches, manual speed controls, and control transformers. VFDs, starter/disconnects, and fan disconnect switches shall have a manual shut down switch located on the outside of the access door.
- f. Factory Wiring of Lights, VFDs, Combination Starters/Disconnects, and Fan Disconnect Switches
 - 1) VFDs shall be wired per NEC, UL, and NFPA 90 A requirements.
 - 2) All power wiring for voltages greater than 24V shall be contained in an enclosed, metal, power-wiring raceway or EMT. When a power-wiring raceway is used, access panels shall be provided in the raceway at each shipping split to enable access to the wiring during installation. Wiring sections less than 6" in length may be contained in FMC.
 - 3) The AHU manufacturer shall provide one single-point power connection for all motors, VFDs, control end devices, on each AHU.
- g. Factory Commissioning of VFDs and Combination Starter/Disconnects
 - 1) After mounting and wiring of VFDs, on the AHUs, trained factory personnel shall ensure proper operation of each VFD, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial

replacement. Coordinate desired quantities with Authority's Facilities Management Department.

E. EXECUTION

1. Factory Inspections
 - a.. All work shall be subject to the Owner's inspection and approval at all times, but such approval does not relieve the AHU Manufacturer of responsibility for proper functioning of material and work. Notification shall be given to the AHU Manufacturer by the Owner, in writing, a minimum of 10 business days in advance of the visit.
2. Shipping
 - a. Paper copies of the IOM shall also be shipped with each AHU.
 - b. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.
 - c. To protect equipment during shipment and delivery, all indoor and outdoor units shall be completely shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.
 - d. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.
3. On-Site Storage
 - a. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.
4. Leveling
 - a. The Mechanical Contractor shall laser level all unit mounting surfaces, including housekeeping pads, roof curbs, and/or structural steel prior to rigging and installation of the AHU units. Should the AHU units be installed on an unlevel surface, the Mechanical Contractor shall rework the installation at his/her own expense and to

- the satisfaction of the Owner and Engineer and to ensure proper installation.
5. Field Examination
 - a. The Mechanical Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
 - b. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.
 6. Installation
 - a. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.
 - b. The AHU Manufacturer shall provide all screws and gaskets for joining of sections in the field.
 - c. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU Manufacturer's final inspection and start-up
 - 1.) All spring-isolated components have had their shipping restraints removed and the components have been leveled.
 - 2.) On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
 - 3.) All water - piping connections have been completed and hydrostatically tested and all waterflow rates have been set in accordance with the capacities scheduled on the Drawings.
 - 4.) All ductwork connections have been completed and all ductwork has been pressure- tested for its intended service.
 - 5.) All power-wiring, including motor starters and disconnects, serving the unit has been completed.
 - 6.) All automatic temperature and safety controls have been completed.
 - 7.) All dampers are fully operational.
 - 8.) All shipping materials have been removed.

- 9.) All (clean) filter media has been installed in the units.
7. Final Inspection and Start-Up Service
 - a. After the Mechanical Contractor has provided all water ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.
 - b. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment start-up.
 - c. The Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:
 - 1.) Record date, time, and person(s) performing service.
 - 2.) Lubricate all moving parts.
 - 3.) Check all motor and starter power lugs and tighten as required.
 - 4.) Verify all electrical power connections.
 - 5.) Conduct a start-up inspection per the AHU manufacturer's recommendations.
 - 6.) Record fan motor voltage and amperage readings.
 - 7.) Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
 - 8.) Check fan for excessive vibration.
 - 9.) Check V-belt drive or coupling for proper alignment.
 - 10.) Check V-belt drive for proper tension. Tighten the belts in accordance with the AHU Manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU Manufacturer.
 - 11.) Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
 - 12.) Disengage all shipping fasteners on vibration isolation equipment.
 - 13.) Check safety guards to ensure they are properly secured.
 - 14.) Secure all access doors to the fan, the unit and the ductwork.
 - 15.) Switch electrical supply "on" and allow fan to reach full speed.

- 16.) Physically check each fan at start-up and shut-down to ensure no abnormal or problem conditions exist.
- 17.) Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
- 18.) Check all control sequences.

23 74 13 PACKAGED, CENTRAL-STATION AIR-HANDLING UNITS

A. SUMMARY

1. Section includes packaged, outdoor, central-station air-handling units with following components and accessories:
 - a. Chilled water coil.
 - b. Heating hot water coil.
 - c. Economizer section.
 - d. Supply fan section.
 - e. Return pan section.
 - f. Dampers.
 - g. Roof curbs.
2. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with ARI 270 for testing and rating sounds performance for RTUs.
4. Provide extended lubrication tubes.
5. Provide viewing ports on all unit sections.
6. Provide marine lights in all sections.
7. Provide convenient power outlets at each unit.
8. Provide primary (60 percent) and secondary (90 percent) efficient filter for all air handling units. Provide charcoal after filters where applicable.
9. Install units for maximum ease of maintenance. For ease of maintenance install units inside fan rooms, closets, or on roof top. Units shall not be installed above ceilings.
10. Provide floor drains in all fan rooms.
11. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.

B. MANUFACTURERS

1. Carrier.
2. Energy Laboratories, Inc.
3. Pace.
4. Trane.

C. PRODUCTS

1. Single zone horizontal, draw-through type. Units shall include supply and return plenum sections with isolation dampers, supply and return attenuator sections, supply and return fan sections, heating and cooling coils with matching cross sectional areas, motors and drives, pre, and final filter sections with filters, economizer sections with dampers, and accessories. Units shall be built on structural steel channel bases with removable lifting lugs.
2. Casing: Double-wall standing seam constructed of minimum 16 gauge steel, bolted together with cadmium plated bolts (drive screw attachment is unacceptable).

Allowable air leakage is 1 percent of the total CFM at 125 percent of the total static pressure or 10 inches whichever is less; provide factory performance test.

- a. Provide solid 20-gauge (Galvanized Steel) liner over insulation in all sections except provide 20-gauge perforated (galvanized steel) sheet metal liner over insulation in all fan sections.
 - b. Insulation:
 - 1) 2 inches thick, 3 pounds per cubic foot density; glued and pinned to inside of unit and cover walls, ceilings and under floors.
 - 2) Meet NFPA 90A smoke and flame spread requirements.
 - 3) All floors shall be double walled.
 - 4) Panel system shall consist of individually insulated panels designed such that removal of single panel does not disturb any insulation or adjacent panels.
 - c. Man-sized access doors:
 - 1) Same thickness as wall.
 - 2) Provide along one side and enter into each section.
 - 3) 16 gage steel, double skin with one-piece unitary aluminum frame.
 - 4) Provide heavy duty stainless steel hinges.
 - 5) Size suitable for man to walk through.
 - 6) Provide replaceable airtight seals.
 - 7) Design to swing against fan pressure.
 - 8) Include minimum 12-inch by 12-inch viewing double pane window in fan access door.
 - d. Entire floor shall be lined on inside with minimum 12 gauge checker plate fully seam welded steel. Floor and base shall have maximum 1/8-inch deflection, provide reinforcing and/or heavier gauge flooring, as required.
 - e. Units shall have standing seam construction.
 - f. All panels shall be caulked watertight.
 - g. Paint Finish: After final assembly, unit exterior shall be coated with marine grade polyurethane paint. Fan bases, springs and structural steel supports shall be coated with same finish.
3. Fans:
- a. Fan sections shall include fully welded aluminum wheels.
 - b. Direct-drive, extruded aluminum SWSI air foil blade plug fans. Formed blades will not be acceptable.
 - c. Fan inlet cone and wheel: Aluminum construction with extruded aluminum blades. Provide L-10 operating life bearings with relief plugs and lubrication.
 - d. Fan shaft: Stainless steel.

- e. Ensure fan and motor are mounted on structural steel, vibration isolation base inside cabinet. Rolled or formed galvanized bases will not be acceptable.
- f. Vibration isolation base shall have earthquake restraints to retain fan assembly in vertical and horizontal direction.
- g. Spring isolators: Un-housed stable type with minimum 2 inches deflection.
- h. Fan steel and shaft assembly: Statically and dynamically balanced prior to and after assembly with motor and drive in place. Shafting of fan shall be sized not to exceed 75 percent of first critical speed for maximum RPM of class required (critical speed will refer to top of speed range of fans' AMCA class). Lateral static deflection shall not exceed 0.003-inch per foot of length of shaft. Shaft and wheel shall be dynamically balanced in two planes as a complete unit to maximum residual unbalance of 0.15 ounce, at 95 percent of fan radius in each plane.
- i. Unit manufacturer shall provide catalog ratings of fan performance with fans running inside cabinets. Fan performance shall be based on tests performed in AMCA certified lab in accordance with AMCA 210.
- j. Motors shall be high efficiency type with totally enclosed fan cooled enclosures with standard NEMA frame rigid ball bearing type motors and rated for variable speed drives. Pre-wire motors to variable speed drives.
- k. Provide factory mounted and wired variable speed drives for filter load compensation. Variable speed drives shall be mounted in compartments which are part of air handling unit. Access shall be through louvered access door that is flush with outside of the unit. Ensure that 2-inch diameter cold air pipe is connected from downstream of supply fan to each VFD enclosure.
- l. Provide factory engineered and manufactured motor removal rail system in each fan section.
- m. Fans shall be supplied with complete flow measuring system capable of supplying 4 - 20 mA output signal to EMCS system that is proportional to air flow. Flow measuring station and flow transmitter will be factory mounted and plumbed. Flow measuring station shall consist of total and static pressure pick-ups located in inlet cone(s) of each fan. Pick ups shall not obstruct inlet air flow.
- n. Provide magnehelic gauge with CFM scale on external side of each fan section which indicates fan volume.

- o. Provide electronic flow transmitter mounted on exterior of fan section. Transmitter shall be capable of receiving signals of total and static pressure from flow element, of amplifying, extracting square root, and scaling to produce 4 - 20 mA DC or 0 - 5 V DC output signal which is linear and scaled to air volume or velocity. Flow transmitter shall be capable of following performance and application criteria:
 - 1) Calibrated spans from 0 - 896 FPM, in eight flow range increments.
 - 2) Output signal 4 - 20 mA DC or 0 - 5 V DC standard.
 - 3) Integral zeroing means three-way zeroing valve with manual switch.
 - 4) Temperature effect plus or minus 2 percent of full span from 40 degrees F to 120 degrees F.
 - p. Transmitter shall be capable of withstanding over-pressurization up to 200 times greater than span without damage, and shall be furnished with a factory calibrated span and integral zeroing means.
 - q. Transmitter shall be housed in NEMA 12 enclosure with external signal tubing, power, and output signal connections.
 - r. Electronic differential pressure transmitter shall be Air Monitor VELTRON Series.
4. Coil Sections:
- a. Include IAQ double-sloped drain pan of double wall construction type with internal insulation, 1-inch, 1-1/2 pound density, neoprene coated fiberglass insulation and 16 gage under liner and Type 304 stainless steel liner.
 - b. Provide intermediate drain pan, separately piped to lower drain pan for multiple height coil banks.
 - c. Pitch drain pan toward coil as well as toward drain connection provided on access side of the unit.
 - d. Coil return bends and headers shall be insulated with foil-faced insulation arranged so that any condensation shall be directed into drain pan.
 - e. Area around coil return bends and headers shall be blanked off upstream and downstream of coil to isolate from air stream.
 - f. Drain pan shall continue under coil; coil shall not sit in pan.
5. Coils:
- a. Seamless 5/8-inch outside diameter copper tubes, 0.020-inch minimum tube wall thickness with copper plate fins of 0.008-inch thickness and shall be placed no closer than 12 fins per inch.
 - b. Extended surface type.

- c. Provide brazed return bends of 0.025-inch wall thickness.
 - d. Coils shall be reinforced for all coils over 60 inches long and shall have seamless copper headers with 1/8-inch vent and drain connections.
 - e. Coils shall be certified in accordance with ARI 410.
 - f. Coils shall have stainless steel casings and blank offs.
 - g. Coil piping shall be combined internal to unit; piping to each coil shall be made equidistant from single unit coil connection and piped reverse return for self balancing.
 - h. Coils shall be counterflow construction.
 - i. Use of internal restrictive devices to obtain turbulent flow will not be acceptable.
 - j. Casing shall be minimum 16 gage, Type 304 stainless steel with double formed 1/2-inch stacking flanges and 3/4-inch flanges on side plates.
 - k. Flanged tube sheets shall have extruded tube holes.
 - l. Reinforcing rods shall be furnished so that unsupported length is not over 60 inches.
 - m. Ensure coil assemblies are tested under water at 300 psig and rated for 150 psig working pressure.
 - n. Provide diverter plates at ends of coil to divert condensate drip from headers and return bends into drain pan.
 - o. Locate headers inside cabinet casing with only pipe connections extending through casing.
 - p. End of coils shall be carefully blanked to ensure all air passes through coil.
 - q. Intermediate condensate pans shall be furnished on multiple coil units with copper down tubes to main drain panel.
 - r. Type 316 stainless steel recessed drain pans shall be provided as integral part of unit base in all cooling coil sections.
 - 1) Pans shall be 16 gage minimum with 1 inch, 1-1/2 pound density, neoprene coated fiberglass insulation and 16 gage under liner.
 - 2) Provide stainless steel condensate connections on sides of unit.
6. Filter sections:
- a. Factory fabricated as part of air-handling unit.
 - b. Filters shall be arranged for face loading.
 - c. Filter manufacturers' frames shall be used.
 - d. All frames shall be Type 316 stainless steel construction, welded in place and caulked airtight.
 - e. Provide units with filter gauge across filter sections.
 - f. Flush mount gauges on exterior of unit.
7. Mixing or Economizer section:

- a. Include damper for return air, exhaust air, and outside air as required.
 - b. Include full size access door for damper service.
 - c. All dampers shall be opposed blade.
 - d. Damper housing and collars shall be minimum 16 gage with bronze or nylon bearing, plated pivot rods and extruded aluminum blades with replaceable edge seal, stainless "arc" end seals, or compression type end seals.
8. Provide factory flush mounted and wired single point 480V connection electrical panel, unit mounted and pre-wired to variable frequency drives and motors. Panel shall be UL labeled as an assembly and be specifically designed for outdoor use.
9. Provide separate factory flush mounted and wired single point 120 volts connection electrical panel, unit mounted and pre-wired to lights as well as provide controls transformer in order to provide source of power to low voltage control devices within unit. Panel shall be UL labeled as an assembly and be designed for outdoor use.
10. Provide door interlocks on fan section doors to shutdown fans when door is unlocked
11. Lighting:
 - a. Separate 120V circuit for lighting.
 - b. Provide vaporproof marine service interior florescent lighting in access sections with single switch with timer for all on outdoor units only.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Filtration shall meet USGBC LEED requirements.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.
 - 4) Balance Test Data: Project data showing calculations for deflection and critical speed of shaft and wheel assembly shall be submitted to A/E with additional copy provided to Authority.

23 81 23 COMPUTER-ROOM AIR-CONDITIONERS

A. SUMMARY

1. Section includes split-system air-conditioning units and mini-split air-conditioning systems consisting of separate evaporator-fan and compressor-condenser components intended for use in computer rooms, electrical meter rooms, elevator/escalator rooms, and mechanical rooms.
2. Floor, wall, and, ceiling-mounted console, air cooled computer room units. Provide air cooled independent split air conditioning units with 100 percent redundancy for IT rooms, main electrical room, and elevator machine rooms.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Submit available factory options for review and approval by Facilities Management Department with 30 percent review phase submittal.

B. MANUFACTURERS

1. Data Air.
2. Friedrich.
3. Liebert Corporation.
4. Mitsubishi.
5. Stulz ATS.

C. PRODUCTS

1. Evaporator Cabinet and Chassis: Heavy gauge galvanized steel, serviceable from one side. Mounting brackets shall be factory attached to cabinet.
2. Fan Motor Assembly:
 - a. Fan: Centrifugal type, double width, double inlet.
 - b. Shaft: Heavy-duty steel with self-aligning ball bearings with minimum life of 100,000 hours.
 - c. Fan motor: 1750 rpm, mounted on adjustable base.
 - d. Drive package shall be equipped with adjustable motor pulley.
 - e. Fan/motor assembly shall be mounted on vibration isolators.
 - f. System shall be suitable for ducted air distribution.
3. Microprocessor Control:
 - a. Control system shall be microprocessor based.
 - b. Wall-mounted control enclosure shall include 2-line by 16-character LCD display providing continuous display of operating status and alarm condition.
 - c. A 7-key membrane keypad for setpoint/program control and unit on/off shall be located below display.

- d. Temperature and humidity sensors shall be located in wallbox, capable of being located up to 300 feet from evaporator unit.
 - e. LCD display shall provide on/off indication, operating mode indication (cooling, heating, humidifying, dehumidifying) and current day, time, temperature and humidity (if applicable) indication.
 - f. Monitoring system shall be capable of relaying unit operating parameters and alarms to the Liebert SiteScan® monitoring system.
 - g. Control Setpoint Parameters:
 - 1) Temperature Setpoint: 65 to 75 degrees F.
 - 2) Temperature Sensitivity: 1 to 5 degrees F.
 - 3) Humidity Setpoint: 20 to 80 percent relative humidity.
 - 4) Humidity Sensitivity: 1 to 10 percent relative humidity.
 - h. Compressor Short-Cycle Control: Control system shall prevent compressor short-cycling by 3-minute timer from compressor stop to next start.
 - i. Provide common alarm relay shall to provide contact closure to remote alarm device. Provide two terminals for remote on/off control. Individual alarms shall be "enabled" or "disabled" from reporting to the common alarm.
 - j. Control shall be programmable on daily basis or on 5-day/2-day program schedule. It shall be capable of accepting two programs per day.
 - k. Control shall include capabilities to calibrate temperature and humidity sensors and adjust sensor response delay time from 1 to 90 seconds. Control shall be capable of displaying temperature values in degrees F or degrees C.
 - l. For start-up after power failure, system shall provide automatic restart with programmable (up to 9.9 minutes in 6-second increments) time delay. Programming can be performed either at wallmounted controller or from central site monitoring system.
4. Alarms:
- a. Control system shall monitor unit operation and activate audible and visual alarm in the event of following factory preset alarm conditions:
 - 1) High Temperature
 - 2) Low Temperature
 - 3) High Humidity
 - 4) Low Humidity
 - 5) High Water Alarm - Lockout Unit Operation
 - 6) High Head Pressure
 - 7) Loss of Power
 - 8) Compressor Short Cycle

- b. Custom Alarms (2x)
 - 1) Humidifier Problem
 - 2) Filter Clog
 - 3) Water Detected
 - 4) Smoke Detected
 - 5) User customized text can be entered for the two custom alarms.
 - c. Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate common alarm (except for high head pressure).
 - d. Audible alarm shall annunciate any alarm that is enabled by the operator.
 - e. Provide programmable common alarm to interface user selected alarms with a remote alarm device.
- 5. Direct Expansion Coil:
 - a. Evaporator section shall include evaporator coil, thermostatic expansion valve, and filter drier.
 - b. Provide coil with stainless steel drain pan, with internally trapped drain line.
- 6. Air-Cooled Prop Fan Condensing Unit:
 - a. Condenser coil shall be constructed of copper tubes and aluminum fins with direct-drive propeller-type fan, and shall include scroll compressor, high pressure switch, and lee-temp receiver.
 - b. Components shall be factory assembled, charged with R-407c or R-410A refrigerant and sealed.
 - c. No internal piping, brazing, dehydration, or charging shall be required.
 - d. Condensing unit shall be designed for 95 degrees F ambient and be capable of operation to minus 30 degrees F.
 - e. Components shall include scroll compressor, high-pressure switch, Lee-temp refrigerant receiver, head pressure control valve, and liquid line solenoid valve, if required by manufacturer's design.
 - f. Baked phenolic coated condensing unit.
- 7. Steam Generating Humidifier:
 - a. Environmental control system shall be equipped with steam generating humidifier that is controlled by microprocessor control system. It shall be complete with disposable canister, all supply and drain valves, steam distributor, and electronic controls. Need to change canister shall be annunciated on microprocessor wallbox control panel.
 - b. LED light on humidifier assembly shall indicate cylinder full, over-current detection, fill system fault, and end of cylinder life conditions.
- 8. Electric Reheat:

- a. Low-watt density, Type 304 stainless steel, finned-tubular.
 - b. Reheat section shall include NRTL-approved safety switch to protect system from overheating.
- 9. Disconnect Switch, Non-Locking:
 - a. Non-automatic, non-locking, molded case circuit breaker shall be factory mounted in high voltage section of electrical panel.
 - b. Switch shall be accessible from front of unit.
- 10. Smoke Detector:
 - a. Smoke detector shall immediately shut down environmental control system and activate alarm system when activated.
 - b. Sensing element shall be located in return air compartment or in close proximity, in accordance with smoke detector manufacturer's instructions.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Fundamental Refrigerant Management, LEED NC, V2.2, EA Prerequisite 3.
 - b. Enhanced Refrigerant Management, LEED NC, V2.2, EA Credit 4.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Specify warranty period against defects in material and workmanship from date of system acceptance.
 - 2) Maintenance: Provide maintenance training for in-house staff for system operation and maintenance.
 - 3) Repair and Replacement: Specify extra material for future repairs and partial replacement. Coordinate desired quantities with Authority's Facilities Management Department.

26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

A. SUMMARY

1. Section includes:
 - a. Hangers and supports for electrical equipment and systems.
 - b. Concrete base construction requirements.
2. Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements below.
 - a. Design supports for multiple raceways capable of supporting combined weight of supported systems and its content.
 - b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - c. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.
3. Qualify welding procedures and personnel in accordance with AWS D1.1.
4. Comply with NFPA 70.
5. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases.

B. MANUFACTURERS

1. Steel Slotted Support Systems:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
2. Mounting, Anchoring, and Attachment Components:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.

C. PRODUCTS

1. Steel Slotted Support Systems:
 - a. Comply with MFMA-4, factory-fabricated components for field assembly.
 - b. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - c. Channel Dimensions: Selected for applicable load criteria.

2. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
3. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
4. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - a. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - b. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - c. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - d. Toggle Bolts: All-steel springhead type.
 - e. Hanger Rods: Threaded steel.
 - f. Mechanical Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - g. Concrete Inserts: Steel or malleable iron, slotted support system units similar to MSS Type 18; in accordance with MFMA-4 or MSS SP-58.
5. Hardware Corrosion Protection:
 - a. Bolts, nuts, studs, washers, pins, terminal, springs, hangers, and other fastenings and fittings shall be of a corrosion resisting material or treated to render hardware 0- resistant to corrosion.
 - b. Hardware for Exterior Use: Type recommended by manufacturer or stainless steel Type 304, SAE Grade 2.
 - c. Provide galvanized ferrous metalwork.

D. CONCRETE BASES

1. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
2. Use 3000-psi, 28-day compressive-strength concrete.
3. Anchor equipment to concrete base.
 - a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

E. SUSTAINABILITY CRITERIA

1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

A. SUMMARY

1. Section Includes:
 - a. Metal conduits, tubing, and fittings.
 - b. Nonmetal conduits, tubing, and fittings.
 - c. Surface raceways.
 - d. Boxes, enclosures, and cabinets.
2. MC and AC conduit and die cast fittings are not acceptable.

B. MANUFACTURERS

1. Metal Conduits, Tubing and Fittings:
 - a. Allied Tube & Conduit.
 - b. Western Tube and Conduit Corporation.
 - c. Wheatland Tube Company.
2. Nonmetallic Conduits, Tubing, and Fittings:
 - a. Condux International, Inc.
 - b. Lamson & Sessions; Carlon Electrical Products.
 - c. PW Eagle.
3. Metal Wireways and Auxiliary Gutters:
 - a. Cooper B-Line, Inc.
 - b. Hoffman.
 - c. Mono-Systems, Inc.
 - d. Square D.
4. Boxes, Enclosures, and Cabinets:
 - a. Hoffman.
 - b. Milbank Manufacturing Co.
 - c. RACO; Hubbell.
 - d. Thomas & Betts Corporation.

C. PRODUCTS

1. Metal Conduits, Tubing, and Fittings:
 - a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - b. GRC: Comply with ANSI C80.1 and UL 6.
 - c. IMC: Comply with ANSI C80.6 and UL 1242.
 - d. EMT: Comply with ANSI C80.3 and UL 797.
 - e. FMC: Comply with UL 1; zinc-coated steel.
 - f. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
 - g. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - h. Fittings for EMT: Steel, compression type.
 - i. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect

- threaded conduit joints from corrosion and to enhance their conductivity.
- j. No M.C. or A.C. allowed.
- k. No die cast fittings allowed
- 2. Nonmetallic Conduits, Tubing, and Fittings:
 - a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - b. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
 - c. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - d. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - e. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 3. Metal Wireways and Auxiliary Gutters:
 - a. Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - b. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - c. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - d. Wireway Covers: Screw-cover type unless otherwise indicated.
 - e. Finish: Manufacturer's standard enamel finish.
- 4. Boxes, Enclosures, and Cabinets:
 - a. When installed in wet locations: Listed for use in wet locations.
 - b. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
 - c. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
 - d. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
 - e. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

- f. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- g. Gangable boxes are prohibited.
- h. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2) Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- i. Cabinets:
 - 1) NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2) Hinged door in front cover with flush latch and concealed hinge.
 - 3) Key latch to match panelboards.
 - 4) Metal barriers to separate wiring of different systems and voltage.
 - 5) Accessory feet where required for freestanding equipment.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 05 43 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

A. SUMMARY

1. Section Includes:
 - a. Concrete-encased conduit, ducts, and duct accessories.
 - b. Handholes and boxes.
 - c. Manholes.

B. MANUFACTURERS

1. Nonmetallic Ducts and Duct Accessories:
 - a. Cantex, Inc.
 - b. Lamson & Sessions; Carlon Electrical Products.
 - c. PW Eagle.
2. Precast Concrete Handholes and Boxes:
 - a. Oldcastle Precast Group.
 - b. U.S. Concrete.
 - c. Utility Vault Co.
3. Precast Manholes:
 - a. Oldcastle Precast Group.
 - b. U.S. Concrete.
 - c. Utility Vault Co.
4. Utility Structure Accessories:
 - a. Oldcastle Precast Group.
 - b. Utility Concrete Products, LLC.
 - c. Utility Vault Co.

C. PRODUCTS

1. Conduit:
 - a. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
 - b. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as conduit, complying with NEMA TC 3 and UL 514B.
2. Nonmetallic Ducts and Duct Accessories:
 - a. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.
 - b. Underground Plastic Utilities Duct for SDG&E ductbanks only: NEMA TC 6 and 8, ASTM F 512, Type DB-60 PVC, with matching fittings complying with NEMA TC 9 by same manufacturer as the duct.
 - c. Duct Accessories:
 - 1) Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, selected to provide minimum duct spacing indicated while

- supporting ducts during concreting or backfilling.
 - 2) Warning Tape: Underground-line warning tape shall comply with products indicated in Facilities Criteria Document Section 260553 "Identification for Electrical Systems."
 - 3) Color: Red dye added to concrete during batching.
 - 3. Precast Concrete Handholes and Boxes:
 - a. Comply with ASTM C 858 for design and manufacturing processes.
 - b. Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - c. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - d. Cover Finish: Nonskid finish shall have minimum coefficient of friction of 0.50.
 - e. Cover Legend: Molded lettering, "ELECTRIC" or as indicated.
 - 4. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 - 5. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
 - 6. Precast Manholes:
 - a. Comply with ASTM C 858 and structural design loading requirements specified for project requirements with interlocking mating sections, complete with accessories, hardware, and features.
 - b. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1) Type and size shall match fittings to duct or conduit to be terminated.
 - 2) Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
 - c. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

- d. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- 7. Utility Structure Accessories:
 - a. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - 1) Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
 - 2) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 3) Cover Legend: Cast in. Selected to suit system.
 - 4) Legend: "ELECTRIC" for duct systems with power wires and cables for systems operating at 120 V or greater.
 - b. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - c. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt. Working load embedded in 6-Inch, 4000-psi concrete, 13,000-lbf minimum tension.
 - d. Pulling-In and Lifting Irons in Concrete Floors:
 - 1) 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 2) Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
 - e. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments:
 - 1) Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 2) Tested Ultimate Pullout Strength: 12,000 lbf minimum.
 - f. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

- g. Cable Rack Assembly: Nonmetallic; components fabricated from nonconductive, fiberglass-reinforced polymer.
 - 1) Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of nine holes for arm attachment.
 - 2) Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- h. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

D. DUCT BANK ENCASEMENT

- 1. Concrete: 2500 psi.
- 2. Color: Red for medium voltage (over 2000 volts) or higher ducts.

E. SUSTAINABILITY CRITERIA

- 1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

A. SUMMARY

1. Section includes:
 - a. Identification for raceways.
 - b. Identification of power and control cables.
 - c. Identification for conductors.
 - d. Underground-line warning tape.
 - e. Warning labels and signs.
 - f. Equipment identification labels.
2. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
3. Apply identification devices to surfaces that require finish after completing finish work.
4. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
5. Underground-Line Warning Type: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade.
6. Conduits and outlet boxes for special systems including emergency power, fire alarm, and communications systems shall be color coded for identification throughout.
7. Conduits shall be spray painted with system color code at 3-foot intervals.
8. Outlet and junction boxes shall be spray painted with system color code on exterior of box, except boxes which are flush mounted in walls, ceilings, or floors shall be painted on box interior.
9. System color codes shall be as follows:
 - a. Emergency Power / UPS Systems: Orange.
 - b. Fire Alarm Systems: Red.
 - c. Ground: Green
 - d. HVAC: Brown.
 - e. Loading Bridge System: Purple.
 - f. Paging / Public Address / Intercom Systems: Black.
 - g. Security / ACS System: Pink.
 - h. Telephone / Data System: White.
 - i. Visual Display Systems (RIDS/BIDS, etc.): Gray.
 - j. 12 kV System: Yellow / Black.
 - k. 120V/208V System: Blue.
 - l. 277/480V System: Yellow.
 - m. Raceways over 600 volts shall have black letters in an orange field.

B. MANUFACTURERS

1. Brady Corporation.

2. Brother International Corporation.
3. Ideal Industries.
4. Panduit Corporation.

C. PRODUCTS

1. Armored and Metal-Clad Cable Identification Materials:
 - a. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - b. Colors for Raceways Carrying Circuits at 600 V or less: Black letters on an orange field.
 - c. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with clear, weather-and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
 - d. Spacing shall be at 10 feet on center.
2. Power and Control Cable Identification Materials:
 - a. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - b. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - c. Spacing shall be at 10 feet on center.
3. Conductor Identification Materials: Tubing type wire markers.
4. Floor Marking Tape: 2-inch wide, 5-mil pressure sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
5. Underground-Line Warning Tape:
 - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - d. Tape shall be reinforced detectable type, 4 inches wide.
 - e. Color and Printing:
 - 1) Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2) Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3) Inscriptions for Yellow-Colored Tapes: TELEPHONE CABLE, CATV CABLE,

- COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,
6. Warning Labels and Signs: Comply with NFPA 70 and 29 CFR 1910.145.
 - a. Baked-Enamel Warning Signs:
 - 1) Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2) 1/4-inch grommets in corners for mounting.
 - 3) Nominal size, 7 by 10 inches.
 - b. Warning label and sign shall include, but are not limited to, following legends:
 - 1) Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2) Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
 7. Equipment Identification Nameplates: Engraved, three-layer laminated plastic with black letters on a white background. Minimum letter height shall be 3/8 inch. Secure with rivets or screws.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 22 00 LOW VOLTAGE TRANSFORMERS

A. SUMMARY

1. Section includes general purpose transformers having a primary voltage of 600 volts or less for the supply of lower voltages should be self-cooled, ventilated dry-type. Specialty transformers having primary voltage of 600 volts or less for supply of lower voltages to support sensitive electronic loads of noise emission, high harmonic load currents and overheating.
2. Do not locate ventilated dry-type transformers in environments containing contaminants including dust, excessive moisture, chemicals, corrosive gases, oils, or chemical vapors.
3. Transformers shall be designed for floor or wall mounting.
4. Comply with code required working clearances.
5. Maximum ground resistance shall be 5 ohms at transformer location.
6. Measure primary and secondary voltages and make appropriate tap adjustments.
7. When transformer is located in areas where noise is a factor, specify sound levels at least 3 decibels below recommended values established by NEMA ST 20.
8. Mount transformer so that vibrations are not transmitted to surrounding structure. Small transformers can usually be solidly mounted on a reinforced concrete floor or wall. Flexible mounting will be necessary if transformer is mounted to structure in normally low-ambient noise area.
9. Use flexible couplings and conduit to minimize vibration transmission through the connection points.
10. Locate transform in spaces where sound level is not increased by sound reflection (e.g. in terms of sound emission, the least desirable transformer location is in a corner near the ceiling because walls and ceiling function as a megaphone.)

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D.

C. PRODUCTS

1. General Requirements:
 - a. Factory-assembled and –tested, air-cooled units for 60-Hz service.
 - b. Cores: Grain-oriented, non-aging silicon steel.
 - c. Coils: Continuous windings without splices except for taps.

- d. Internal Coil Connections: Brazed or pressure type.
 - e. Coil Material: Copper.
- 2. Distribution Transformers:
 - a. Comply with NEMA ST 20 and list and label as complying with UL 1561.
 - b. Cores: One leg per phase.
 - c. Enclosure: Ventilated, NEMA 250, Type 2.
 - d. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 - e. Taps for Transformer Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
 - f. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
 - g. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
 - h. Insulation Class:
 - 1) 220 degrees C, UL-component-recognized insulation system with a maximum of 115 degrees C rise above 40 degrees C ambient temperature.
 - 2) Energy Efficiency for Transformers Rated 15 kVA and Larger: Complying with NEMA TP 1, Class 1 efficiency levels.
 - i. K-Factor Rating: Transformers required to be K-Factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-Factor.
 - 1) Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2) Indicate value of K-factor on transformer nameplate.
 - j. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1) Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2) Include special terminal for grounding the shield.
 - 3) Shield Effectiveness:
 - Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

- Common-Mode Noise Attenuation:
Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - Normal-Mode Noise Attenuation:
Minimum of minus 52 dBA at 1.5 to 10 kHz.
- k. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
 - 1) 9 kVA and Less: 40 dBA.
 - 2) 30 to 50 kVA: 45 dBA.
 - 3) 51 to 150 kVA: 50 dBA.
 - 4) 151 to 300 kVA: 55 dBA.
 - 5) 301 to 500 kVA: 60 dBA.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: To achieve significant long-term energy savings, keep transformer losses as low as possible. Manufacturers have adjusted transformer designs to maximize efficiencies at varying load levels. 115 and 80 degree C rise transformers achieve efficiency by increasing coil conductor sizes, thereby reducing coil losses.

26 23 00 LOW VOLTAGE SWITCHGEAR

A. SUMMARY

1. Section includes metal-enclosed, floor mounted, free standing, low-voltage power circuit-breaker switchgear rated 1000 volts and less for use in AC systems.
2. Install space-only cubicles and appropriate bus provisions for future protective device additions, as necessary to accommodate planned future growth.
3. Provide concrete housekeeping pad.
4. Installation shall comply with applicable portions of NECA 400.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company
3. Siemens Energy & Automation, Inc.
4. Square D

C. PRODUCTS

1. Fabrication:
 - a. Factory assembled and tested and complying with IEEE C37.20.1.
 - b. Indoor Enclosure Material: Steel.
 - c. Outdoor Enclosure Material: Galvanized steel.
 - d. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
 - e. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.
 - f. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
 - g. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
 - h. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
 - i. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
 - 1) Bus transition sections.
 - 2) Incoming-line pull sections.
 - 3) Hinged front panels for access to metering, accessory, and blank compartments.
 - 4) Pull box on top of switchgear for extra room for pulling cable, with removable top, and side covers and ventilation provisions adequate to

maintain air temperature in pull box within same limits as switchgear.

- Set pull box back from front to clear circuit-breaker lifting mechanism.
- Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
- Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

- 5) Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
- Main Phase Bus: Uniform capacity the entire length of assembly.
 - Neutral Bus: 100 percent of phase-bus ampacity. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
 - Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
 - Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
 - Use copper for connecting circuit-breaker line to copper bus.
 - Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4-inch by 2 inches.
 - Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
 - Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors.
 - Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2 inch copper bus, arranged to connect neutral bus to ground bus.
 - Provide for future extensions from either end of main phase, neutral, and ground bus by means of predilled bolt-holes and connecting links.

- Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
 - Sprayed Insulation Thickness: 3 mils minimum.
 - Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
- 2. Circuit Breakers:
 - a. Comply with IEEE C37.13.
 - b. Ratings: As required for continuous, interrupting, and short-time current ratings for each circuit breaker, voltage and frequency ratings same as switchgear.
 - c. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
 - 1) Normal Closing Speed: Independent of both control and operator.
 - 2) Slow Closing Speed: Optional with operator for inspection and adjustment.
 - 3) Stored-Energy Mechanism: Manually charged.
 - 4) Operation counter.
 - d. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
 - 1) Functions: Long-time delay, short-time delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
 - 2) Temperature Compensation: Ensures accuracy and calibration stability from minus 5 degrees C to plus 40 degrees C.
 - 3) Field-adjustable, time-current characteristics.
 - 4) Current Adjustability: Dial settings and rating plus on trip units or sensors on circuit breakers, or a combination of these methods.
 - 5) Three bands, minimum, for long-time- and short-time-trip delay functions; marked “minimum,” “intermediate,” and “maximum.”
 - 6) Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I²t operation.
 - 7) Pickup Points: Five minimum, for instantaneous-trip functions.
 - 8) Ground-fault protection with at least three short-time delay settings and three trip-time-delay bands; adjustable current pickup.Arrange to provide protection for the following:

- Three-wire circuit or system.
 - Four-wire circuit or system.
 - Four-wire, double-ended substation.
- e. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
 - 1) Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
 - 2) Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from structure with the door open. Status for connection devices for different positions include following:
 - Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
 - Disconnected Position: Primary and secondary devices and ground contact disengaged.
- f. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
- g. Operating Handle: One for each circuit breaker capable of manual operation.
- h. Shunt-Trip Devices: Where required by code.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 24 13 SWITCHBOARDS

A. SUMMARY

1. Section includes:
 - a. Service and distribution switchboards rated 600 V and less.
 - b. Transient voltage suppression devices.
 - c. Disconnecting and overcurrent protective devices.
2. Secure switchgear in accordance with manufacturer's instructions.
3. Support cable routed to switchgear to minimize forces applied to conductor terminals.
4. Do not route piping containing liquids, corrosive gases, or hazardous gases in vicinity of switchgear unless suitable barriers are installed to protect switchgear from damage in event of pipe failure. Do not locate switchgear where foreign flammable or corrosive gases routinely and normally are discharged.
5. Do not use switchgear enclosure surfaces as physical support for any item unless specifically designed for that purpose.
6. Ground metal instrument cases.
7. Place safety sign on any cubicles containing more than one voltage source.
8. Locate switchboards that have any exposed live parts in permanently dry locations and accessible only to qualified persons.
9. Circuit breakers must clearly indicate whether they are in open (off) or closed (on) position.
10. Clearly and permanently mark all circuit breakers to show purpose of each breaker.
11. Place switchboards as close as possible to the center of loads to be served.
12. Series rated systems shall not be used.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company
3. Siemens Energy & Automation, Inc.
4. Square D
5. Do not use: RSE – Sierra.

C. PRODUCTS

1. Manufacturer Units:
 - a. Front-Connected, Front-Accessible Switchboards:
 - 1) Main devices: Fixed, individually mounted.
 - 2) Branch Devices: Panel mounted.
 - 3) Sections front and rear aligned.
 - b. Seismic Requirements: Fabricate and test switchboards according to IEEE 344.

- c. Indoor Enclosures: Steel, NEMA 250, Type 1.
- d. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- e. Outdoor Enclosures: Type 3R.
 - 1) Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 - 2) Enclosure: Flat roof; for each section, with provisions for padlocking.
- f. Barriers: Between adjacent switchboard sections.
- g. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- h. Customer Metering Compartment: Separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- i. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- j. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- k. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- l. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1) Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with tin-plated aluminum or copper feeder circuit-breaker line connections.
 - 2) Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 3) Ground Bus: 1/4-by-2-inch- Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment

- grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4) Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 5) Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 6) Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - m. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- 2. Transient Voltage Suppression Devices:
 - a. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
 - 1) Fuses, rated at 200-kA interrupting capacity.
 - 2) Fabrication using bolted compression lugs for internal wiring.
 - 3) Integral disconnect switch.
 - 4) Redundant suppression circuits.
 - 5) Redundant replaceable modules.
 - 6) Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 7) LED indicator lights for power and protection status.
 - 8) Audible alarm, with silencing switch, to indicate when protection has failed.
 - 9) Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - 10) Six-digit, transient-event counter set to totalize transient surges.
 - b. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

- c. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- 3. Disconnecting and Overcurrent Protective Devices
 - a. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1) Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2) Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3) Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - Instantaneous trip.
 - Long- and short-time pickup levels.
 - Long- and short-time time adjustments.
 - Ground-fault pickup level, time delay, and I²t response.
 - 4) GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 5) Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 6) Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - Standard frame sizes, trip ratings, and number of poles.
 - Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - b. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit

breaker with interrupting capacity rating to meet available fault current.

- 1) Fixed circuit-breaker mounting.
- 2) Two-step, stored-energy closing.
- 3) Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - Instantaneous trip.
 - Long- and short-time time adjustments.
 - Ground-fault pickup level, time delay, and I_{2t} response.
4. Instrumentation: Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - a. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
 - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - 4) Megawatts: Plus or minus 2 percent.
 - 5) Megavars: Plus or minus 2 percent.
 - 6) Power Factor: Plus or minus 2 percent.
 - 7) Frequency: Plus or minus 0.5 percent.
 - 8) Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - 9) Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - 10) Contact devices to operate remote impulse-totalizing demand meter.
 - b. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 24 16 PANELBOARDS

A. SUMMARY

1. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.
2. Panelboards shall be provided with 25 percent spare capacity.
3. Feeder conductors shall meet panelboard bussing requirements.
4. Panelboards shall be provided main disconnect breaker.
5. Panelboards shall be provided with hinged front cover.
6. Seires rated combination circuit breakers shall not be used.
7. Where flush mounted panelboards are used, stub five 1-inch empty conduits from panelboard into accessible ceiling space.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company
3. Siemens Energy & Automation, Inc.
4. Square D

C. PRODUCTS

1. General Requirements:
 - a. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces.
 - b. Enclosures: Flush-and surface-mounted cabinets
 - 1) Rated for environmental conditions at installed location.
 - Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - Outdoor Locations: NEMA 250, Type 3R.
 - Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12
 - 2) Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3) Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4) Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front

- with flanges for attachment to panelboard, wall, and ceiling or floor.
- 5) Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- 6) Finishes:
 - Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - Back Boxes: Galvanized steel.
 - Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- 7) Directory Card: Inside panelboard door, mounted in transparent card holder.
- c. Incoming Mains Location: Top and bottom.
- d. Phase, Neutral, and Ground Buses:
 - 1) Material: Hard-drawn copper, 98 percent conductivity.
 - 2) Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3) Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- e. Conductor Connectors: Suitable for use with conduct material and sizes.
 - 1) Material: Hard-drawn copper, 98 percent conductivity.
 - 2) Main and Neutral Lugs: Compression type.
 - 3) Ground Lugs and Bus-Configured Terminators: Compression type.
 - 4) Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5) Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6) Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 7) Extra-Capacity Neutral Lugs: Rated 200 percent phase lugs mounted on extra-capacity neutral bus.

- f. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 - g. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
 - 2. Distribution Panelboards:
 - a. Panelboards: NEMA PB 1, power and feeder distribution type.
 - b. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - c. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - d. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
 - 3. Lighting and Appliance Branch-Circuit Panelboards
 - a. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
 - b. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - c. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
 - d. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses
 - 4. Disconnecting and Overcurrent Protective Devices
 - a. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1) Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2) Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - Instantaneous trip.
 - Long- and short-time pickup levels.
 - Long-and short-time adjustments.
 - Ground-fault pickup level, time delay, and I_{2t} response.

- 3) GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 4) Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 5) Molded-Case Circuit Breaker (MCCB)
Features and Accessories:
 - Standard frame sizes, trip ratings, and number of poles.
 - Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 24 19 MOTOR CONTROL CENTERS

A. SUMMARY

1. Section includes motor control centers for use with ac circuits rated 600 V and less and having the following factory-installed components:
 - a. Incoming main lugs and OCPDs.
 - b. Full-voltage magnetic controllers
 - c. Feeder-tap units.
 - d. Auxiliary devices.
2. Install motor control centers on 4-inch nominal thickness concrete base.
3. Install motor controllers in accordance with manufacturer's instructions.
4. Select and install heater elements in motor starters to match installed motor characteristics.
5. Provide engraved nameplate.
6. Installation shall comply with NECA 1.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company
3. Siemens Energy & Automation, Inc.
4. Square D

C. PRODUCTS

1. Functional Features
 - a. Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of motor control centers.
 - b. Controller Units: Combination controller units.
 - 1) Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - 2) Equip units in Type B and Type C motor control centers with pull-apart terminal strips for external control connections.
 - c. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - d. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

2. Incoming Mains:
 - a. Location: Top or bottom.
 - b. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.
 - 1) Material: Hard-drawn copper, 98 percent conductivity.
 - 2) Main and Neutral Lugs: Compression type.
 - c. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1) Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2) Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - Instantaneous trip.
 - Long- and short-time pickup levels.
 - Long- and short-time time adjustments.
 - Ground-fault pickup level, time delay, and I^2t response.
 - 3) MCCB Features and Accessories:
 - Standard frame sizes, trip ratings, and number of poles.
 - Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - Auxiliary Contacts: One single pole double throw switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
3. Combination Controllers:
 - a. Full-Voltage Enclosed Controllers:

- 1) Comply with NEMA ICS 2, general purpose, Class A.
 - 2) Magnetic Controllers: Full voltage, across the line, electrically held; nonreversing configuration.
 - b. Disconnecting Means and OCPDs:
 - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - 2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - c. Control Power:
 - 1) Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT control power source of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 2) CPT Spare Capacity: 100 VA.
4. Feeder-Tap Units, MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - b. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long- and short-time time adjustments.
 - 4) Ground-fault pickup level, time delay, and I_{2t} response.
 - c. Features and Accessories:
 - 1) Standard frame sizes, trip ratings, and number of poles.
 - 2) Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - 3) Application Listing: Appropriate for application; Type SWD for switching

- fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
- 4) Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- 5) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- 6) Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- 5. Motor Control Center Control Power: Control Circuits, 120-V ac, supplied through secondary disconnecting devices from CPT
- 6. Enclosures:
 - a. Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location.
 - b. Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
 - c. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
 - d. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
 - e. Wiring Spaces:
 - 1) Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
 - 2) Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.
- 7. Auxiliary Devices:
 - a. Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

- 1) Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - Push Buttons: Covered types; maintained contact unless otherwise indicated.
 - Pilot Lights: LED types; push to test.
 - Selector Switches: Rotary type.
 - b. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
 - c. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
8. Characteristics and Ratings:
 - a. Wiring: NEMA ICS 18, Class II, Type B, for starters above Size 3 Type B-D, for starter Size 3 and below.
 - b. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
 - c. Short-Circuit Current Rating for Each Unit: Fully rated.
 - d. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device.
 - e. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.
 - f. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections.
 - g. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
 - h. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver plated.
 - i. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables.
 - j. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit equipment grounding conductors.
 - k. Front-Connected, Front-Accessible Motor Control Centers:
 - 1) Main Devices: Drawout mounted.

- 2) Controller Units: Drawout mounted.
- 3) Feeder-Tap Units: Drawout mounted.
- 4) Sections front and rear aligned.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 25 00 ENCLOSED BUS ASSEMBLIES

A. SUMMARY

1. Section includes feeder-bus assemblies for interior applications only.
2. Support bus assemblies independent from other equipment.
3. Install expansion fittings at locations where assemblies cross building expansion joints.
4. Use of exterior enclosed busing is not allowed.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D.

C. PRODUCTS

1. NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
2. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces.
3. Temperature Rise: 55 degrees C above 40 degrees C ambient maximum for continuous rated current.
4. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
5. Ground:
 - a. 50 percent capacity internal bus bars of material matching bus material.
 - b. 50 percent capacity isolated, internal bus bar of material matching bus material.
6. Enclosure: Steel with manufacturer's standard finish.
7. Fittings and Accessories: Manufacturer's standard.
8. Mounting: Arranged flat, edgewise, or vertically without derating.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 27 13 ELECTRICAL METERING

A. SUMMARY

1. Section includes equipment for electricity metering by Airport.
2. Provide installation requirements that permit the Airport to meter electricity consumption and demand for individual tenants or loads.
3. Meter readings shall be used for billing tenants and similar situations where sub-metered data are of value.
4. Meter shall be capable of being reset and monitored remotely; meter shall have the capability of monitoring electrical, water and natural gas.

B. MANUFACTURERS

1. E-Mon.
2. National Meter Industries.
3. Osaki Meter Sales, Inc.
4. Square D.

C. PRODUCTS

1. General Requirements:
 - a. Comply with UL 1244.
 - b. Meters used for billing shall have accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
 - c. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
 - d. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
 - e. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters required for application; split core type.
 - f. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with specified sensors.
2. Kilowatt-hour/Demand Meter: Electronic single or three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
 - a. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 - b. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and

- historic peak demand in a nonvolatile memory until reset.
3. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway.
 4. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.
 - a. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs for the following:
 - 1) At least 100 tenants.
 - 2) At least 20 buildings.
 - b. Tenant or Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare tenant bills based on metering of energy use. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic:
 - 1) The main deterrent to widespread use of tenant submetering has been cost of installation, which is especially true for retrofit projects because of cost installing wiring in existing facilities.
 - 2) Most objections can be overcome with solid-state electronic meters and accessories, ability to install current transformers in small spaces, consumption and demand data that are digital and readily computerized, and wireless acquisition of metered data.
 - 3) Airport equipment shall meet California Code of Regulations for electric watt-hour meters, permitting meter accuracy of 1 percent; to reduce size and cost of meters substantially when compared to ANSI standard utility meters.
 - b. Operational: Another deterrent of metering is the "hassle factor" of reading meters, maintaining accuracy, computing and sending bills, and collection.
 - c. Natural Resource: Tenant submetering is one of the most effective energy-conservation measures.

26 27 26 WIRING DEVICES

A. SUMMARY

1. Section includes:
 - a. Receptacles, receptacles with integral GFCI, and associated device plans.
 - b. Twist-locking receptacles.
 - c. Wall-box motion sensors.
 - d. Isolated-ground receptacles.
 - e. Snap switches and wall-box dimmers.
 - f. Wall-switch occupancy sensors.
 - g. Communications outlets.
 - h. Pendant cord-connector devices.
 - i. Cord and plug sets.
 - j. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies
2. Require ground pin of vertically mounted receptacles installed up and on horizontally mounted receptacles to left.
3. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engrave machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

B. MANUFACTURERS

1. As identified with products.

C. PRODUCTS

1. Straight Blade Receptacles:
 - a. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 5351 (single), 5352 (duplex).
 - 2) Hubbell; HBL5351 (single), 5352 (duplex).
 - 3) Leviton; 5891 (single), 5352 (duplex).
 - 4) Pass & Seymour; 5381 (single), 5352 (duplex).
 - b. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Orange in color. Subject to compliance with requirements, provide one of the following:
 - 1) Hubbell; IG20CR.

- 2) Leviton; 5362-IG.
 - 3) Pass & Seymour; IG6300.
2. GFCI Receptacles:
 - a. Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
 - b. Duplex GFCI Convenience Receptacles, 125 V, 20 A: Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; GF20.
 - 2) Pass & Seymour; 2084.
 - 3) Hubbell; GF20LA.
3. Hazardous (Classified) Location Receptacles: Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010. Subject to compliance with requirements, provide products of one of the following:
 - a. Cooper Crouse-Hinds.
 - b. EGS/Appleton Electric.
 - c. Killark; a division of Hubbell Inc.
4. Twist-Locking Receptacles:
 - a. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; L520R.
 - 2) Hubbell; HBL2310.
 - 3) Leviton; 2310.
 - 4) Pass & Seymour; L520-R.
 - b. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Orange in color. Subject to compliance with requirements, provide one of the following:
 - 1) Hubbell; IG2310.
 - 2) Leviton; 2310-IG.
5. Pendant Cord-Connector Devices: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 - a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand,

- matched to cable diameter, and with attachment provision designed for corresponding connector.
6. Cord and Plug Sets: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - a. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - b. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.
 7. Snap Switches: Comply with NEMA WD 1 and UL 20.
 - a. Switches, 120/277 V, 20 A: Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - 2) Hubbell; 1221 (single pole), HBL1222 (two pole), 1223 (three way), 1224 (four way).
 - 3) Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - 4) Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
 - b. Pilot Light Switches, 20 A: Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 2221PL for 120 V and 277 V.
 - 2) Hubbell; HPL1221PL for 120 V and 277 V.
 - 3) Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - 4) Pass & Seymour; PS20AC1-PLR for 120 V.
 - c. Key-Operated Switches, 120/277 V, 20 A: Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 2221L.
 - 2) Hubbell; HBL1221L.
 - 3) Leviton; 1221-2L.
 - 4) Pass & Seymour; PS20AC1-L.
 - d. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 1995.
 - 2) Hubbell; HBL1557.
 - 3) Leviton; 1257.
 - 4) Pass & Seymour; 1251.
 8. Wall Box Dimmers:
 - a. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

- b. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
 - c. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."
 - d. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
9. Occupancy Sensors:
- a. Passive-Infrared Wall-Switch Sensors: 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 6111 for 120 V, 6117 for 277 V.
 - 2) Hubbell; WS1277.
 - 3) Leviton; ODS 10-ID.
 - 4) Pass & Seymour; WS3000.
 - 5) Watt Stopper (The); WS-200.
 - b. Adaptive-Technology Wall-Switch Sensors: 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with minimum coverage area of 900 square feet. Subject to compliance with requirements, provide one of the following:
 - 1) Hubbell; AP1277W.
 - 2) Leviton; ODS 15-ID.
 - c. Long-Range Wall-Switch Sensors: Dual technology, with passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 square feet. Subject to compliance with requirements, provide one of the following:
 - 1) Hubbell; ATP1600W.
 - 2) Leviton; ODW12-MRW.
 - 3) Watt Stopper (The); DT-200.
 - d. Wide-Range Wall-Switch Sensors: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with minimum coverage area of 1200 square feet. Subject to compliance with requirements, provide one of the following:
 - 1) Hubbell; AT1277.
 - 2) Leviton; ODWHB-IRW.
 - 3) Pass & Seymour; HS1001.
 - 4) Watt Stopper (The); CX-100-3.

10. Communications Outlets:
 - a. Telephone Outlet: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 6. Comply with UL 1863. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 3560-6.
 - 2) Leviton; 40649.
 - b. Combination TV and Telephone Outlet: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 6; and one Type F coaxial cable connector. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper; 3562.
 - 2) Leviton; 40595.
11. Wall Plates:
 - a. Single and combination types to match corresponding wiring devices.
 - 1) Plate-Securing Screws: Metal with head color to match plate finish.
 - 2) Material for Finished Spaces: Smooth, high-impact thermoplastic.
 - 3) Material for Unfinished Spaces: Galvanized steel.
 - 4) Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
 - b. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R weather-resistant, die-cast aluminum with lockable cover.
12. Floor Service Fittings:
 - a. Type: Modular, flap-type, dual-service units suitable for wiring method used. Hubbell #B2436 (Single Duplex), Hubbell #B4233 (Double Duplex).
 - b. Compartments: Barrier separates power from voice and data communication cabling.
 - c. Service Plate: Rectangular, solid brass with satin finish. Hubbell #S3825.
 - d. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
 - e. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 6 jacks for UTP cable.
13. Poke-Through Assemblies:
 - a. Manufacturers:
 - 1) Hubbell Incorporated; Wiring Device-Kellems.
 - 2) Pass & Seymour/Legrand; Wiring Devices & Accessories.
 - 3) Square D/ Schneider Electric.
 - 4) Thomas & Betts Corporation.

- 5) Wiremold Company (The).
- b. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 1) Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
 - 2) Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
 - 3) Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4) Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
 - 5) Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, 4-pair, Category 5e voice and data communication cables.
- 14. Multioutlet Assemblies:
 - a. Manufacturers:
 - 1) Hubbell Incorporated; Wiring Device-Kellems.
 - 2) Wiremold Company (The).
 - b. Components: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
 - c. Raceway Material: Metal, with manufacturer's standard finish.
 - d. Wire: No. 12 AWG.
- 15. Service Poles:
 - a. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 - b. Poles: Nominal 2.5-inch- square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 - c. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 - d. Finishes: Satin-anodized aluminum.
 - e. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 6 voice and data communication cables.
 - f. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
 - g. Voice and Data Communication Outlets: Four RJ-45 Category 5e jacks.

16. Finishes:
 - a. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
 - b. Wiring Devices Connected to Emergency Power System: Red.
 - c. Isolated-Ground Receptacles: Orange.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: Utilize occupancy sensors to limit operation of lighting systems to save energy and comply with state mandated regulations.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 28 13 FUSES

A. SUMMARY

1. Section includes cartridge fuses rated 600 volts AC and less for use in enclosed switches, switchboards, enclosed controllers, and motor-control centers.
2. Applications:
 - a. Service Entrance: Class L, time delay.
 - b. Feeders: Class RK1, time delay.
 - c. Motor Branch Circuits: Class RK5, time delay.
 - d. Other Branch Circuits: Class RK1, time delay.
 - e. Control Circuits: Class CC, fast acting.

B. MANUFACTURERS

1. Copper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littlefuse, Inc.

C. PRODUCTS

1. Cartridge Fuses: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. SUMMARY

1. Section includes:
 - a. Fusible switches.
 - b. Nonfusible switches.
 - c. Receptacle switches.
 - d. Shunt trip switches.
 - e. Molded-case circuit breakers (MCCBs).
 - f. Molded-case switches.
 - g. Enclosures
2. Circuit breakers, disconnect switches, and other devices that are electrical energy-isolating must be lockable in accordance with NFPA 70.
3. Ensure identification will be installed.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D.

C. PRODUCTS

1. Fusible Switches:
 - a. Type HD, Heavy Duty, Single Throw, 1200A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept these padlocks, and interlocked with cover in closed position.
 - b. Type HD, Heavy Duty, Double Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
 - c. Accessories:
 - 1) Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2) Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3) Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

- 4) Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5) Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6) Hookstick Handle: Allows use of a hookstick to operate handle.
 - 7) Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 8) Service-Rated Switches: Labeled for use as service equipment.
2. Nonfusible Switches:
 - a. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
 - b. Type HD, Heavy Duty, Double Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
 - c. Accessories:
 - 1) Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2) Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3) Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4) Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5) Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 6) Lugs: Mechanical type, suitable for number, size, and conductor material.
3. Receptacle Switches:
 - a. Type HD, Heavy-Duty, Single-Throw Fusible Switch: A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
 - b. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept

- three padlocks; interlocked with cover in closed position.
 - c. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
 - d. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug) or as required for project conditions.
- 4. Shunt Trip Switches
 - a. Manufacturers
 - 1) Cooper Bussmann, Inc.
 - 2) Ferraz Shawmut, Inc.
 - 3) Littelfuse, Inc.
 - b. Comply with UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
 - c. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
 - d. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
 - e. Accessories:
 - 1) Oiltight key switch for key-to-test function.
 - 2) Oiltight green ON pilot light.
 - 3) Isolated neutral lug; 100 percent rating.
 - 4) Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5) Form C alarm contacts that change state when switch is tripped.
 - 6) Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
 - 7) Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
 - f. Molded-Case Circuit Breakers:
 - 1) Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
 - 2) Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting

- for circuit-breaker frame sizes 250 A and larger.
- 3) Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- 4) Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - Instantaneous trip.
 - Long- and short-time pickup levels.
 - Long- and short-time time adjustments.
 - Ground-fault pickup level, time delay, and I_{2t} response.
- g. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- h. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- i. Features and Accessories:
 - 1) Standard frame sizes, trip ratings, and number of poles.
 - 2) Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4) Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5) Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 7) Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8) Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
- 5. Molded-Case Switches:
 - a. MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

- b. Features and Accessories:
 - 1) Standard frame sizes and number of poles.
 - 2) Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3) Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4) Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 6) Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
 - 7) Alarm Switch: One NO contact that operates only when switch has tripped.
- 6. Enclosures for Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - a. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - f. Hazardous Areas as required by code: NEMA 250, Type 7 or Type 9.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 29 13 ENCLOSED CONTROLLERS

A. SUMMARY

1. Section includes full-voltage manual and magnetic controllers.
2. Where reversing or multi-speed contactors are required, provide a mechanical interlock of the lever type (with electrical contacts included) mechanism to prevent closing of one contactor when the other is closed. Mechanical interlock to be of a design that is capable of being utilized on NEMA size 1 through 6 contactors.
3. Floor mounted controllers shall be installed on 4-inch nominal-thickness concrete pad.

B. MANUFACTURERS

1. Eaton Electrical Inc.
2. General Electric Company.
3. Rockwell Automation, Inc.
4. Siemens Energy & Automation, Inc.
5. Square D.

C. PRODUCTS

1. Full-Voltage Controllers:
 - a. Comply with NEMA ICS 2, general purpose, Class A.
 - b. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on. Nonreversing configuration.
 - c. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1) Nonreversing configuration.
 - 2) Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 - 3) Red pilot light.
 - d. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1) Nonreversing configuration.
 - 2) Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.

- 3) Red pilot light.
 - 4) Normally open auxiliary contact.
- e. Magnetic Controllers: Full voltage, across the line, electrically held.
 - 1) Nonreversing configuration.
 - 2) Contactor Coils:
 - Pressure-encapsulated type with coil transient suppressors.
 - Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 3) Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 4) Control Circuits:
 - 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - CPT Spare Capacity: 100 VA.
 - 5) Solid-State Overload Relay:
 - Switch or dial selectable for motor running overload protection.
 - Sensors in each phase.
 - Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - Analog communication module.
 - 6) Normally closed isolated overload alarm contact.
 - 7) External overload reset push button.
- f. Combination Magnetic Controller:
 - 1) Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 2) Fusible Disconnecting Means:
 - NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
 - Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - Auxiliary Contacts: Normally open/normally closed, arranged to activate before switch blades open.

2. Enclosures:
 - a. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1) Dry and Clean Indoor Locations: Type 1.
 - 2) Outdoor Locations: Type 3R.
 - 3) Kitchen Wash-Down Areas: Type 4X, stainless steel.
 - 4) Other Wet or Damp Indoor Locations: Type 4.
 - 5) Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
 - 6) Hazardous Areas Indicated as required by code: Type 7 or Type 9.
3. Accessories:
 - a. Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1) Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - Push Buttons: Covered Recessed types.
 - Pilot Lights: LED types; colors as indicated; push to test.
 - Selector Switches: Rotary type.
 - 2) Elapsed Time Meters: Heavy duty with digital readout in hours resettable.
 - 3) Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
 - b. Reversible normally closed/normally open auxiliary contact(s).
 - c. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
 - d. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - e. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 or Type 4X or Type 7 or Type 9 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
 - f. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
 - g. Cover gaskets for Type 1 enclosures.
 - h. Terminals for connecting power factor correction capacitors to the line side of overload relays.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

26 29 23 VARIABLE FREQUENCY MOTOR CONTROLLERS

A. SUMMARY

1. Separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. MANUFACTURERS

1. ABB.
2. Eaton Electrical Inc.
3. General Electric Company.
4. Siemens Energy & Automation, Inc.
5. Square D.

C. PRODUCTS

1. Manufactured Units:
 - a. Comply with NEMA ICS 7, NEMA ICS 61800-2.
 - b. Application: Variable torque.
 - c. Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1) Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 - 2) Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 - 3) Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
 - d. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
 - e. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

- f. Unit Operating Requirements:
 - 1) Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 - 2) Input AC Voltage Unbalance: Not exceeding 3 percent.
 - 3) Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 - 4) Minimum Efficiency: 97 percent at 60 Hz, full load.
 - 5) Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
 - 6) Minimum Short-Circuit Current (Withstand) Rating: Verify prior to selection.
 - 7) Ambient Temperature Rating: Not less than 14 degrees F and not exceeding 104 degrees F.
 - 8) Ambient Storage Temperature Rating: Not less than minus 4 degrees F and not exceeding 140 degrees F.
 - 9) Humidity Rating: Less than 95 percent (noncondensing).
 - 10) Vibration Withstand: Comply with IEC 60068-2-6.
 - 11) Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times base load current for three seconds.
 - 12) Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 - 13) Speed Regulation: Plus or minus 10 percent.
 - 14) Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 - 15) Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- g. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- h. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
 - 1) Signal: Electrical.
- i. Internal Adjustability Capabilities:
 - 1) Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2) Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3) Acceleration: 0.1 to 999.9 seconds.
 - 4) Deceleration: 0.1 to 999.9 seconds.
 - 5) Current Limit: 30 to minimum of 150 percent of maximum rating.
- j. Self-Protection and Reliability Features:

- 1) Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
- 2) Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
- 3) Under- and overvoltage trips.
- 4) Inverter overcurrent trips.
- 5) VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
- 6) Critical frequency rejection, with three selectable, adjustable deadbands.
- 7) Instantaneous line-to-line and line-to-ground overcurrent trips.
- 8) Loss-of-phase protection.
- 9) Reverse-phase protection.
- 10) Short-circuit protection.
- 11) Motor overtemperature fault.
- k. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- l. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- m. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- n. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- o. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- p. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

- 1) Disconnect Rating: Not less than 115 percent of VFC input current rating.
 - 2) Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 - 3) Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
 - 4) Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 - 5) NC alarm contact that operates only when circuit breaker has tripped.
2. Controls and Indication
- a. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - 1) Power on.
 - 2) Run.
 - 3) Overvoltage.
 - 4) Line fault.
 - 5) Overcurrent.
 - 6) External fault.
 - b. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - 1) Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - 2) Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
 - c. Historical Logging Information and Displays:
 - 1) Real-time clock with current time and date.
 - 2) Running log of total power versus time.
 - 3) Total run time.
 - 4) Fault log, maintaining last four faults with time and date stamp for each.
 - d. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
 - 1) Output frequency (Hz).
 - 2) Motor speed (rpm).
 - 3) Motor status (running, stop, fault).
 - 4) Motor current (amperes).

- 5) Motor torque (percent).
- 6) Fault or alarming status (code).
- 7) PID feedback signal (percent).
- 8) DC-link voltage (V dc).
- 9) Set point frequency (Hz).
- 10) Motor output voltage (V ac).
- e. Control Signal Interfaces:
 - 1) Electric Input Signal Interface:
 - A minimum of two programmable analog inputs: Operator-selectable "x"- to "y"-mA dc.
 - A minimum of six multifunction programmable digital inputs.
 - 2) Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - 0- to 10-V dc.
 - 4- to 20-mA dc.
 - Potentiometer using up/down digital inputs.
 - Fixed frequencies using digital inputs.
 - 3) Output Signal Interface: A minimum of one programmable analog output signal(s) (operator-selectable "x"- to "y"-mA dc), which can be configured for any of the following:
 - Output frequency (Hz).
 - Output current (load).
 - DC-link voltage (V dc).
 - Motor torque (percent).
 - Motor speed (rpm).
 - Set point frequency (Hz).
 - 4) Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - Motor running.
 - Set point speed reached.
 - Fault and warning indication (overtemperature or overcurrent).
 - PID high- or low-speed limits reached.
- f. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
 - 1) Network Communications Ports: Ethernet and RS-422/485.
 - 2) Embedded BAS Protocols for Network Communications: Siemens system 600

APOGEE Protocols accessible via the communications ports.

3. Line Conditioning and Filtering:
 - a. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of all VFCs to less than 5 percent and THD(V) to 3 percent.
 - b. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
 - c. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.
4. Bypass Systems:
 - a. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
 - b. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
 - c. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
 - 1) Bypass Contactor: Load-break, NEMA-rated contactor.
 - 2) Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
 - 3) Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
 - d. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
 - 1) NORMAL/BYPASS selector switch.
 - 2) HAND/OFF/AUTO selector switch.
 - 3) NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while motor is running in bypass mode.

- 4) Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
- 5) Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - CPT Spare Capacity: 100 VA.
- 6) Overload Relays: NEMA ICS 2.
 - Solid-State Overload Relays:
 - Switch or dial selectable for motor-running overload protection.
 - Sensors in each phase.
 - Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - Analog communication module.
 - NC isolated overload alarm contact.
 - External overload reset push button.
- 5. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - a. Dry and Clean Indoor Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - c. Kitchen Wash-Down Areas: Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- 6. Accessories:
 - a. Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - b. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - 1) Push Buttons: Covered Recessed types.
 - 2) Pilot Lights: LED types; push to test.
 - 3) Selector Switches: Rotary type.

- 4) Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- c. Reversible NC/NO bypass contactor auxiliary contact(s).
- d. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- e. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays:
 - 1) Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 2) Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- f. Supplemental Digital Meters:
 - 1) Elapsed-time meter.
 - 2) Kilowatt meter.
 - 3) Kilowatt-hour meter.
- g. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 Type 4X Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- h. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Economic: If VFC installation is considered on basis of energy efficiency, perform economic evaluation whether or not motor will be fully loaded under expected operating conditions.
 - b. Natural Resource: Utilize VFCs for energy conservation opportunities for loads operating for significant periods of time.

26 51 00 INTERIOR LIGHTING

A. SUMMARY

1. Interior lighting lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Exit signs shall be led type.
6. Exit signs and emergency lighting fixtures shall be connected to engine generators whenever possible.

B. MANUFACTURERS

1. No preferred manufacturers have been identified.

C. PRODUCTS

1. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
2. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
3. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
4. Metal Parts: Free of burrs and sharp corners and edges.
5. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
7. Diffusers and Globes:
 - a. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 1) Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - 2) UV stabilized.
 - b. Glass: Annealed crystal glass unless otherwise indicated.
8. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place. Label shall include following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.

- b. Lamp diameter code (T-4, T-5, T-8, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.
- 9. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly.
 - a. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
 - b. Heat-Removal Units: Air path leads through lamp cavity.
 - c. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
 - d. Dampers: Operable from outside fixture for control of return-air volume.
 - e. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.
- 10. Ballasts for Linear Fluorescent Lamps
 - a. Comply with UL 935 and with ANSI C82.11.
 - b. Designed for type and quantity of lamps served.
 - c. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 - d. Sound Rating: Class A.
 - e. Total Harmonic Distortion Rating: Less than 10 percent.
 - f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - g. Operating Frequency: 42 kHz or higher.
 - h. Lamp Current Crest Factor: 1.7 or less.
 - i. BF: 0.88 or higher.
 - j. Power Factor: 0.95 or higher.
 - k. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
 - l. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
 - m. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
 - 1) Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.

- 2) Automatic lamp starting after lamp replacement.
 - n. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1) Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2) Ballast Input Watts: Can be reduced to 20percent of normal.
 - 3) Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
 - 4) Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
 - o. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
 - 1) Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - High-Level Operation: 100 percent of rated lamp lumens.
 - Low-Level Operation: 30 percent of rated lamp lumens.
 - 2) Ballast shall provide equal current to each lamp in each operating mode.
 - 3) Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.
- 11. Ballasts for Compact Fluorescent Lamps:
 - a. Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 - b. Lamp end-of-life detection and shutdown circuit.
 - c. Automatic lamp starting after lamp replacement.
 - d. Sound Rating: Class A.
 - e. Total Harmonic Distortion Rating: Less than 20 percent.
 - f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - g. Operating Frequency: 20 kHz or higher.
 - h. Lamp Current Crest Factor: 1.7 or less.
 - i. BF: 0.95 or higher unless otherwise indicated.
 - j. Power Factor: 0.95 or higher.
 - k. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

12. Emergency Fluorescent Power Unit :
 - a. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - b. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - c. Nightlight Connection: Operate one fluorescent lamp continuously.
 - d. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - 1) Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 2) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - e. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - f. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
13. Ballasts for HID Lamps:
 - a. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
 - 1) Minimum Starting Temperature: Minus 20 degrees F for single-lamp ballasts.
 - 2) Rated Ambient Operating Temperature: 130 degrees F.
 - 3) Lamp end-of-life detection and shutdown circuit.
 - 4) Sound Rating: Class A.
 - 5) Total Harmonic Distortion Rating: Less than 20 percent.
 - 6) Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 7) Lamp Current Crest Factor: 1.5 or less.
 - 8) Power Factor: 0.90 or higher.
 - 9) Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 - 10) Protection: Class P thermal cutout.

- b. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 degrees C.
 - 1) Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 - 2) Minimum Starting Temperature: Minus 40 degrees F.
- 14. Exit Signs:
 - a. Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
 - b. Internally Lighted Signs:
 - 1) Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - 2) Self-Powered Exit Signs (Battery Type):
 - Integral automatic charger in a self-contained power pack.
 - Battery: Sealed, maintenance-free, nickel-cadmium type.
 - Charger: Fully automatic, solid-state type with sealed transfer relay.
 - Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- 15. Emergency Lighting Units:
 - a. Self-contained units complying with UL 924.
 - b. Battery: Sealed, maintenance-free, lead-acid type.

- c. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - d. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - e. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - f. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - g. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 - h. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 - i. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
16. Fluorescent Lamps:
- a. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours unless otherwise indicated.
 - b. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
 - c. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
 - d. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
 - e. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at three hours operation per start unless otherwise required by Airport.

- 1) 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 - 2) 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 - 3) 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 - 4) 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
17. HID Lamps:
 - a. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.
 - 1) Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
 - b. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.
18. Lighting Fixture Support Components:
 - a. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
 - b. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
 - c. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
 - d. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
 - e. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria:
 - a. Design interior lighting to maintain the majority of direct beam illumination within the building. To accomplish this, project teams should strive to locate interior lighting fixtures in such a way that the direct beam illumination produced by the interior luminaires intersects solid/opaque building surfaces, preventing light spill through transparent and translucent surfaces to exterior areas. Manufacturer's candela plots or photometric data should be used to determine the direction of maximum luminous intensity for each fixture type. Overlay the data for each fixture type on building plans and sections to confirm that the maximum candela angle does not intersect transparent or

- translucent building surfaces that face exterior areas.
 - b. An alternate compliance path requires that all non-emergency interior lighting fixtures be automatically controlled and programmed to turn off following regular business hours. Controls may be automatic sweep times, occupancy sensors, or programmed master lighting control panels. Manual override capabilities that enable lights to be turned on for after-hours use must be included in the design.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Ballasts shall be warranted for five years. Emergency lighting unit batteries shall be fully warranted for a two year period and prorated warranty for the next eight years.
 - 2) Maintenance: Regular and appropriate cleaning of fixture lens. This can be done with mild soap agent.
 - 3) Repair and Replacement: Specify extra lamps, ballasts, plastic diffusers and lenses for future replacement. Coordinate desired quantities with Authority's Facilities Management Department.
 - b. Natural Resources: Design energy efficient systems to comply with California Building Energy Efficiency Standards Title 24.

26 56 00 EXTERIOR LIGHTING

A. SUMMARY

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.
4. Installation of lamps in each luminaire.
5. Pole installation using web fabric slings (not chain or cable).

B. MANUFACTURERS

1. No preferred manufacturers have been identified.
2. Do not use Bieber Lighting.

C. PRODUCTS

1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
 - a. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
 - b. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
2. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
3. Metal Parts: Free of burrs and sharp corners and edges.
4. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
5. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
7. Exposed Hardware Material: Stainless steel.
8. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
9. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
10. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - a. White Surfaces: 85 percent.

- b. Specular Surfaces: 83 percent.
 - c. Diffusing Specular Surfaces: 75 percent.
- 11. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- 12. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Match finish process and color of pole or support materials.
- 13. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel. Color as selected by Airport from manufacturer's full range.
- 14. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611. Color as selected by Architect from manufacturer's full range.
- 15. Factory-Applied Labels:

- a. Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - b. Label shall include the following lamp and ballast characteristics:
 - 1) "USES ONLY" and include specific lamp type.
 - 2) Lamp diameter code (T-4, T-5, T-8), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - 3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - 4) Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
 - 5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - 6) CCT and CRI for all luminaires.
- 16. Luminaire-Mounted Photoelectric Relays:
 - a. Comply with UL 773 or UL 773A.
 - b. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1) Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2) Adjustable window slide for adjusting on-off set points.
- 17. Fluorescent Ballasts and Lamps:
 - a. Power Factor: 90 percent, minimum.
 - b. Sound Rating: Class A.
 - c. Total Harmonic Distortion Rating: Less than 10 percent.
 - d. Electronic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
 - e. Case Temperature for Compact Lamp Ballasts: 65 degrees C, maximum.
 - f. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
- 18. Ballasts for HID Lamps:
 - a. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

- 1) Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2) Minimum Starting Temperature: Minus 22 degrees F.
 - 3) Normal Ambient Operating Temperature: 104 degrees F.
 - 4) Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
 - b. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 degrees C.
 - 1) Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 - Restrike Range: 105 volts to 130 volts ac.
 - Maximum Voltage: 250 volts peak or 150 volts ac rms.
 - 2) Minimum Starting Temperature: Minus 40 degrees F.
19. HID Lamps:
 - a. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), CCT color temperature 1900 K, and average rated life of 24,000 hours, minimum.
 - 1) Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
 - b. Low-Pressure Sodium Lamps: ANSI C78.43.
 - c. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.
20. Poles and Support Components:
 - a. Structural Characteristics: Comply with AASHTO LTS-4-M.
 - 1) Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
 - 2) Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires

- and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
 - c. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1) Materials shall not cause galvanic action at contact points.
 - 2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 - 3) Anchor-Bolt Template: Plywood or steel.
 - d. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
 - e. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange.
21. Aluminum Poles:
- a. Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
 - b. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
 - c. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
 - d. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug.
 - e. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 1) Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2) Finish: Same as pole.
 - f. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
 - g. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1) Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying

- with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3) Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4) Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611. Color as selected by Airport from manufacturer's full range.
22. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria:
 - a. Design exterior lighting to comply with light pollution requirements for specific project zone. Lighting requirements address overall site illumination level and luminaire distribution.
 - b. Consider use of low intensity, shielded fixtures to further reduce effects of light pollution. Minimize lighting of architectural and landscape features. Where lighting is required for safety, security, egress or identification, utilize down-lighting techniques rather than up-lighting.
 - c. If shielded, use low brightness sources to selectively light features, properly aimed so that light from luminaries cannot be measured across project boundaries. In all cases, controls should be used wherever possible to turn off non-essential lighting after normal operating hours or in post-curfew periods. Consider at least the following strategies when designing the exterior lighted environment:
 - d. Employ lighting professional to assess project's lighting needs and provide recommendations based specifically on lighting for a sustainable design environment.
 - e. Carefully review and respond to any applicable lighting ordinances or by-laws that might impact the lighting design for the project site.
 - f. Use the least amount of lighting equipment possible to achieve the goals of the project, but balance the

- quantity of equipment used with the need to provide for glare control than one higher output luminaire.
- g. Select lighting equipment carefully. Any type of luminaire, whether it is full cut-off, semi-cutoff or non-cutoff, can produce excessive brightness in the form of glare. For example, horizontal lamp positions in full cutoff luminaires tend to produce much less glare than vertical lamps. Selecting high-performance equipment of good quality is not only essential in maintaining visual quality and providing sustainable lighting, but also will quickly pay for itself in reduced maintenance costs.
 - h. Design exterior lighting to produce minimal upward illumination from reflected light sources. Select luminaire locations carefully to control glare and contain light within the design area. Pay special attention to luminaires that are located near the property line to ensure that minimal measurable light from these luminaires crosses the project boundary.
 - i. Use minimum amount of light necessary and only light areas that require it. Design and develop a control scheme to minimize, or turn lighting off, after hours.
 - j. Create computer model of proposed electric lighting design and simulate system performance. Use this tool to provide point by point horizontal illuminance information or an iso-footcandle contour map demonstrating that illuminance values are as required at the project boundary. Where luminaires are within 2.5 times their mounting height from the project boundary and the light levels are not zero at the boundary, light trespass is more likely to be a problem.
 - k. After lighting system is constructed, commissioned system to ensure that it is installed and operating properly. Maintenance should be performed on the system on a regular basis to ensure that it continues to operate correctly, and that light pollution is minimized.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
- a. Operational:
 - 1) Warranties: Ballasts shall be warranted for five years. Emergency lighting unit batteries shall be fully warranted for a two year period and prorated warranty for the next eight years.
 - 2) Maintenance: Regular and appropriate cleaning of fixture lens. This can be done with mild soap agent.

- 3) Repair and Replacement: Specify extra lamps, ballasts, plastic diffusers and lenses for future replacement. Coordinate desired quantities with Authority's Facilities Management Department.
- b. Natural Resources: Design energy efficient systems to comply with California Building Energy Efficiency Standards Title 24.

27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. SUMMARY

1. Section includes telecommunications mounting elements; backboards; telecommunications equipment racks and cabinets; telecommunications service entrance pathways; and grounding.
2. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
3. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
4. Cable Trays: Comply with NEMA VE2 and TIA/EIA-569-A-7.
5. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
6. Comply with BICSI TDMM, "Firestopping Systems" Article.
7. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
8. Bond metallic equipment to the ground bus bar, using not smaller than No. 6 AWG equipment grounding conductor. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.
9. Provide preprinted or computer-printed type labels.

B. MANUFACTURERS

1. Cable Tray Manufacturers:
 - a. Cooper B-Line, Inc.
 - b. Cope - Tyco/Allied Tube & Conduit.
 - c. GS Metals Corp.
 - d. PW Industries.
2. Equipment Frame Manufacturers:
 - a. Hubbell Premise Wiring.
 - b. Leviton Voice & Data Division.
 - c. Panduit Corp.

C. PRODUCTS

1. Pathways:
 - a. Comply with TIA/EIA-569-A.
 - b. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

- 1) Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
 - 2) Support brackets with cable tie slots for fastening cable ties to brackets.
 - 3) Lacing bars, spools, J-hooks, and D-rings.
 - 4) Straps and other devices.
 - c. Cable Trays:
 - 1) Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.
 - 2) Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.
 - d. Conduit and Boxes: Flexible metal conduit shall not be used. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
 2. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
 3. Equipment Frames:
 - a. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - b. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
 - c. Finish: Manufacturer's standard, baked-polyester powder coat.
 - d. Floor-Mounted Racks: Modular-type, aluminum construction.
 - 1) Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 - 2) Baked-polyester powder coat finish.
 - e. Modular Freestanding Cabinets:
 - 1) Removable and lockable side panels.
 - 2) Hinged and lockable front and rear doors.
 - 3) Adjustable feet for leveling.
 - 4) Screened ventilation openings in the roof and rear door.
 - 5) Cable access provisions in the roof and base.
 - 6) Grounding bus bar.
 - 7) Rack-mounted, 550-cfm fan with filter.
 - 8) Power strip.
 - 9) Baked-polyester powder coat finish.
 - 10) All cabinets keyed alike.
 - f. Modular Wall Cabinets:
 - 1) Wallmountable.
 - 2) Steel or aluminum construction.

- 3) Treated to resist corrosion.
 - 4) Lockable front doors.
 - 5) Louvered side panels.
 - 6) Cable access provisions top and bottom.
 - 7) Grounding lug.
 - 8) Rack-mounted, 250-cfm fan.
 - 9) Power strip.
 - 10) All cabinets keyed alike.
- g. Cable Management for Equipment Frames:
 - 1) Metal, with integral wire retaining fingers.
 - 2) Baked-polyester powder coat finish.
 - 3) Vertical cable management panels shall have front and rear channels, with covers.
 - 4) Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.
- 4. Power Strips: Comply with UL 1363.
 - a. Rack mounting.
 - b. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
 - c. LED indicator lights for power and protection status.
 - d. LED indicator lights for reverse polarity and open outlet ground.
 - e. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
 - f. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 - g. Cord connected with 15-foot line cord.
 - h. Rocker-type on-off switch, illuminated when in on position.
 - i. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
 - j. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.
- 5. Grounding:
 - a. Telecommunications Main Bus Bar:
 - 1) Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 - 2) Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
 - 3) Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
 - b. Comply with ANSI J-STD-607-A.

6. Labeling: Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

27 13 00 COMMUNICATIONS BACKBONE CABLING

A. SUMMARY

1. Section includes UTP cable; 50/125-micrometer, optical fiber cabling; cable connecting hardware, patch panels, and cross-connects; and cabling identification products.
2. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
3. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
4. Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

B. MANUFACTURERS

1. Copper B-Line, Inc.
2. Cope – Tyco/Allied Tube & Conduit.
3. GS Metals Corp.
4. PW Industries.
5. Berk-Tek; a Nexans company.
6. CommScope, Inc.
7. SYSTIMAX Solutions; a CommScope Inc. brand.
8. Hubbell Premise Wiring.
9. Leviton Voice & Data Division.
10. Corning Cable Systems.

C. PRODUCTS

1. Pathways: Comply with TIA/EIA-569-A.
 - a. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1) Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2) Lacing bars, spools, J-hooks, and D-rings.
 - 3) Straps and other devices.
 - b. Cable Trays:
 - 1) Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches thick.
 - 2) Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.

- c. Conduit and Boxes:
 - 1) Flexible metal conduit shall not be used.
 - 2) Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
- 2. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- 3. UTP Cable: 100-ohm, -pair UTP, covered with a gray thermoplastic jacket.
 - a. Comply with TIA/EIA-568-B.1 for performance specifications.
 - b. Comply with TIA/EIA-568-B.2, Category 6.
 - c. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - 1) Communications, General Purpose: Type CM or CMG.
 - 2) Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - 3) Communications, Riser Rated: Type CMR, complying with UL 1666.
- 4. UTP Cable Connecting Hardware:
 - a. Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
 - b. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
 - c. Cross-Connect:
 - 1) Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 2) Number of Terminals per Field: One for each conductor in assigned cables.
 - d. Patch Panel:
 - 1) Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 2) Number of Jacks per Field: One for each four-pair UTP cable.
 - e. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
 - f. Patch Cords: Factory-made, 4-pair cables in 36-inch lengths; terminated with 8-position modular plug at each end.
 - 1) Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure

- Category 6 performance. Patch cords shall have latch guards to protect against snagging.
- 2) Patch cords shall have color-coded boots for circuit identification.
5. Optical Fiber Cable:
- a. Multimode, 50/125-micrometer, -fiber, tight buffer, optical fiber cable.
 - 1) Comply with ICEA S-83-596 for mechanical properties.
 - 2) Comply with TIA/EIA-568-B.3 for performance specifications.
 - 3) Comply with TIA/EIA-492AAAA-B for detailed specifications.
 - 4) Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 5) General Purpose, Nonconductive: Type OFN or OFNG.
 - 6) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 7) Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
 - 8) Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 - 9) Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
 - b. Jacket:
 - 1) Jacket Color: Aqua for 50/125-micrometer cable.
 - 2) Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - 3) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
6. Optical Fiber Cable Hardware:
- a. Cross-Connects and Patch Panels:
 - 1) Modular panels housing multiple-numbered, duplex cable connectors.
 - 2) Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
 - b. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.
 - c. Cable Connecting Hardware:
 - 1) Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

- 2) Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
7. Grounding: Comply with ANSI-J-STD-607-A.
8. Identification Products: Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility): No currently identified EONS criteria.

27 15 00 COMMUNICATIONS HORIZONTAL CABLING

A. SUMMARY

1. Section includes pathways; UTP Cabling; and 50/125-micrometer, optical fiber cabling.
2. Telecommunication pathways and spaces shall comply with TIA/EIA-569A.
3. Installation of cables shall comply with NECA 1 and TIA/EIA-568-B.1.
4. Maintain separation from EMI sources in accordance with TIA/EIA-569-A.
5. Firestopping shall comply with TIA/EIA-569-A, Annex A, "Firestopping".
6. Identify conductors, raceways and equipments.
7. Performance tests shall be conducted in accordance with TIA/EIA-568B.

B. MANUFACTURERS

1. Berk-Tek; a Nexans company.
2. Cablofil Inc.
3. Chatsworth Products.
4. CommScope, Inc.
5. Cooper B-Line, Inc.
6. Corning Cable Systems.
7. GS Metals Corp.
8. Hubbell Premise Wiring.
9. Leviton Voice & Data Division.
10. PW Industries.
11. Superior Essex.
12. SYSTIMAX Solutions; a CommScope, Inc. brand.

C. PRODUCTS

1. Pathways:
 - a. Comply with TIA/EIA-569-A.
 - b. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1) Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2) Lacing bars, spools, J-hooks, and D-rings.
 - 3) Straps and other devices.
 - c. Cable Trays:
 - 1) Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472-inch thick.
 - 2) Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.

- d. Conduit and Boxes:
 - 1) Flexible metal conduit shall not be used.
 - 2) Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
- 2. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- 3. UTP Cable: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - a. Comply with ICEA S-90-661 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.1 for performance specifications.
 - c. Comply with TIA/EIA-568-B.2, Category 6.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - 1) Communications, General Purpose: Type CM or CMG.
 - 2) Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - 3) Communications, Riser Rated: Type CMR, complying with UL 1666.
- 4. UTP Cable Hardware:
 - a. Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
 - b. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
 - c. Cross-Connect:
 - 1) Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 2) Number of Terminals per Field: One for each conductor in assigned cables.
 - d. Patch Panel:
 - 1) Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 2) Number of Jacks per Field: One for each four-pair UTP cable.
 - e. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

- f. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.
 - 1) Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - 2) Patch cords shall have color-coded boots for circuit identification.
- 5. Optical Fiber Cable:
 - a. Multimode, 50/125-micrometer, tight buffer, optical fiber cable.
 - 1) Comply with ICEA S-83-596 for mechanical properties.
 - 2) Comply with TIA/EIA-568-B.3 for performance specifications.
 - 3) Comply with TIA/EIA-492AAAA-B for detailed specifications.
 - 4) Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 5) General Purpose, Nonconductive: Type OFN or OFNG.
 - 6) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 7) Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
 - 8) Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 - 9) Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
 - b. Jacket:
 - 1) Jacket Color: Aqua for 50/125-micrometer cable.
 - 2) Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - 3) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- 6. Optical Fiber Cable Hardware:
 - a. Cross-Connects and Patch Panels:
 - 1) Modular panels housing multiple-numbered, duplex cable connectors.
 - 2) Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
 - b. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

- c. Cable Connecting Hardware:
 - 1) Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 - 2) Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
- 7. Telecommunications Outlet/Connectors
 - a. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
 - b. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.
 - 1) Plastic Faceplate: High-impact plastic. Coordinate color with Airport personnel.
 - 2) Metal Faceplate: Stainless steel.
 - 3) For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 4) Legend: Machine printed, in the field, using adhesive-tape label.
 - 5) Legend: Snap-in, clear-label covers and machine-printed paper inserts.
- 8. Grounding: Comply with ANSI-J-STD-607-A.
- 9. Identification Products: Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Provide minimum five-year manufacturer's and installer warranty.
 - 2) Maintenance: This equipment will require little to no maintenance.
 - 3) Repair and Replacement: Specify extra materials for patch panels, connecting blocks, device plates and patch cords. Coordinate desired quantities with Authority's Facilities Management Department.

27 51 16 PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

A. SUMMARY

1. Section includes:
 - a. Preamplifiers.
 - b. Power amplifiers.
 - c. Microphones.
 - d. Volume Limiter/compressors.
 - e. Control console.
 - f. Equipment cabinet.
 - g. Equipment rack.
 - h. Telephone paging adapters.
 - i. Tone generator.
 - j. Monitor panel.
 - k. Loudspeakers.
 - l. Microphone and headphone outlets.
 - m. Conductors and cables.
2. Telecommunication pathways and spaces shall comply with TIA/EIA-569A.
3. Installation of cables shall comply with NECA 1 and TIA/EIA-568-B.1.
4. Maintain separation from EMI sources in accordance with TIA/EIA-569-A.
5. Firestopping shall comply with TIA/EIA-569-A, Annex A, "Firestopping".
6. Identify conductors, raceways and equipments.
7. Performance tests shall be conducted in accordance with TIA/EIA-568B.

B. MANUFACTURERS

1. Atlas Sound LP.
2. Bogen Communications, Inc.
3. Dukane Communications Systems; part of GE Infrastructure, Security.
4. Rauland-Borg Corporation

C. PRODUCTS

1. System Functions:
 - a. Selectively connect any zone to any available signal channel.
 - b. Selectively control sound from microphone outlets and other inputs.
 - c. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
 - d. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.

- e. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
 - f. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.
- 2. Equipment and Materials:
 - a. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
 - b. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
 - c. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.
 - d. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.
- 3. Preamplifiers:
 - a. Separately mounted.
 - b. Integral to power amplifier.
 - c. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
 - d. Total Harmonic Distortion: Less than 1 percent.
 - e. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
 - f. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.
 - g. Minimum Noise Level: Minus 55 dB below rated output.
 - h. Controls: On-off, input levels, and master gain.
- 4. Power Amplifiers:
 - a. Mounting: Rack.
 - b. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
 - c. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
 - d. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

- e. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
- f. Output Regulation: Less than 2 dB from full to no load.
- g. Controls: On-off, input levels, and low-cut filter.
- h. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.
- 5. Paging Microphone:
 - a. Type: Dynamic, with cardioid polar characteristic.
 - b. Impedance: 150 ohms.
 - c. Frequency Response: Uniform, 50 to 14,000 Hz.
 - d. Output Level: Minus 58 dB, minimum.
 - e. Finish: Satin chrome.
 - f. Cable: C25J.
 - g. Mounting: Desk stand with integral-locking, press-to-talk switch.
- 6. Volume Limited/Compressor:
 - a. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
 - b. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
 - c. Distortion: 1 percent, maximum.
 - d. Rated Output: Minimum of plus 14 dB.
 - e. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
 - f. Rack mounting.
- 7. Control Console:
 - a. Cabinet: Modular, desktop; complying with TIA/EIA-310-D.
 - b. Housing: Steel, 0.0478 inch minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
 - c. Panel for Equipment and Controls: Rack mounted.
 - d. Controls:
 - 1) Switching devices to select signal sources for distribution channels.
 - 2) Program selector switch to select source for each program channel.
 - 3) Switching devices to select zones for paging.
 - 4) All-call selector switch.
 - e. Indicators: A visual annunciation for each distribution channel to indicate source being used.
 - f. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
 - g. Spare Positions: 20 percent spare zone control and annunciation positions on console.

- h. Microphone jack.
 - 8. Equipment Cabinet:
 - a. Comply with TIA/EIA-310-D.
 - b. House amplifiers and auxiliary equipment at each location.
 - c. Cabinet Housing:
 - 1) Constructed of 0.0478-inch steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, 19-inch racks.
 - 2) Arranged for floor or wall mounting as indicated.
 - 3) Sized to house all equipment indicated, plus spare capacity.
 - 4) Include 20 percent minimum spare capacity for future equipment in addition to space required for future cassette deck and CD player.
 - d. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
 - e. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.
 - 9. Equipment Rack:
 - a. Racks: 19 inches standard, complying with TIA/EIA-310-D.
 - b. Power-Supply Connections: Compatible plugs and receptacles.
 - c. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
 - d. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
 - e. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
 - f. Service Light: At top rear of rack with an adjacent control switch.
 - g. Vertical Plug Strip: Grounded receptacles, 12 inches on center; full height of rack.
 - h. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.

- i. Spare Capacity: 20 percent in rack for future equipment.
- 10. Telephone Paging Adapter: Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.
 - a. Minimum Frequency Response: Flat, 200 to 2500 Hz.
 - b. Impedance Matching: Adapter matches telephone line to public address equipment input.
 - c. Rack mounting.
- 11. Tone Generator:
 - a. Generator shall provide clock and program interface with public address and mass notification system.
 - b. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
 - c. Pitch Control: Chimes and tone.
 - d. Volume Control: All outputs.
 - e. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
 - f. Mounting: Rack.
- 12. Monitor Panel:
 - a. Monitor power amplifiers.
 - b. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
 - c. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
 - d. Mounting: Rack.
- 13. Loudspeakers:
 - a. Cone-Type Loudspeakers:
 - 1) Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
 - 2) Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
 - 3) Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
 - 4) Minimum Dispersion Angle: 100 degrees.
 - 5) Rated Output Level: 10 W.
 - 6) Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
 - 7) Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.

- 8) Flush-Ceiling-Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.
- b. Horn-Type Loudspeakers:
 - 1) Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
 - 2) Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
 - 3) Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
 - 4) Dispersion Angle: 130 by 110 degrees.
 - 5) Mounting: Integral bracket.
 - 6) Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.
14. Outlets:
 - a. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
 - 1) Wattage Rating: 10 W unless otherwise indicated.
 - 2) Attenuation per Step: 3 dB, with positive off position.
 - 3) Insertion Loss: 0.4 dB maximum.
 - 4) Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
 - 5) Label: "PA Volume."
 - b. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
 - c. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.
15. Conductors and Cables: Jacketed, twisted pair and twisted multipair, untinned solid copper.
 - a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
 - b. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper

strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.

- c. Plenum Cable: Listed and labeled for plenum installation.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Provide minimum five-year manufacturer's and installer warranty.
 - 2) Maintenance: This equipment will require little to no maintenance.
 - 3) Repair and Replacement: Specify additional spare speakers and microphone stations. Coordinate desired quantities with Authority's Facilities Management Department.

27 51 23 INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

A. SUMMARY

1. Section includes microprocessor-switched intercommunications and program systems with the following components:
 - a. Master stations.
 - b. Speaker-microphone stations.
 - c. All-call amplifier.
 - d. Intercommunication amplifier.
 - e. Loudspeakers/speaker microphones.
 - f. Conductors and cables.
2. Installation shall comply with NFPA 70 and NECA 1.
3. Match input and output impedances and signal levels at signal interfaces.
4. Identify conductors, raceways, and equipment.
5. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pick-up and cross-talk.
6. Fully program equipment in accordance with Owner's decisions.

B. MANUFACTURERS

1. Alpha Communications.
2. Bogen Communications, Inc.
3. Dukane Communication Systems; part of GE Infrastructure, Security.
4. Rauland-Borg Corporation.

C. PRODUCTS

1. Microprocessor-Switched System Function:
 - a. Master Station:
 - 1) Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
 - 2) Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
 - 3) Communicating with individual stations in privacy.
 - 4) Including other master-station connections in a multiple-station conference call.
 - 5) Accessing separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
 - 6) Overriding any conversation by a designated master station.
 - 7) Displaying selected station.

- b. Speaker-Microphone Station:
 - 1) Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
 - 2) Communicating hands free.
 - 3) Calling master station by actuating call switch.
 - 4) Returning a busy signal to indicate that station is already in use.
 - 5) Being free of noise and distortion during operation and when in standby mode.
 - c. Speakers: Free of noise and distortion during operation and when in standby mode.
- 2. Equipment and Materials:
 - a. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
 - b. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
 - c. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
 - d. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.
- 3. Master Station for Microprocessor-Switched Systems
 - a. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.
 - b. Volume Control: Regulates incoming-call volume.
 - c. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
 - d. Tone Annunciation: Momentary audible tone signal announces incoming calls.
 - e. Handset with Hook Switch: Telephone type with 18-inch- long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
 - f. Reset Control: Cancels call and resets system for next call.
 - g. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices

- required for conversation channels and control functions.
- 4. Speaker-Microphone Stations:
 - a. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.
 - b. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.
 - c. Back Box: Two-gang galvanized steel with 2-1/2-inch minimum depth.
 - d. Speaker: 3 inches, 2.3 oz. minimum; permanent magnet.
 - e. Tone Annunciation: Recurring momentary tone indicates incoming calls.
 - f. Call Switch: Mount on faceplate. Permits calls to master station.
 - g. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.
 - h. Handset with Hook Switch: Telephone type with 18-inch- long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
- 5. All-Call Amplifier:
 - a. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
 - b. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.
 - c. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
 - d. Frequency Response: Within plus or minus 3 dB from 70 to 12,000 Hz.
 - e. Output Regulation: Maintains output level within 2 dB from full to no load.
 - f. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
 - g. Amplifier Protection: Prevents damage from shorted or open output.
- 6. Intercommunication Amplifier:
 - a. Minimum Output Power: 2 W; adequate for all functions.
 - b. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.

- c. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
- d. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.
- e. Output Regulation: Maintains output level within 2 dB from full to no load.
- f. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
- g. Amplifier Protection: Prevents damage from shorted or open output.
- 7. Cone-Type Loudspeakers/Speaker Microphones:
 - a. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
 - b. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
 - c. Minimum Dispersion Angle: 100 degrees.
 - d. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
 - e. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
 - f. Baffle: For flush speakers, minimum thickness of 0.032-inch aluminum with textured white finish.
 - g. Vandal-Proof, High-Strength Baffle: For flush-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi, 0.025-inch minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.
 - h. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
- 8. Horn-Type Loudspeakers/Speaker Microphones:
 - a. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.
 - b. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
 - c. Minimum Power Rating of Driver: 15 W, continuous.
 - d. Minimum Dispersion Angle: 110 degrees.
 - e. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
- 9. Conductors and Cables:

- a. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
 - b. Insulation: Thermoplastic, not less than 1/32 inch thick.
 - c. Shielding:
 - 1) For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
 - 2) Minimum Shielding Coverage on Conductors: 60 percent.
 - d. Plenum Cable: Listed and labeled for plenum installation.
10. Raceways:
- a. Intercommunication and Program System Raceways and Boxes: EMT.
 - b. Outlet boxes shall be not less than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
 - c. Flexible metal conduit is prohibited.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Provide minimum five-year manufacturer's warranty.
 - 2) Maintenance: This equipment will require little to no maintenance.
 - 3) Repair and Replacement: Specify additional spare speakers, and microphone stations. Coordinate desired quantities with Authority's Facilities Management Department.

28 31 11 DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

A. SUMMARY

1. Section includes:
 - a. Fire-alarm control unit.
 - b. Manual fire-alarm boxes.
 - c. System smoke detectors.
 - d. Heat detectors.
 - e. Notification appliances.
 - f. Magnetic door holders.
 - g. Addressable interface device.
2. Non-coded system, dedicated to fire-alarm service only.
3. Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
4. Coordinate and interconnect to existing center system.
5. Identify conductors, raceways, and equipment.
6. Comply with NFPA 72 for installation of fire alarm equipment.
7. Install framed instructions in a location visible from fire alarm control unit.
8. Prepare test and inspection reports.
9. Ground fire alarm control unit and associated circuits; comply with IEEE 1100.
10. Train Airport Facility Management Department or other designated personnel to operate and maintain fire alarm system.

B. MANUFACTURERS

1. GE Infrastructure; a unit of General Electric Company.
2. NOTIFIER; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.

C. PRODUCTS

1. System Operation:
 - a. Fire-alarm signal initiation shall be by one or more of the following devices:
 - 1) Smoke detectors.
 - 2) Manual stations.
 - 3) Heat detectors.
 - b. Fire-alarm signal shall initiate the following actions:
 - 1) Continuously operate alarm notification appliances.
 - 2) Identify alarm at fire-alarm control unit and remote annunciators.
 - 3) Transmit an alarm signal to the existing alarm receiving station.
 - 4) Unlock electric door locks in designated egress paths.

- 5) Release fire and smoke doors held open by magnetic door holders.
 - 6) Activate voice/alarm communication system.
 - 7) Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 8) Activate stairwell and elevator-shaft pressurization systems.
 - 9) Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 10) Recall elevators to primary or alternate recall floors.
 - 11) Record events in the system memory.
 - c. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1) Valve supervisory switch.
 - 2) Low-air-pressure switch of a dry-pipe sprinkler system.
 - 3) Elevator shunt-trip supervision.
 - d. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of primary power at fire-alarm control unit.
 - 4) Ground or a single break in fire-alarm control unit internal circuits.
 - 5) Abnormal ac voltage at fire-alarm control unit.
 - 6) Break in standby battery circuitry.
 - 7) Failure of battery charging.
 - 8) Abnormal position of any switch at fire-alarm control unit or annunciator.
 - e. System Trouble and Supervisory Signal Actions:
Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.
Record the event on system printer.
 2. Fire-Alarm Control Unit:
 - a. General Requirements for Fire-Alarm Control Unit:
 - 1) Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

- Include a real-time clock for time annotation of events on the event recorder and printer.
 - 2) Addressable initiation devices that communicate device identity and status.
 - Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - 3) Addressable control circuits for operation of mechanical equipment.
- b. Alphanumeric Display and System Controls:
 - 1) Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 2) Annunciator and Display: Liquid-crystal type, 2 line(s) of 40 characters, minimum.
 - 3) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- c. Circuits:
 - 1) Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 - Initiating Device Circuits: Style D.
 - Notification Appliance Circuits: Style Z.
 - Signaling Line Circuits: Style 5.
 - Install no more than 50 addressable devices on each signaling line circuit.
 - 2) Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
 - Initiating Device Circuits: Style B.
 - Notification Appliance Circuits: Style W.
 - Signaling Line Circuits: Style 4.5.
 - Install no more than 50 addressable devices on each signaling line circuit.
 - 3) Serial Interfaces: Two RS-232 ports for printers.
- d. Smoke-Alarm Verification:
 - 1) Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2) Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - 3) Record events by the system printer.

- 4) Sound general alarm if the alarm is verified.
 - 5) Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
 - e. Elevator Recall:
 - 1) Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
 - Elevator lobby detectors except the lobby detector on the designated floor.
 - Smoke detector in elevator machine room.
 - Smoke detectors in elevator hoistway.
 - 2) Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 - 3) Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
 - f. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
 - g. Primary Power:
 - 1) 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V dc source.
 - 2) Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
 - h. Secondary Power:
 - 1) 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 2) Batteries: Sealed lead calcium.
 - i. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- 3. Manual Fire-Alarm Boxes
 - a. Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in

- contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
- b. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - c. Station Reset: Key- or wrench-operated switch.
 - d. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. System Smoke Detectors:
- a. General Requirements for System Smoke Detectors:
 - 1) Comply with UL 268; operating at 24-V dc, nominal.
 - 2) Detectors shall be four-wire type.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 4) Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 5) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6) Integral Visual-Indicating Light: LED type indicating detector has operated.
 - 7) Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 degrees F or 20 degrees F per minute.
 - Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 degrees F or 155 degrees F.
 - Provide multiple levels of detection sensitivity for each sensor.

- b. Photoelectric Smoke Detectors:
 - 1) Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2) An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - Primary status.
 - Device type.
 - Present average value.
 - Present sensitivity selected.
 - Sensor range (normal, dirty, etc.).
- c. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1) Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2) An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - Primary status.
 - Device type.
 - Present average value.
 - Present sensitivity selected.
 - Sensor range (normal, dirty, etc.).
 - 3) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 - 4) Each sensor shall have multiple levels of detection sensitivity.
 - 5) Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 6) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- 5. Heat Detectors:
 - a. Comply with UL 521.
 - b. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 degrees F or a rate of rise that exceeds 15 degrees F per minute unless otherwise indicated.
 - 1) Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

6. Notification Appliances:
 - a. Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
 - b. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
 - c. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
 - d. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
 - e. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1) Rated Light Output: 15/30/75/110 cd, selectable in the field.
 - 2) Mounting: Wall mounted unless otherwise indicated.
 - 3) For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4) Flashing shall be in a temporal pattern, synchronized with other units.
 - 5) Strobe Leads: Factory connected to screw terminals.
 - 6) Mounting Faceplate: Factory finished, white.
7. Magnetic Door Holders:
 - a. Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1) Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 - 2) Wall-Mounted Units: Flush mounted unless otherwise directed by Airport.
 - 3) Rating: 24-V ac or dc.
 - 4) Rating: 120-V ac.
 - b. Material and Finish: Match door hardware.
8. Addressable Interface Device:
 - a. Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

- b. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.
- 9. Digital Alarm Communicator Transmitter:
 - a. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
 - b. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
 - c. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1) Verification that both telephone lines are available.
 - 2) Programming device.
 - 3) LED display.
 - 4) Manual test report function and manual transmission clear indication.
 - 5) Communications failure with the central station or fire-alarm control unit.
 - d. Digital data transmission shall include the following:
 - 1) Address of the alarm-initiating device.
 - 2) Address of the supervisory signal.
 - 3) Address of the trouble-initiating device.
 - 4) Loss of ac supply or loss of power.
 - 5) Low battery.
 - 6) Abnormal test signal.
 - 7) Communication bus failure.
 - e. Secondary Power: Integral rechargeable battery and automatic charger.
 - f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
- 10. Device Guards:
 - a. Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

- b. Factory fabricated and furnished by manufacturer of device.
- c. Finish: Paint of color to match protected device.

D. SUSTAINABILITY CRITERIA

- 1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
- 2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Provide minimum five-year manufacturer's warranty.
 - 2) Maintenance: This equipment will require little to no maintenance.
 - 3) Repair and Replacement: Specify spare strobe lamps, smoke and fire detectors, detector bases, and audio notification devices. Coordinate desired quantities with Authority's Facilities Management Department.

28 31 12 ZONED (DC) FIRE ALARM SYSTEM

A. SUMMARY

1. Section includes:
 - a. Fire-alarm control unit.
 - b. Manual fire-alarm boxes.
 - c. System smoke detectors.
 - d. Heat detectors.
 - e. Notification appliances.
 - f. Magnetic door holders.
 - g. Digital alarm communicator transmitter.
2. Non-coded system, dedicated to fire-alarm service only.
3. Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
4. Coordinate and interconnect to existing center system.
5. Identify conductors, raceways, and equipment.
6. Comply with NFPA 72 for installation of fire alarm equipment.
7. Install framed instructions in a location visible from fire alarm control unit.
8. Prepare test and inspection reports.
9. Ground fire alarm control unit and associated circuits; comply with IEEE 1100.
10. Train Authority Facility Management Department or designated maintenance personnel to operate and maintain fire alarm system.

B. MANUFACTURERS

1. GE Infrastructure; a unit of General Electric Company.
2. NOTIFIER; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.

C. PRODUCTS

1. System Operation:
 - a. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1) Manual stations.
 - 2) Heat detectors.
 - 3) Smoke detectors.
 - 4) Duct smoke detectors.
 - 5) Automatic sprinkler system water flow.
 - 6) Fire-extinguishing system operation.
 - 7) Fire standpipe system.
 - b. Fire-alarm signal shall initiate the following actions:
 - 1) Continuously operate alarm notification appliances.
 - 2) Identify alarm zone at fire-alarm control unit and remote annunciators.
 - 3) Transmit an alarm signal to the remote alarm receiving station.

- c. Supervisory signal initiation shall be by valve supervisory switch.
 - d. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of primary power at fire-alarm control unit.
 - 4) Ground or a single break in fire-alarm control unit internal circuits.
 - 5) Abnormal ac voltage at fire-alarm control unit.
 - 6) Break in standby battery circuitry.
 - 7) Failure of battery charging.
 - 8) Abnormal position of any switch at fire-alarm control unit or annunciator.
 - e. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.
2. Fire-Alarm Control Unit:
- a. Modular, power-limited design with electronic modules, UL 864 listed and compatible with existing systems. Include a real-time clock for time annotation of events.
 - b. Alphanumeric Display and System Controls:
 - 1) Display alarm, supervisory, and component status messages and the programming and control menu.
 - 2) Annunciator and Display: Liquid-crystal type, one line of 40 characters, minimum.
 - c. Circuits:
 - 1) No Fewer Than Five Initiating Device Circuits:
 - Four circuits, NFPA 72, Class B.
 - One circuit(s), NFPA 72, Class A, Style 6
 - 2) No Fewer Than Two Notification Appliance Circuits: NFPA 72, Class B, Style Y.
 - d. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
 - e. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
 - f. Primary Power:
 - 1) 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble

- signals, supervisory signals shall be powered by the 24-V dc source.
- 2) Alarm current draw of the entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- g. Secondary Power:
 - 1) 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 2) Batteries: Sealed lead calcium.
- h. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- 3. Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - a. Single-action mechanism, pull-lever type.
 - b. Station Reset: Key- or wrench-operated switch.
 - c. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 - d. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
- 4. System Smoke Detectors:
 - a. Operating at 24-V dc, nominal.
 - b. Four-wire type.
 - c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - e. Integral Visual-Indicating Light: LED type indicating detector has operated.
 - f. Provide multiple levels of detection sensitivity for each sensor.
 - g. Photoelectric Smoke Detectors: Comply with UL 268.

- h. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1) Remote indication and test station.
 - 2) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 - 3) Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 4) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- 5. Heat Detectors:
 - a. Comply with UL 521.
 - b. Combination type, actuated by fixed temperature of 135 degrees F or a rate of rise that exceeds 15 degrees F per minute unless otherwise indicated.
 - c. Mounting: Twist-lock base interchangeable with smoke-detector bases.
- 6. Notification Appliances:
 - a. Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - b. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
 - c. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
 - d. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
 - e. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1) Rated Light Output: 15/30/75/110 cd, selectable in the field.
 - 2) For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 3) Flashing shall be in a temporal pattern, synchronized with other units.
 - 4) Strobe Leads: Factory connected to screw terminals.
 - 5) Mounting Faceplate: Factory finished, white.

7. Magnetic Door Holders:
 - a. Provide units equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - 1) Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 - 2) Rating: 24-V ac or dc.
 - b. Material and Finish: Match door hardware.
8. Digital Alarm Communicator Transmitter:
 - a. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
 - b. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
 - c. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1) Programming device.
 - 2) LED display.
 - 3) Manual test report function and manual transmission clear indication.
 - 4) Communications failure with the central station or fire-alarm control unit.
 - d. Digital data transmission shall include the following:
 - 1) Zone of the alarm initiating device.
 - 2) Zone of the supervisory signal.
 - 3) Zone of the trouble initiating device.
 - 4) Loss of ac supply or loss of power.
 - 5) Low battery.
 - 6) Abnormal test signal.
 - 7) Communication bus failure.
 - e. Secondary Power: Integral rechargeable battery and automatic charger.
 - f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

9. Device Guards:
 - a. Welded wire mesh of size and shape for manual station, smoke detector, gong, or other device requiring protection.
 - b. Factory fabricated and furnished by manufacturer of device.
 - c. Finish: Paint of color to match protected device.

D. SUSTAINABILITY CRITERIA

1. USGBC LEED Equivalent Criteria: No currently identified USGBC LEED criteria.
2. EONS (Economic Viability/Operational Excellence/Natural Resource Conservation/Social Responsibility):
 - a. Operational:
 - 1) Warranties: Provide minimum five-year manufacturer's warranty.
 - 2) Maintenance: This equipment will require little to no maintenance.
 - 3) Repair and Replacement: Specify spare strobe lamps, smoke and fire detectors, detector bases, and audio notification devices. Coordinate desired quantities with Authority's Facilities Management Department.

Appendix A – SDCRAA Policy 8.31: Sustainability

SAN DIEGO COUNTY REGIONAL AIRPORT AUTHORITY

POLICIES

ARTICLE 8 - GENERAL OPERATIONS
PART 8.3 - STRATEGY AND PLANNING
SECTION 8.31 - SUSTAINABILITY

PURPOSE: To establish a formal policy statement of the Board of Directors (the “**Board**”) of the San Diego County Regional Airport Authority (the “**Authority**”) formalizing commitment to a sustainable future for the airport, the Authority and the region.

POLICY STATEMENT:

Sustainability has emerged as a global environmental theme and a major business imperative for the 21st century, dramatically influencing regional thinking and policy making. It is essential for the Authority to become a known benchmark and respected role model for best sustainable practices in the San Diego region and the aviation industry. Sustainability is consistent with and vigorously reinforces the Authority’s Mission Statement: *to operate San Diego’s air transportation gateways in a manner that promotes the region’s prosperity and protects its quality of life.*

The Board recognizes the need for the Authority to be a sustainable organization and endorses the four sustainability elements of Economic Viability (E), Operational Excellence (O), Natural Resource Conservation (N), and Social Responsibility (S) (EONS) to guide and implement the Authority’s sustainable practices. These four elements have been put forth within the aviation industry as the core precepts for a holistic approach to airport sustainability. Incorporating the EONS elements into the Authority’s business practices, policies and programs will ensure sustainability is fully deployed across the Authority’s operational and business functions.

By setting forth this policy, the Board commits the Authority to these sustainable practices:

- (1) Affirm commitment to regulatory compliance, pollution prevention, continuous improvement and transparency in environmental performance.
- (2) Actively participate in local and regional sustainability partnerships and strongly encourage and promote sustainable practices both in the aviation industry and the region.
- (3) Review and evaluate all new programs and projects in terms of addressing all four Sustainability Elements (EONS), in a balanced, holistic and measurable approach.
- (4) Analyze the life cycle operating costs and impacts of our facilities, operations and services, using a Total Cost of Ownership approach to determine project feasibility and economic sustainability.

POLICY SECTION NO. 8.31

- (5) Adopt the standards set forth by the United States Green Building Council (USGBC); Leadership in Energy and Environmental Design (LEED) as guiding criteria for achieving sustainable design in the development and remodeling of airport facilities.
- (6) Apply EONS and LEED criteria as a significant factor when reviewing tenant development/redevelopment projects and provide incentives to encourage sustainable design features.
- (7) Develop language within all new leases, agreements and contracts that supports the Authority's sustainability initiatives.
- (8) Require the Authority's lessees and contractors to comply with the terms and conditions of their agreements pertaining to sustainability.
- (9) Establish a work environment that maximizes our employee assets and stimulates an atmosphere of innovation, productivity, pride, and a personal commitment to sustainability.
- (10) Take a leadership role in sustainability initiatives that strengthen the social well-being and community relationships with visitors, airport stakeholders and the public we serve.

[Adopted by Resolution No. 2008-0013 dated February 7, 2008.]

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Appendix B – Alternative Resolution Form

The purpose of the Facilities Criteria Document is to define requirements, preferences, and minimum standards as established by the Facilities Management Department (FMD) based on departmental experience with maintaining the existing airport facilities. FMD will consider use of alternative materials, manufacturers, products in the development of a particular design provided proof of “equality” and sustainability is submitted by the proposing architect or engineer, using the following or similar format:

Project Description or Title:

From:

Task Authorization Number:

A/E Project Number:

Specification Section Number/Title:

Product Description:

Proposed Alternative:

Manufacturer, Trade Name, Material, Product Name:

Attach data that includes product description, specifications, drawings, photographs, performance and test data adequate for evaluation of the proposed alternative request with applicable portions of the submitted data clearly identified.

Attach letter certifying that:

- Proposed alternative has been fully investigated and determined to be “equal” or superior in all respects.
- Impacts of proposed alternative on EONS (service life, durability, maintenance requirements, sustainable features such as natural resource, energy conservation)
- Same warranty will be furnished for proposed alternative.
- Same maintenance service and source of replacement materials and parts is available.
- Proposal will have no adverse effect on other trades and will not affect or delay project schedule.
- Proposal will not affect dimensions and functional clearances.

Submitted by:

Signed by:

Firm:

Address:

Point of Contact Phone Number:

FMD reviewer will provide communication (hard copy or via electronic means) either accepting or rejecting the suggested alternative.

Use of the proposed design alternative is prohibited until, based on submission of this form and requested supplemental materials, approval is received from the SDCRAA Project Manager and the Facilities Management Department (FMD).

Appendix C – VOC Limits

SCQAMD VOC LIMITS (RULE #1168)

Architectural Applications	VOC Limit [g/L less water]
Indoor Carpet Adhesives	50
Carpet Pad Adhesives	50
Wood Flooring Adhesives	100
Rubber Floor Adhesives	60
Subfloor Adhesives	50
Ceramic Tile Adhesives	65
VCT & Asphalt Adhesives	50
Drywall & Panel Adhesives	50
Cove Base Adhesive	50
Multipurpose Construction Adhesives	70
Structural Glazing Adhesive	100
Architectural Applications	VOC Limit [g/L less water]
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250
Structural Wood Member Adhesive	140
Sheet Applied Rubber Lining Operations	850
Top & Trim Adhesive	250
Substrate Specific Applications	VOC Limit [g/L less water]
Metal to Metal	30
Plastic Foams	50
Porous Material (except wood)	50
Wood	30
Fiberglass	80

Sealants	VOC Limit [g/L less water]
Architectural	250
Nonmembrane Roof	300
Roadway	250
Single-Ply Roof Membrane	450
Other	420
Sealant Primers	VOC Weight [g/L less water]
Architectural Non Porous	250
Architectural Porous	775
Other	750

GREENSEAL VOC LIMITS (GS-36)

Aerosol Adhesives	VOC Weight [g/L minus water]
General purpose mist spray	65% VOCs by weight
General purpose web spray	55% VOCs by weight
Special purpose aerosol adhesives (all types)	70% VOCs by weight

Appendix D - “Green” Product Checklist

One of the easiest ways to get started selecting green products is to develop a checklist of choices. While a checklist could be dozens of pages long, the following list is limited to a smaller number of reasonable choices that can be used in many projects at San Diego International Airport. This checklist is intended to help the design team select “green” products efficiently for projects. The identified choices are listed in CSI MasterFormat 2004 order.

After completion of this (or similar) checklist, the author (usually the designer or project architect) should circulate it to the project team and specification writer for input. Since these choices should be included in the project specifications, ensure there are appropriately identified specific products, manufacturers, and telephone numbers for each item.

DATE: _____
PROJECT NAME: _____
COMPLETED BY: _____

DIVISION 01 – GENERAL REQUIREMENTS

- ☐ Certification: Require USGBC LEED-[NC] [EB] [CI] [CS] [H] [ND] certification at [certified] [silver] [gold] [platinum] level.
- ☐ Green Globes: Provide [final structure in compliance] [work consistent] with Green Globes – US level [Two Globes] [Three Globes] requirements.
- ☐ EPA Rating: Comply with Energy Star building label qualifications.
- ☐ EPA Rating: Comply with WaterSense recommendations.
- ☐ EPA National Performance Track: Comply with EPA Performance Track criteria and Environmental Management System.
- ☐ During Construction: Implement construction pollution and IAQ controls.
- ☐ During Construction: Implement a construction waste management system.
- ☐ Final Cleaning: Implement green housekeeping practices for final cleaning procedures
- ☐ System Performance After Construction: Implement commissioning.
- ☐ Substitutions: Require impact on green design goals for proposed substitutions.

DIVISION 02 – EXISTING CONDITIONS

- ☐ Disassemble components and existing structures for reuse.
- ☐ Verify hazardous materials are deposited in licensed landfills.

DIVISION 03 - CONCRETE

- ☐ Permanent insulating concrete formwork.

- ☐ Reusable concrete formwork.
- ☐ Rebar supports fabricated from recycled steel.
- ☐ Rebar supports fabricated from recycled plastic.
- ☐ Cellular concrete.
- ☐ Recycled aggregate in concrete mix.
- ☐ Coal fly ash or ground granulated furnace slag in concrete mix.
- ☐ Low-VOC concrete hardening compounds.

DIVISION 04 - MASONRY

- ☐ Glass block fabricated from recycled plastics.
- ☐ Glass bricks fabricated from recycled glass.
- ☐ Simulated stone fabricated from recycled materials.
- ☐ Concrete masonry units with integral insulation.
- ☐ Concrete masonry units fabricated from recycled materials.
- ☐ Autoclaved aerated concrete masonry units.
- ☐ Brick fabricated from cleaned, petroleum-contaminated soils.
- ☐ Salvaged brick reuse.
- ☐ Rubber blocks fabricated from recycled rubber.
- ☐ Masonry cavity drainage material fabricated from recycled materials.
- ☐ Locally sourced stone.

DIVISION 05 - METALS

- ☐ Structural steel with recycled content.
- ☐ Cold-formed metal framing with recycled content.
- ☐ Metal fabrications fabricated with recycled content.

DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

- ☐ Certified wood, Forest Stewardship Council (FSC).
- ☐ Arsenic- and chromium-free pressure-treated wood.
- ☐ Engineered framing fabricated from small wood pieces.
- ☐ Sheathing fabricated from recycled waste paper.
- ☐ Sheathing fabricated from recycled waste paper, fire-retardant.
- ☐ Structural insulated panels.
- ☐ Floor decking fabricated from recycled wastepaper.
- ☐ Underlayment fabricated from recycled wastepaper.
- ☐ Underlayment fabricated from recycled materials.
- ☐ Salvaged and reclaimed wood (for timbers and flooring).
- ☐ Medium density fiberboard fabricated with recycled and recovered wood fibers.
- ☐ Particleboard fabricated with recycled and recovered wood fibers.
- ☐ Medium density fiberboard fabricated with no added urea formaldehyde.
- ☐ Particleboard fabricated with no added urea formaldehyde.
- ☐ Rapidly renewable agrifiber board fabricated with no added urea formaldehyde.
- ☐ Rapidly renewable bamboo wall paneling.

- ☐ Wood trim fabricated from veneered finger-jointed wood.
- ☐ Low emitting wood adhesives, interior use.
- ☐ Countertop materials fabricated from recycled materials.

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

- ☐ Fiberglass insulation fabricated from recycled glass.
- ☐ Fiberglass insulation manufactured with no added urea formaldehyde.
- ☐ Mineral wool insulation manufactured with recycled material.
- ☐ Cellulose insulation with recycled material and borate-based primer.
- ☐ Cotton batt insulation manufactured with recycled material.
- ☐ Biobased spray insulation manufactured with plant based soy content.
- ☐ Spray foam air barrier insulation and sealant.
- ☐ Foamed-in-place insulation.
- ☐ Extruded polystyrene insulation, non-ozone depleting.
- ☐ Polyisocyanurate insulation, non-ozone depleting.
- ☐ Exterior water-repellent sealers with low VOCs.
- ☐ Air and vapor barrier membrane at exterior building envelope.
- ☐ Fiber-cement roofing shingles.
- ☐ Metal wall and roof panels manufactured with recycled content.
- ☐ Green roof systems.
- ☐ Solar reflective materials for roof surfaces, Energy Star qualified.
- ☐ Roof walkway pads fabricated from recycled materials.
- ☐ Expanding foam sealants.
- ☐ Joint fillers fabricated from recycled materials.
- ☐ Low emitting joint sealers, interior use.

DIVISION 08 - OPENINGS

- ☐ Steel doors and frames with recycled content.
- ☐ Wood doors with certified wood, Forest Stewardship Council.
- ☐ Wood doors fabricated from hardboard.
- ☐ Wood doors fabricated with agrifiber board cores.
- ☐ Wood doors fabricated with no added urea formaldehyde.
- ☐ Plastic doors fabricated from recycled plastic.
- ☐ Aluminum framing systems fabricated with recycled content aluminum.
- ☐ Skylights for daylighting.
- ☐ High-performance wood windows, Energy Star qualified.
- ☐ High-performance vinyl replacement windows, Energy Star qualified.
- ☐ High-performance fiberglass windows, Energy Star qualified.
- ☐ High-performance insulating glass, with low-e coating.
- ☐ High -performance solar tinting film on windows and doors, Energy Star qualified.

DIVISION 09 - FINISHES

- ☐ Low emitting adhesives, interior use.
- ☐ Gypsum board fabricated with synthetic gypsum.
- ☐ Gypsum board fabricated at local plant.
- ☐ Ceramic tile with recycled content.
- ☐ Terrazzo flooring with recycled content.
- ☐ Acoustical ceiling panels with recycled content.
- ☐ Wood flooring with certified wood, Forest Stewardship Council (FSC).
- ☐ Wood flooring finishes, low emitting.
- ☐ Engineered wood flooring with recycled content and no added urea formaldehyde.
- ☐ Salvaged and reclaimed wood flooring.
- ☐ Rapidly renewable flooring, [cork] [bamboo].
- ☐ Linoleum flooring, [tile] [sheet].
- ☐ Recycled rubber flooring.
- ☐ PVC-free flooring, wall base and accessories.
- ☐ Carpet system with CRI Green Label [Plus] certification.
- ☐ Carpet fabricated with recycled materials.
- ☐ Carpet fabricated with natural materials (wool).
- ☐ Carpet tile fabricated with recycled materials.
- ☐ Carpet cushion fabricated from recycled materials.
- ☐ Cork wallcovering.
- ☐ Recycled fiberboard wall panels.
- ☐ Sisal wallcoverings.
- ☐ Acoustical wall panels with recycled content.
- ☐ Sound control board fabricated from recycled newsprint.
- ☐ Interior paints with zero-VOC content.
- ☐ Interior water-based multi-color paints with zero-VOC content.
- ☐ Latex vapor barrier coating with low VOCs.
- ☐ Exterior paints with zero-VOC content.

DIVISION 10 - SPECIALTIES

- ☐ Bulletin boards fabricated from cork.
- ☐ Toilet compartments fabricated from recycled HDPE plastic.
- ☐ Wall protection systems with PVC-free materials.
- ☐ Lockers fabricated from recycled HDPE plastic.
- ☐ Electric hand dryers in toilet rooms.
- ☐ Shower curtains fabricated of cotton.

DIVISION 11 - EQUIPMENT

- ☐ Dock bumpers fabricated from recycled vehicle tires.
- ☐ Appliances with Energy Star labels.

DIVISION 12 - FURNISHINGS

- ☐ Manufactured casework held to same environmental standards as Division 06.

- ☐ Systems furniture held to same environmental standards as Division 06.
- ☐ Anti-fatigue mats fabricated from recycled materials.
- ☐ Entry mats fabricated from recycled vehicle tires.
- ☐ Entry mats fabricated from cocoa fibers.
- ☐ Permanent entryway systems with drain pans.
- ☐ Window treatment systems with photosensors, automated operation.
- ☐ Window treatment systems that allow views and are Greenguard or equivalent low VOC certified

DIVISION 13 - SPECIAL CONSTRUCTION

- ☐ Solar water heaters.
- ☐ Photovoltaic systems, rooftop mounted modular units.
- ☐ Photovoltaic systems, integrated into building envelope.

DIVISION 14 - CONVEYING SYSTEMS

- ☐ Energy-efficient elevators.
- ☐ Interior cab finishes to same environmental finish standards.

DIVISION 22 – PLUMBING

- ☐ ~~Waterless~~ or low flow urinals.
- ☐ Composting toilets.
- ☐ Ultra low flow toilets.
- ☐ Gray water recycling system.
- ☐ Heat-sensing flow consumption fittings.
- ☐ Underfloor air distribution system/displacement ventilation system.
- ☐ Commissioning.

DIVISION 23 – HVAC

- ☐ Energy modeling.
- ☐ Commissioning.

DIVISION 26 - ELECTRICAL

- ☐ Energy efficient lighting fixtures and bulbs.
- ☐ Occupancy sensors.
- ☐ Perimeter daylighting controls.
- ☐ Commissioning.

DIVISION 31 – EARTHWORK

- ☐ Recycled subbase materials.
- ☐ Containment structures fabricated from recycled materials.
- ☐ Retaining walls fabricated from recycled plastic.

- ☐ Geomembrane liner fabricated with recycled geotextiles.
- ☐ Geotextiles fabricated from recycled materials.
- ☐ Soil stabilization mat fabricated from recycled plastic.

DIVISION 32 – EXTERIOR IMPROVEMENTS

- ☐ Rubber paving manufactured from recycled tires.
- ☐ Porous paving manufactured from recycled plastic.
- ☐ Rubber paving fabricated from post-consumer recycled rubber.
- ☐ Brick paving fabricated from cleaned oil-contaminated soils.
- ☐ Glass pavers fabricated from recycled glass.
- ☐ Plastic pavers fabricated from recycled glass.
- ☐ Rubber unit pavers fabricated from post-consumer vehicle tires.
- ☐ Stepping stones fabricated from recycled rubber.
- ☐ Hi albedo (solar reflectance) materials for exterior surfacing.
- ☐ Irrigation hosing fabricated from recycled vehicle tires.
- ☐ High efficiency irrigation system design using [gray water]
[harvested rainwater].
- ☐ PVC-free pipe material options: HDPE and PEX.
- ☐ Play equipment fabricated from recycled components.
- ☐ Granulated rubber play surfacing fabricated from recycled tires.
- ☐ Fencing fabricated from PVC-free HDPE recycled plastic or composite lumber.
- ☐ Bicycle racks.
- ☐ Site furnishings fabricated with recycled content.
- ☐ Erosion control mats fabricated from recycled fibers.
- ☐ Organic fertilizers.
- ☐ Landscape edging fabricated from recycled plastic.
- ☐ Landscape timbers fabricated from recycled plastic.
- ☐ Mulch fabricated from recycled hardwood blend.
- ☐ Mulch fabricated from recycled newspapers.
- ☐ Root barriers fabricated from recycled polypropylene.
- ☐ Soil amendments composed of recycled or composted materials.
- ☐ Native or adapted climate appropriate planting materials.
- ☐ Xeriscaping, landscaping to minimize the use of water and chemicals.

¹ Adapted from *Green Building: Project Planning and Cost Estimating*, Second Edition, 2006; Chapter 9 author M. Kalin; published by RSMeans, a product line of Reed Construction Data; also available for public use on CSIWiki website.

Appendix E – Design, Technical, & Construction Requirements for Tenant Improvement Projects

A. SPECIALIZED AIRPORT SYSTEMS:

1. Tenant is required to use the Authority's designated subcontractor and match the existing system components/manufacture for any improvements or modifications to the following systems/improvements: HVAC Controls, Fire Alarm, Security, Paging, EVIDS, Roofing, Fire Sprinkler as applicable to Tenant Location.
2. Any required connection to the existing fire alarm system shall be fully tested for functionality by the Authority's designated subcontractor prior to acceptance of the Tenant's Improvements.

B. METAL STUD GAUGE REQUIREMENTS:

1. Walls: 18 gauge minimum (20 gauge if non-load bearing)
2. Bathroom Walls: 16 gauge minimum (20 gauge if non-load bearing and does not include wall-hung equipment/fixtures)
3. Soffits: 20 gauge minimum

C. DOOR LOCKS:

1. All doors in the terminals except as noted in E.3 below shall have Schlage brand lever handle cylindrical type locks ND Series or full mortise lever handle type. All locks shall be "FG" keyway with 6-pin IC core. All lock cores shall be key pinned by the Authority's Locksmith, and the Authority will provide keys.
2. Tenant shall provide access to all spaces that contain Authority infrastructure utilities through use of a master key maintained by the Authority. Such access shall be for emergencies and preventative maintenance only.
3. Where required by regulatory code(s) and unavoidable emergency exterior exit doors allowing access to the Airport Operations area (AOA) shall be provided with panic (crash bar) hardware and integrated into the Authority's Access Control System (ACS) per "Standard installation of Door Finish Hardware Associated with the ACS at Emergency Exit doors" (**refer to exhibit C**).

D. ROOF PENETRATIONS/MODIFICATIONS:

1. No penetrations or modifications are allowed unless specifically requested, detailed and approved by the Authority.
2. Mechanical Systems/Other Improvements on the Roof:
 - a. No mechanical improvements are allowed on the roof without detailed plans showing the exact locations of the equipment, curbs, and associated roof details.

- b. Existing equipment to be abandoned shall be removed and the roof patched as required by a contractor approved by the Roof Warrantor.
- c. All proposed new roof-mounted mechanical equipment shall be installed independently of the existing roof membrane material unless regulatory code(s) require structural attachment/restraint considerations. Reuse existing roof curbs when replacing existing mechanical units with new units to the extent possible. Provide the necessary documentation to depict compliance if required.

E. MASONRY OR CONCRETE PENETRATIONS:

- 1. Penetrations shall be made only with diamond-tipped cutting tools.
- 2. Penetrations through concrete decks and all penetrations larger than one inch shall be cored.
- 3. Fire-safe joint covers, etc., shall be provided as required to re-establish fire protection of the affected wall or floor in accordance with all applicable codes.
- 4. Penetrations through concrete walls should be x-rayed for electric conduit and structural re-bar.

F. ATTACHMENT TO CONCRETE WAFFLE SLAB ABOVE:

- 1. Specify fastener type for attachment to overhead concrete waffle slab.
- 2. Use of double expansion anchor-type fastener or other fastener that minimizes hammering is required to protect the structure.
- 3. No hammer drilling is allowed at the bottom of concrete ribs on existing waffle slab.

G. PLUMBING AND WASTE WATER AREAS:

- 1. Provide continuous waterproofing membrane on slab under finish flooring in all wet areas and areas where sinks occur.

H. ALL WIRING, CABLE AND CONDUIT INSTALLATIONS SHALL CONFIRM TO THE FOLLOWING REQUIREMENTS:

- 1. All wiring and cable shall be installed in conduit.
- 2. All conduit, cable, and wiring abandoned as a result of this project shall be removed.
- 3. All new conduits shall be installed using steel compression-type fittings. The use of set screw and zinc die-cast compression-type fittings is prohibited.

I. PROPOSED UTILITY OUTAGES:

1. Any proposed or probable utility outages shall be coordinated with the Authority's REM TI Program Manager and inform the Lead Electrician. Except where specifically permitted, all utility outages shall be scheduled a minimum of two weeks in advance and shall occur only between the hours of midnight and 4AM. Airport Operations and all affected tenants shall be notified at least 72 hours in advance of any planned utility shut-off. Tenant/Contractor to submit Form 15 (SDIA Contractor Interface with Airport Systems Notification) to the Authority's Construction Inspector (refer to Appendix 1).

J. STRUCTURAL AND FLOOR SYSTEMS:

1. No structural system or component shall be altered without prior written approval by the Authority. Required submittals for proposed structural changes include detailed plans and associated calculations.
2. Floor Penetrations:
 - a. All proposed floor penetrations shall be reviewed with, and approved by the Authority's REM TI Program Manager and an FMD Maintenance Supervisor prior to any construction.
 - b. All existing floor penetration abandoned as a result of tenant project shall be filled with Authority approved structural patch.

K. COMMUNICATIONS:

1. Voice/Data Cable Standard: CAT6E cable.
2. All auxiliary systems shall be labeled to indicate function, termination, and ownership at the following locations: origination, termination and wall/floor/ceiling.
3. All cabling shall be installed in conduit.