SECTION 00910

ADDENDUM NO. 1

SUMMARY

This document includes requirements that clarify or supersede portions of the Request for Proposal. This Addendum is a Contract Document.

General
The following changes, additions and deletions shall be made to the following document(s); all other conditions shall remain the same.

NOTE: ADDENDUM ONE – SWING SPACE (Buildings 5, 6, 20 & 21) is reflected on the Bid Form Alternate No 1). This work will be performed as Phase One (9/24/07 through 12/14/07).

I. BID FORM

A.	No Changes	

II. AGREEMENT

A.	No Changes	

III. SPECIFICATIONS

Item	Reference	Description
A.	**Section 00010- TABLE OF CONTENTS**	Revise the table of contents to ADD the following sections: CLARIFICATION: The below specification sections apply ONLY to ADDENDUM No. 1 – SWING SPACE (BUILDINGS 5, 6, 20 & 21). These sections reflect minor differences in requirements for the Swing Space and thus they supersede the related sections for Buildings 16 & 18. Except as noted herein, the specification sections for Building 16 & 18 will apply to Addendum One – Swing Space. **SECTION 13851** – FIRE ALARM **SECTION 15401** – PLUMBING SYSTEMS - SWING SPACE **SECTION 15701** – HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS - SWING SPACE **SECTION 16051**- BASIC ELECTRICAL MATERIAL AND METHODS- SWING SPACE **SECTION 16061**- GROUNDING AND BONDING - SWING SPACE **SECTION 16073**- ELECTRICAL SUPPORTS - SWING SPACE **SECTION 16076**- ELECTRICAL IDENTIFICATION - SWING SPACE **SECTION 16121**- CONDUCTORS AND CABLES - SWING SPACE **SECTION 16131**- RACEWAYS AND BOXES - SWING SPACE **SECTION 16141**- WIRING DEVICES - SWING SPACE **SECTION 16146**- LIGHTING CONTROLS - SWING SPACE **SECTION 16411**- ENCLOSED SWITCHES AND CIRCUIT BREAKERS-

		SWING SPACE **SECTION 16421**- ENCLOSED CONTROLLERS - SWING SPACE **SECTION 16512**- LIGHTING - SWING SPACE
B.	Section 101920-Cubicle Track and Hardware-Swing Space	Replace Section 10192 Curtain Track and Hardware in its entirety with Section 10192 Cubicle Track and Hardware-Swing Space

IV. DRAWINGS

Item	Reference	Description
A.		**CANADA COLLEGE B20 + B21 Swing Space, (Dated June 04, 2007)**
		CLARIFICATION: The below drawings apply ONLY to ADDENDUM NO. 1 – SWING SPACE BUILDINGS 20 & 21. **ARCHITECTURAL** G0.0 COVER SHEET G0.1 INDEX, ABBREVIATIONS, SYMBOLS AND VICINITY MAP G0.2 CAMPUS PLAN A1.1 SITE PLAN BUILDINGS 19, 20 & 21 A1.2 DEMOLITION PLAN BUILDING 20 + 21 1ST FLOOR A2.1 NEW WORK PLAN BUILDING 20 + B21 A2.2 REFLECTED CEILING PLANS B20 + B21 A3.1 FINISH SCHEDULE, DOOR SCHEDULE AND DETAILS A4.1 INTERIOR ELEVATIONS BUILDING 20 + B21 A7.1 CEILING DETAILS A8.0 METAL STUD DETAILS A8.1 METAL STUD DETAILS A8.2 PARTITION TYPES AND DETAILS A9.1 CASEWORK DETAILS **MECHANICAL** M0.1 MECHANICAL LEGENDS AND NOTES M0.2 MECHANICAL SCHEDULES M1.1 MECHANICAL DEMOLITION PLAN M2.1 MECHANICAL FLOOR PLAN-BUILDING 21 M2.2 MECHANICAL FLOOR PLAN-BUILDING 20 M2.3 MECHANICAL ROOF PLAN-BUILDING 21 M2.4 MECHANICAL ROOF PLAN-BUILDING 20 M4.1 MECHANICAL DETAILS M4.2 MECHANICAL DETAILS M4.3 MECHANICAL DETAILS M5.1 MECHANICAL CONTROL DIAGRAMS M5.2 MECHANICAL CONTROL DIAGRAMS **PLUMBING** P0.1 PLUMBING LEGENDS AND NOTES

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B.		**CANADA COLLEGE B5 + B6 Swing Space, (Dated June 22, 2007)**
		CLARIFICATION: The below drawings apply ONLY to ADDENDUM No. 1 – SWING SPACE BUILDINGS 5 & 6. **ARCHITECTURAL** G0.0 TITLE SHEET G0.1 INDEX, ABBREVIATIONS, SYMBOLS AND VICINITY MAP G0.2 PROJECT LOCATION PLANS- FIRST + SECOND FLR. A1.1 DEMOLITION PLAN B/5 + B/6 FIRST FLOOR A1.2 DEMOLITION PLAN B/5 + B/6 SECOND FLOOR A2.1 NEW CONSTRUCTION PLAN B/5 + B/6 FIRST FLOOR A2.2 NEW CONSTRUCTION PLAN B/5 + B/6 SECOND FLOOR A2.3 RCP PLAN B/5 + B/6 FIRST FLOOR A2.4 RCP PLAN B/5 + B/6 SECOND FLOOR A3.1 FINISH SCHEDULE, DOOR SCHEDULE AND DETAILS A7.1 CEILING DETAILS A7.2 CEILING DETAILS A7.3 INTERIOR DETAILS A8.0 METAL STUD DETAILS A8.1 METAL STUD DETAILS A8.2 PARTITION TYPES AND DETAILS **MECHANICAL** M0.1A MECHANICAL LEGEND AND NOTES M0.2A MECHANICAL SCHEDULES M1.2 BUILDING 5- MECHANICAL PARTIAL FIRST FLOOR DEMOLITION PLAN M2.5 BUILDING 5- MECHANICAL FLOOR PLAN

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SECTION 15401 *A1

PLUMBING SYSTEMS-SWING SPACE *A1

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

A. The General Conditions, Supplementary Conditions, and Division 1 General Requirements apply to the work specified in this Section.

1.02 SUMMARY

A. All materials and operations for a complete and operating plumbing and drainage system, including, but not necessarily limited to, the following:
   1. Demolition of certain plumbing fixtures, equipment, piping and related accessories.
   2. Soil, waste, and vent piping systems inside the building to 5'-0" outside the building.
   3. Condensate drainage piping system.
   4. Cold water, hot water and hot water return piping systems inside the building to 5'-0" outside the building.
   5. Compressed air piping system.
   6. Emergency shower/eyewashes.
   7. Instantaneous hot water heaters.
   8. Grade cleanouts.
   9. Sinks.
   10. Floor cleanouts.
   11. Lavatories.
   12. Plumbing fixtures and trim, including required backing.
   13. Connection to mechanical equipment.
   14. Connection to and installation of laboratory casework fixtures, furnishings and equipment.

1.03 RELATED WORK

A. Electrical connections to equipment, Division 16.

B. Heating, Ventilating, and Air Conditioning Systems, Section 15701.

C. Laboratory Equipment.

D. Laboratory Fume Hoods.

1.04 GENERAL REQUIREMENTS

A. Submittals: A complete list of materials and equipment proposed, accompanied by manufacturer's data sheets, giving sizes, capacities, etc., shall be submitted to the architect in quintuplicate. The list shall include specified and/or substituted materials. No consideration will be given to partial or incomplete lists. Refer to Division 1 for procedures.

B. Examination Of Site: Examine site prior to bidding. Compare it with drawings and specifications. Check conditions and take measurements which may affect work. No allowance shall subsequently be made for any extra expense due to failure to make such examination.

C. Drawings: Plumbing Drawings indicate general arrangement of piping and equipment. Should it be necessary to deviate from arrangement or location indicated in order to meet architectural conditions or site

conditions, or due to interference with work in other divisions, such deviations as offsets, rises, or drops in piping that may be necessary, whether shown or not, shall be made without extra expense to District.

D. Manufacturer's Directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over drawings and specifications. Where these are in conflict with drawings and specifications, notify project manager for clarifications before installing the work.

E. Codes: Work and materials shall be in full accordance with all applicable local or state ordinances, California Building Code, California Plumbing Code, National Fire Protection Association, State of California Safety Orders, and State Fire Marshal. Whenever drawings and specifications require larger sizes or higher standards than are required by regulations, drawings and specifications govern. Whenever drawings or specifications require something, which will violate regulations, regulations govern. No extra charge will be paid for furnishing items required by regulations but not specified or shown on drawings.

F. Cooperation With Other Trades: Schedule work and cooperate with other divisions to avoid delays, interferences and unnecessary work, conforming to construction schedule, making installation when and where required. A special effort shall be made to coordinate with the mechanical contractor so as not to block installation of the mechanical systems. The clearances above ceilings on this project are limited and the ductwork is to have the highest priority. All plumbing work is to be coordinated with the mechanical contractor such that the ductwork can be installed in the locations shown on the mechanical drawings. If installed work is later found to interfere with work of other divisions, make all necessary changes at contractor's expense.

G. Licenses, Permits, Services, and Fees: Secure and pay for all licenses required to begin, perform, and complete work.

H. Quietness of Operation: Adjust, repair, or replace any equipment producing objectionable noise or vibration in any occupied areas of building, including providing additional brackets, bracing, etc., to prevent objectionable noise or vibration.

I. Operating and Maintenance Instructions: Immediately upon completion of work and before final inspection, turn over to owner shop drawings, instruction sheets, bulletins, and pertinent information required by District for proper operation and adjustment of each and every piece of equipment furnished. This information shall be bound in a hard covered loose-leaf binder, typed, and indexed into sections, and labeled for easy reference. Refer to Division 1 for procedure.

J. Manufacturer's names and model numbers are used to establish standard of quality. Use only such items or their approved equal. Architect's/Engineer's approval required for all equipment.

K. As-built Drawings: Submit one (1) complete set of reproducible drawings, obtained from the Architect, marked to show the installed plumbing and piping conditions, and show all deviations from contract drawings. Refer to Division 1 for procedure.

L. Guarantee: Furnish written guarantee that work has been performed in accordance with plans and specifications and to replace or repair, to satisfaction of District, any portion of new work that fails within a period of one (1) year after final acceptance, provided that such failure is due to defects in material or workmanship. Refer to Division 1 for procedure and form.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Soil, Waste and Vent Piping

1. Above Grade: No-hub cast iron soil pipe and fittings. All pipe and fittings shall conform to CISPI 301, ASTM 888 or ASTM A-74 standards. Pipe and fittings shall be marked with the collective trademark or the Cast Iron Soil Pipe Institute. Pipe and fittings are to be manufactured by AB&I Foundry, Charlotte Pipe, Tyler Pipe or equal. Joints shall be made with No-hub couplings with neoprene gasket, stainless shield and clamp, Tyler pipe, or equal.
2. Below Grade: No-hub cast iron soil pipe and fittings. All pipe and fittings shall conform to CISPI 301, ASTM 888 or ASTM A-74 standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings are to be manufactured by AB&I Foundry, Charlotte Pipe, Tyler Pipe or equal. Joints shall be made with heavy-duty No-hub couplings with neoprene gasket, stainless steel with 305 stainless steel worm drive screws. Gaskets per ASTM C564. (4 band 80 inch pound torque). Mission Heavy Weight, Husky SD4000, or equal.

B. Cold Water, Hot Water and Hot Water Return Piping
1. Above Grade: Type L copper tubing ANSI H23.1 with wrought copper sweat fittings ANSI B16.22 joined with 95-5 solder.
2. Below Grade: Type L hard drawn copper tubing ASTM B88. ANSI/ASME B16.23 cast brass or ANSI/ASME B16.29 solid wrought copper. No bullhead tees. ANSI/ASTM A5.8 Bcup silver braze joints.

C. Compressed Air Piping
1. Type L copper tubing ANSI H23.1 with wrought copper sweat fittings ANSI B16.22, long sweep elbows joined with brazed joints.

D. Condensate Drain Piping
1. Type M copper tubing ANSI H23.1 with wrought copper sweat fittings ANSI B16.22 joined with lead free solder.

E. Unions and Flanges
1. Steel pipe unions: Malleable iron ground joint pattern with brass to iron seats, 150 psi.
2. Steel pipe flanges: ANSI B16.C, 150 psi forged steel welding type with flat face.
3. Copper tubing unions: 150 psi ground joint cast bronze unions with sweat connections.
4. Copper tubing flanges: ANSI B16.24, bronze, 150 psi to match standard ASA 150 psi steel flanges with flat face.
5. Flange gaskets: Crane Co Cranite, 1/16" full face sheet packing, 150 psi. Coat gaskets with thread lubricant before installation.

F. Dielectric Protection
1. Location: For connection between dissimilar metals in the piping systems to control corrosion caused by galvanic or electrolytic action. No dielectric unions allowed.
2. Listing: Victaulic Style 47, Lochinvar V-line or equal.
   a. Dielectric couplings: Threaded for sizes 2 inches and smaller, grooved or flanged for 2-1/2 inches and larger.

G. Thread Lubricant For Steel Pipe: Armite Joint Seal Compound No. 250.

H. Valves: Shall be a product of single manufacturer, Red-White or equal.
1. Gate valves (threaded): #280, bronze, 125 psi.
2. Gate valves (solder): #281, bronze, 125 psi.
3. Ball valves (threaded): #5544, bronze, 400 psi, full port.
4. Ball valves (solder): #5549, bronze, 400 psi full port.
5. Valves shall be same size as line in which they are installed. No valve shall be installed with stem pointed below horizontal.

I. Pipe Sleeves: Adjus-To-Crete 24 ga., electrogalvanized sheet metal adjustable sleeve, or equal.

J. Pipe Hangers and Supports: Superstrut or equal.

1. Horizontal piping: C-711 J-Hanger.
2. Vertical piping: C-720 riser clamp.
3. Multiple piping runs and piping supported from walls; A-1200 channel and standard fittings and pipe clamps.
4. Inserts: U-576, U-577, U-579, S-541, or C-475.
5. Rods: H-104.

K. Seismic Bracing: Conform to SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems, Second Edition, 1998.

L. Cleanouts
1. Zurn or equal, as shown in Plumbing Fixture/Equipment Schedule on the drawings. Cleanouts shall be furnished with flashing collars when installed in membraned slabs. Furnish suitable wrought iron or steel wrenches for each style of cleanout plug cap.

M. Piping Identification
1. Piping identification shall be manufactured by Brady or equal.
2. Materials:
   a. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
   b. Plastic nameplates: Laminated 3-layer plastic with engraved black 2 inch letters on light contrasting background color.
   c. Metal tags: brass aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
   d. Plastic pipe parkers: Factory fabricated, flexible semi-rigid plastic, preformed to fit around pipe or covering; minimum information indicating flow direction arrow and fluid being conveyed.

N. Insulation
1. Cold Water, Hot Water and Hot Water Return Piping:
   a. Owens/Corning Fiberglass ASJ/SSL-II, or equal, heavy density, 2-piece sectional pipe insulation, jacketed with vapor barrier laminate, continuous pressure sealing adhesive lap and butt joint stripe, 1 inch thick for pipe sizes 2 inch and smaller. 1-1/2 inch thick for pipe sizes 2-1/2 inch and larger.
   b. Apply insulation over clean, dry surfaces butting adjoining sections firmly together, seal smoothly and securely with self-sealing longitudinal lap. Adhere factory furnished 3" wide pressure sealing strips to joints.
   c. Insulate fittings with fiberglass strips and finish with one-piece PVC fitting cover (Zeston).

O. Plumbing Fixtures: Make and model as scheduled on the drawings or approved equal.
1. Fixtures and trim: As described in manufacturer's catalog with modifications noted.
2. Fixture trim and exposed metal items: Chrome plated unless otherwise noted. Pipes passing through finished walls shall have chrome plated escutcheon plates.
3. Install stops in each water supply to fixtures.
4. No unoccupied fixture faucet holes shall be permitted.
5. Fit exposed fixture setting bolts with china caps.
6. Properly support and securely fasten all fixtures to adequate backing per manufacturer's recommendations.
7. Point up joints between fixtures and wall or floors with white mastic. Mastic shall have sufficient resiliency to prevent cracking or pulling away from wall due to fixture movement.
8. Rough-in and set fixtures to height shown on architectural drawings or as standard for the industry.

P. Escutcheon Plates: For pipes passing through finished ceilings, walls, and floors in conspicuous locations, use chromium-plated steel floor and ceiling plates with set screw or other approved means of holding securely in place.

Q. Flashing and Counterflashing: For cast iron pipe penetrations through roof, use 4 pound lead flashing with counterflashing. For copper pipe penetrations through roof, use copper flashing and counterflashing.

R. Access Panels
1. In areas other than toilet rooms: Karp Model DSC-214-M, or equal, prime coated steel with 14 gauge door and trim and 16 gauge frame, continuous concealed piano hinge, flush screwdriver operated cam latch, size shall be 12" x 12".
2. In toilet rooms: Karp Model DSC-214-M, or equal, Type 304 stainless steel, continuous concealed piano hinge, flush screwdriver operated cam latch, size shall be 12" x 12".

S. Underground, Uninsulated, Steel Pipe Lines: Shall be wrapped conforming to AWWA HOC203.

T. Equipment Scheduled on Drawings:
1. Sinks.
2. Lavatories.
3. Floor cleanout.
4. Grade cleanouts.
5. Instantaneous hot water heaters.
6. Emergency shower/eyewashes.

PART 3 - EXECUTION

3.01 GENERAL

A. Support exposed and concealed piping on specified hangers properly spaced and set to allow piping to adjust for temperature change expansion and contraction. Evenly space and support piping in parallel.

B. Install equipment, products and materials in complete accordance with the manufacturer's installation requirements and recommendations.

C. Coordinate with other trades to provide continuous support channel for all pipes and conduit in exposed locations.

D. Conceal piping in ceilings, furred walls, partitions and pipe spaces, except where noted otherwise. Provide maximum head room and run piping to maintain proper clearance for piping runs beforehand and with other divisions to insure clearance. Where work of other divisions prevents installation of piping shown on drawings, reroute piping as directed by architect at no extra cost to owner.

E. Install exposed piping parallel to or at right angles with building walls.

F. No valve, piece of equipment, or trim shall support the weight of any pipe. Install valves, traps, cleanouts, etc., in accessible locations.

G. Install piping free from traps and air pockets.

H. Use special wrenches in assembly of polished, chrome plated tubing and fittings so that no tool marks are left on pipe or fittings.

I. Wherever changes in sizes of piping occur, use reducing fittings.

J. Install unions adjacent to threaded valves, equipment, and at other points where required for disassembly.

K. Provide sleeves wherever pipes run through walls, slabs, beams, footings, and floors large enough for passage of pipe and/or pipe insulation. Sufficiently size sleeves to allow for contraction and expansion of pipe. Pack sleeves with approved packing material. Pack sleeves in walls and slabs below grade and through exterior walls above grade with waterproof mastic or grout.

L. Set floor cleanouts so top of plate and rim will be flush with top of finish flooring.

M. Where sleeves are missed or misplaced during canning, core holes with rotary diamond tooth core drills.

N. Fit exposed pipes, which pass through walls, ceilings, or floors in finished rooms and conspicuous locations with escutcheon plates.

O. Install insulating unions or flanges at ferrous and nonferrous piping connections.

P. Install water hammer arrestors at all locations of fast closing positive shut-off valves and equipment with fast closing solenoid valves; including but not limited to flush valves, single handle faucets, dishwashers, etc. Install behind wall access panel with ball shut-off valve. Follow manufacturer's installation instructions of proximity to valve and specific configuration of inlet piping.

Q. Install 12" long air chamber on hose bibbs and non-single handle faucets including, but not limited to, mop sinks.

R. Minimum bury for exterior piping: 30" below finish grade, except as otherwise noted or determined by invert elevations.

3.02 PIPE HANGERS, SUPPORTS, AND BRACES

A. General: Support piping from building structure so that there is no apparent deflection in piping runs. Fit piping with steel sway braces and anchors to prevent vibration and/or horizontal displacement under load when required. Support piping only by approved pipe hangers. Pipes shall not be supported from, or braced to, ducts, other pipes, conduits, or any materials except building structure. Piping or equipment shall not be supported or hung by wire, rope, plumbers tape, or blocking of any kind.

B. Hanger Spacing (not for piping or multiple piping supports):

Type of Pipe	1" diam. & smaller	1-1/4" diam. & lgr
Steel pipe	8'- 0"	10'- 0"
Copper tubing	6'- 0"	8'- 0"
Cast iron pipe	All sizes 5'- 0" max. and not less than one hanger per joint	

C. Poly Propylene and PVC piping: Per manufacturer's recommendations. Provide continuous support.

D. Multiple piping support: 6'- 0".

E. Support vertical piping at each floor level with rise clamps.

F. Piping at completion of job shall be rigid and immobile. Install additional pipe supports, brackets, and hangers as required to accomplish a rigid and immobile piping system.

G. Double wrap copper pipe with heavy vinyl tape where pipe comes in contact with ferrous materials.

3.03 EXCAVATING, TRENCHING, AND BACKFILLING

A. Trenches: Shall have uniform grades. In case of over excavation, fill to bottom of pipe with selected fill or sand. Provide dewatering pumping as required.

B. Shoring: Comply with earthwork section of specifications.

C. Cleaning of Trenches: After pipe lines have been tested, inspected, and approved, and prior to backfilling, remove forms, trash, and debris from trenches, then backfill.

D. Backfill and Compaction: Comply with earthwork section of specifications.

3.04 CLEANING

A. Thoroughly clean exterior and interior of piping, equipment, and materials before systems are put in operation. Clean plumbing fixtures with soap and water. Remove marks and labels. Clean and polish chrome. Remove paint, concrete, plaster, and other foreign materials. Clean valve handles and stems of any paint, dirt, or other foreign materials. Clean drains of dirt and debris. Remove shipping paper from cleanout covers and polish. Remove and clean out dirt and debris from pipe spaces, including wire and blocking.

3.05 ADJUSTMENTS

A. Adjust water closet and urinal flush valves to provide proper flush. Adjust faucets and drinking fountains to their normal working conditions.

3.06 TESTING

A. Sanitary Soil, Waste and Vent Piping
   1. Test with minimum height of stand pipe 10'-0". Test duration to be minimum of four (4) hours.

B. Condensate Drain Piping
   1. Test with minimum height of stand pipe 10'-0". Test duration to be minimum of four (4) hours.

C. Cold Water, Hot Water and Hot Water Return Piping
   1. Hydrostatically test under a pressure of 150 PSI at highest point for minimum test duration of four (4) hours.

D. Compressed Air Piping
   1. Test with air under pressure of 200 PSI for a minimum test duration of four (4) hours.

E. If systems are tested in sections, include connection to previously tested section. Final pressures at end of test period shall be no more nor less than that caused by expansion or contraction of test medium due to temperature changes. Apply tests for a minimum period of four (4) hours or as required by local codes or agencies having jurisdiction. Where testing pressures are higher than rated pressure for equipment, or special trim, remove and bypass item with temporary piping for purposes of test.

3.07 PIPING IDENTIFICATION

A. Installation
   1. Degrease and clean surfaces to receive adhesive for identification materials.
   2. Plastic nameplates: Install with corrosive-resistant mechanical fasteners or adhesive.
   3. Plastic or metal tags; Install with corrosive-resistant chain.
   4. Plastic pipe markers: Install in accordance with manufacturer's instructions.
   5. Valves: Identify valves in main and branch piping with tags.
   6. All exposed piping and piping above accessible ceilings shall be neatly identified spaced not more than twenty (20) feet on center. The piping identification is also to be shown at each change of direction in the piping and at each side of any wall penetrated by the piping.

3.08 COLD WATER, HOT WATER AND HOT WATER RETURN PIPING SYSTEMS

A. At the completion of all work and after the system is tested, flushed, and cleaned, all potable water lines shall be sterilized in accordance with local Department of Public Health, "AWWA" Standard C601, and the following:

B. Water treatment firm shall be Bennett Marine Utility, Inc., Burlingame, California, or approved equal.

C. A solution of sodium hypochlorite containing not less than 200 ppm of free chlorine shall be injected into the system in such a manner as to insure that the entire system is completely filled with the solution. During this procedure, all valves shall be operated and outlets shall be tested for residual chlorine. Injection shall continue until all outlets indicate at least 200 ppm of free chlorine.

D. After injection, the system shall be isolated and the solution held in retention for a period of not less than three (3) hours. Tests shall be made for residual chlorine for retention. If such tests indicate less than 200 ppm of residual chlorine, the entire procedure shall be repeated. After satisfactory sterilization has been effected, the system shall be flushed from an approved source, until all traces of chlorine have been removed or until the chlorine content is no greater than that in the existing supply.

E. A Certificate of Sterilization/Chlorination, together with bacteriological reports, shall be prepared by the water treatment firm and delivered to the architect and mechanical engineer stating the work has been done in accordance with the specifications set forth above and prior to final acceptance by owner.

END OF SECTION

SECTION 15701*[A1]

HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS-SWING SPACE*[A1]

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

A. The General Conditions, Supplementary Conditions, and Division 1 General Requirements apply to the work specified in this Section.

1.02 SUMMARY

A. Section Includes: The work shall consist of furnishing all labor, material, and equipment required to complete the installation of the Heating, Ventilating, and Air Conditioning (HVAC) Systems as indicated on the Drawings and described herein, including all incidental work necessary to make it complete and satisfactory and ready for operation. Work shall include but not be limited to the following principal items:
   1. Package heat pump units.
   2. Filters.
   3. Roof-mounted centrifugal exhaust fans.
   4. Side wall-mounted exhaust fan.
   5. Laboratory exhaust fans.
   6. Air distribution equipment including grilles, registers, and diffusers.
   7. Duct systems complete with necessary volume dampers, access doors, hangers, supports, and accessories for the following service:
      a. Air supply.
      b. General exhaust systems.
      c. Laboratory exhaust systems.
      d. Air return.
      e. Air transfer.
   8. Insulation and covering for ductwork and equipment.
   9. Access panels and doors in ductwork and plenums.
   10. Access panels in ceiling which relate to this trade, furnishing shop drawings, and coordination for the proper location of the panels.
   11. Testing and adjusting all system components.
   12. Testing and balancing of all air systems.
   13. Complete control system including:
      a. Time switches.
      b. Thermostats.
      c. Low voltage wiring.
      d. Coordination with other trades to ensure required work is completed.
   14. Connection to laboratory equipment and fume hoods.

1.03 RELATED WORK

A. Plumbing Systems, Section 15400.

B. Electrical Systems, Division 16.

C. Grounds or backing for grilles, diffusers, or registers.

D. Installation of ceiling and wall access panels.

E. Laboratory Equipment.

F. Laboratory Fume Hoods.

1.04 GENERAL REQUIREMENTS

A. Verification of Conditions: Prior to installation of heating, ventilating, and air conditioning work, inspect all surfaces to receive said work and arrange for the satisfactory correction of all defects in workmanship and/or material that could interfere with the work specified herein. Installation of any air conditioning work or materials on any surface shall constitute acceptance of such surfaces as being in proper condition to receive herein specified materials.

B. Codes: Work must comply with the Applicable Code Requirements.

C. Reference Standards: Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of this Section where cited below:
1. Air Moving and Conditioning Association (AMCA).
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Plumbing Engineers (ASPE).
5. Associated Air Balance Council (AABC).
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA).
8. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
9. California Building Code (CBC).
10. State of California - OSHA.
11. California Mechanical Code (CMC).
12. The State of California Codes and Safety Orders.
13. State Fire Marshal requirements (SFM).
14. Air Conditioning and Refrigeration Institute (ARI).
15. State of California Environmental Quality Act.
16. American Society of Testing and Materials (ASTM).
17. Underwriters Laboratories (UL).
18. Occupational Safety and Health Act (OSHA).
19. National Bureau of Standards (NBS).
20. American National Standards Institute (ANSI).
21. AMCA Standard 99: Standards Handbook
22. AMCA/ANSI Standard 204: Balance Quality and Vibration Levels for Fans
23. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
24. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
25. AMCA Standard 500:Test Methods for Louvers, Dampers and Shutters
26. ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
27. ANSI/ASHRAE 15: Safety Code for Mechanical Refrigeration
28. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
29. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems
30. ASME Section VIII: Unified Pressure Vessel Code
31. UL Standard 1995: Heating and Cooling Equipment
32. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

D. Substitutions, Material List, Shop Drawings
1. Refer also to Section Division 1 Submittal Procedures for additional submittal requirements.
2. When specific names are used in connection with materials, they are used as standards only, but this does not imply the right to use other materials or methods unless approved by the architect/engineer.

3. Decision of the architect/engineer shall govern as to what materials are acceptable substitutions. Burden of proof as to equality of any proposed fixtures, material, or equipment shall be upon the contractor. Petition in favor of proposed substitute materials shall be made directly by the contractor. If any tests are necessary to determine equality of proposed items, such tests shall be made at the expense of the contractor by an unbiased laboratory satisfactory to the architect/engineer.
4. Submit shop drawings and material list in six (6) copies. Submit material list and shop drawings after official award of contract. Obtain approval of the architect/engineer before installation. Shop drawings shall be submitted for all materials, equipment, and controls.
5. Check shop drawings and submittals before forwarding to architect/engineer and ascertain that submittals meet all requirements of drawings and specifications and conform to structural conditions available.
6. Shop drawings also shall be prepared for modifications to architectural, structural, plumbing, electrical, and mechanical work required by proposed materials - i.e., relocation of drains, revised electrical circuits, relocation of penetrations, etc.
7. Installation of any approved substituted equipment is the contractor's responsibility, and any changes required to work included under other sections for installation of approved substituted equipment must be made to the satisfaction of the architect/engineer and without any additional cost. Approval by architect/engineer of substituted equipment and/or dimension drawings does not waive these requirements.
8. Review of drawings and materials submitted for approval shall not be construed as a complete check or constitute a waiver of the requirements of the plans and specifications but will indicate that the material submitted is acceptable in quality, utility, and capacity. This review shall not relieve the contractor of the responsibility to fit the proposed materials to the spaces provided and to effect necessary rearrangement or construction of other work. Contractor agrees that shop drawing submittals processed by the architect/engineer do not become contract documents and are not change orders; that the purpose of the shop drawing review is to establish a reporting procedure and is intended for the contractor's convenience in organizing his work and to permit the architect/engineer to monitor the contractor's progress and understanding of the design. The process of review of the contractor's submittals is not for the purpose of testing the architect/engineer's perception. If deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents are discovered either prior to or after the shop drawing submittals are processed by the architect/engineer, the contractor agrees that the contract documents shall control and shall be followed.
9. Submittal lists shall include the identifying marks assigned to the items. Give name of manufacturer, brand name, and catalog number of each item. Submit complete list at one time with items arranged and identified in numerical sequence within each section and article of the specifications. Listing items "as specified" without both make and model or type designation is not acceptable except pipe and pipe fittings not specified by brand names, which may be listed "as specified" without manufacturer's name, provided proposed materials comply with specification requirements. Descriptive Data: Submit complete description, information, and performance data covering equipment which is specified but for which catalog plate numbers, brand names, or specific models have not been used. Include fan performance curves for all equipment with fans and for each individual fan submitted.
10. Submittal of substitutions shall be limited to one (1) proposal for each type or kind of item, unless otherwise permitted by the architect/engineer.

E. Drawings, Specifications, and Coordination of Work
1. Drawings are essentially diagrammatic. Size and locations of equipment are generally shown to scale. Make use of data in all Contract Documents, and verify this information against field conditions.
2. The Drawings indicate the required size and point of termination of ductwork, pipes, and equipment. Install pipe with all necessary offsets and fittings to conform to the structure, avoid obstructions, preserve headroom, maintain required accessibility, and satisfy the requirements of the governing codes and the standards of good practice.

3. The Architectural and Structural Drawings and Specifications take precedence over the Mechanical Drawings in the representation of the general construction work. Refer to the Drawings, Specifications, and review shop drawings for all work in order to coordinate mechanical work with the other work of the project.
4. Where changes in indicated locations or arrangements are necessary due to conditions in building construction, rearrangement of equipment, or conflict in location, make such changes at no cost to the District, provided that the change is ordered before pipe ductwork and/or equipment is installed and that the length of run is not revised by more than 5 percent of the indicated run.
5. Bring discrepancies between different drawings, between Drawings and actual field conditions, or between Drawings and Specifications promptly to the attention of the District for decision, and stop all work on affected areas subject to resolution of the conflict.

F. Materials and Workmanship
1. All materials and equipment to be new and in perfect condition. Materials or equipment for similar uses are to be of same type and manufacturer.
2. Workmanship shall be of best standard practice of the trade.

G. Protection of equipment: The contractor shall be responsible for any damage to any of the work of this Section until final acceptance. Cover all duct, pipe and equipment openings, and cover all apparatus, equipment, and appliances both before and after being set in place to prevent misuse or disfigurement of the apparatus, equipment, or appliances.

H. Openings
1. Cooperate with other trades in providing information as to openings required in walls, floors, and roof for ducts and equipment.
2. Pay all extra costs for cutting of openings as a result of incorrect, delayed, or neglected information.
3. Make absolutely watertight any openings through waterproofed construction caused by the penetration of ductwork or piping, in a manner approved by the District.

I. Cleanup
1. Thoroughly clean all parts of the apparatus and equipment. Exposed parts, which are to be painted shall be thoroughly cleaned of cement, plaster, and other materials, and all grease and oil spots removed with cleaning solvent.
2. Inside of all pipes, ducts, etc., shall be flushed or cleaned before being placed in operation, and all strainers shall be cleaned after operational tests.
3. Remove all debris and surplus equipment and leave installation in perfect condition ready for use.

J. Construction review
1. All services rendered by the architect/engineer or any of his consultants consist of professional opinions and recommendations made in accordance with generally accepted engineering practice.
2. Under no circumstances is it the intent of the architect/engineer or any of his consultants to directly control the physical activities of the contractor or the contractor's workmen in the accomplishment of the Work.
3. The presence of the field representative of the architect/engineer or any of his consultants at the site is to provide to the District and/or architect/engineer an additional source of professional advice, opinions, and recommendations based upon the field representative's observations.

K. Safety
1. In accordance with generally accepted construction practices, the contractor will be solely and completely responsible for conditions on the Project Site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited by normal working hours.
2. Construction review by the architect/engineer or any of his consultants is not intended to include review of the adequacy of the contractor's safety measures in, on, or near the Project Site or at any other location.

1.05 OPERATING INSTRUCTIONS

A. Comply with the requirements of Division 1 – General Requirements.

B. Upon completion of the work, the contractor shall place a competent person in charge who will operate the system and instruct the District's representative in all details of the operation and maintenance.

C. The contractor shall carefully prepare 4 descriptive booklets of the entire Heating, Ventilating, and Air Conditioning systems and a full description of the operation and maintenance of each piece of equipment.

D. Operating instructions manuals are to include names, addresses, and telephone numbers for the following: project name, District, mechanical contractor, and equipment manufacturers (including local representatives).

1.06 GUARANTEE

A. This contractor shall furnish a written guarantee to the District that the materials, equipment, and installation are new, free from mechanical defects, noiseless, and are in perfect operating condition.

B. He shall guarantee to replace and repair at his own expense any and all unsatisfactory and defective work and items to the satisfaction of the District for a period of at least one (1) year after final acceptance of work.

C. The contractor shall also furnish the District with all manufacturer's written guarantees of materials and equipment.

D. See also Division 1.

1.07 RECORD DRAWINGS

A. Comply with the requirements of Division 1 – General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Access Doors
   1. General: All concealed equipment, valves, controls, fire dampers, fire/smoke dampers, volume dampers, etc., shall be provided with access doors which shall be furnished and installed by the general contractor. The coordination of the location of the access doors is the responsibility of this section of work. Access doors are not required in removable ceilings. Access doors which provide access to fire dampers are to be labeled with one-half inch (1/2") high letters reading "Fire Damper." Access door which provide access to fire/smoke dampers are to be labeled with one-half inch (1/2") high letters reading "fire/smoke damper."
   2. Access doors shall be bonderized steel, with flush screwdriver operated cam latch, fitted with concealed hinges, factory prime coated. Doors shall be Milcor, or approved equal, Style "A" for acoustical tile, Style "B" for acoustical plaster, Style "K" for nonacoustical plaster, and Style "M" elsewhere, 24" square unless otherwise noted on the drawings. Access doors in 1 or 2-hour construction shall be Milcor or equal U/L "B" label doors.

B. Air Diffusers, Grilles and Registers
   1. Provide opposed blade damper volume controls only where specifically scheduled on he drawings.
   2. Contractor to verify that the mounting frame of ceiling diffusers, grilles, and registers matches the ceiling or wall system actually being installed. Color to be standard off-white.

3. All air diffusers, grilles, and registers are to be as shown on the Drawings.
4. Manufacturer: Titus, Krueger or Price.

2.02 EQUIPMENT

A. Package Heat Pump Units
1. Completely packaged, high efficiency, self contained, fully charged electric unit, weatherproofed, suitable for outdoor installation. Unit to be ARI certified, and U.L. listed. Units shall meet the California Energy conservation Standards.
2. Trane WSC or equal. Verify that the refrigeration cooling capacity, heating capacity, and blower capacity meet or exceed those for the Trane units scheduled. Provide all options and accessories as scheduled on the drawings.
3. A complete unit, factory assembled, pre-charged, and ready for operation except for external service connections. Unit shall be internally prewired including contacts, relays, CIVA camstat for compressor short cycle and low voltage protections overload protection control wiring to terminal block. Crackcase heater, low ambient control of 0°F and fully modulating enthalpy controlled economizer cycle.
4. Each unit shall be one hundred (100) percent factory run tested before shipping.
5. Each unit is to be equipped with a conventional thermostat interface kit.
6. Manufacturer's economizer damper actuator is to accept input control signal 4-20MA from energy management control system.
7. Provide factory five (5) year refrigeration compressor warranty.

B. Roof-Mounted Centrifugal Exhaust Fans
1. Greenheck series G or equal belt drive, roof-curb mounted, centrifugal roof exhaust fans. Verify that the air delivery capabilities, fan wheel size, and motor horsepower meet those listed for the Greenheck fans scheduled.
2. Fans shall have non-overloading, backwardly inclined, centrifugal wheels, birdscreen, direct drive motor and drive assembly, aluminum housing, backdraft damper, and disconnect switch, all completely weatherproofed for outdoor installation.
3. Provide all options and accessories as scheduled on the drawings.

C. Side Wall-Mounted Exhaust Fan
1. Greenheck Series CW or equal direct drive, side wall-mounted, centrifugal exhausters.
2. Fans shall have non-overloading, backwardly inclined, centrifugal wheels, birdscreens, direct drive motor and drive assembly, aluminum housing, backdraft damper, and disconnect switch, all completely weatherproofed for outdoor installation. All installation brackets and accessories required.
3. Provide all options and accessories as scheduled on the drawings.

D. Laboratory Exhaust Fans
1. Fan construction: Fans shall be of airtight Permalock construction with the scroll panel material formed and embedded into the side panels. The housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
2. Fan wheel: The fan wheel shall be of the nonoverloading, backward inclined centrifugal type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19. The wheel cone and fan inlet cone shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency. Turned, precision ground, and polished steel shafts shall be size so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
3. Bearings: Bearings shall be heavy duty grease lubricated, self aligning, or roller pillow block type. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class.

4. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in the horizontal, vertical, and axial direction. The maximum allowable fan vibration shall be 0.15 in./sec. peak velocity.
5. Fans shall be licensed to bear the AMCA Seal for sound and air performance. Centrifugal fans shall be Model BISW or equal as manufactured by Greenheck Fan Corporation and shall be supplied as shown on the drawings and in the schedules.

E. Filters
1. Filters for each type of equipment shall be as follows:
a. Packaged heat pump units: Package heat pump units are shipped from the factory with 1" throwaway type filters. These filters are to be used for startup and air balancing purposes. After startup and air balance work is complete, replace all of the filters with 2" EFC Envopleat Type 40 or equal 30-35% (ASHRAE Test Standard 52-76) pleated media type filters.

2.03 SYSTEMS

A. Duct Systems
1. Sheet Metal Work
a. 2,500 fpm, +2.0" SP to 2.0" SP for supply air, return air, general exhaust air and transfer air duct.
b. General: Ductwork shall be round spiral lock seam or rectangular galvanized steel construction.
c. Duct Construction:
1) General: Construction shall be in accordance with the latest ASHRAE Standards, SMACNA 1995 - Second Edition with Addendum No. 1 November 1997 HVAC Duct Construction Standards, California State Mechanical Code, and the Title 24 energy standards.
2) All duct joints and seams are to be constructed to meet the requirements of the 1995 SMACNA HVAC Duct Construction Standards noted in 2.a. above. Manufactured joints, such as Ductmate or TDC, are to be installed in strict accordance with the manufacturer's installation requirements.
3) Care shall be taken to ensure that all duct reinforcing requirements are met.
4) All 90° branch fittings for round ducts are to be of the conical tee type, conical saddle tap, or as detailed on the drawings.
5) All spiral duct and fittings inside buildings to be United McGill, Uni-Seal, or equal.
6) Spiral duct joints for diameters up to 36" are to be fabricated using sleeve type couplings. Galvanized steel "Uni-Rings" or angle iron rings are to be used for joints on ducts 36" diameter and larger.
7) Commercial gauge adjustable elbows may be used in concealed areas for duct sizes up through 14" diameter. For duct sizes greater than 14" diameter and where duct is exposed, elbows shall be United McGill "Uni-Seal" gored elbows or equal.
8) All spiral round duct shall be installed in strict accordance with the manufacturer's requirements.
9) All rectangular duct, fittings and plenums are to be constructed in accordance with 1995 SMACNA, HVAC Duct Construction Standards noted in 2.a above.
10) Provide galvanized steel angle ring, 2" wide at all locations where exposed ducts penetrate walls. Angle rings are to be installed to present a finished and aesthetically pleasing appearance.
11) All exposed duct, fittings, sealants and apparatus are to be installed suitable for painting.
12) All elbows and bends are to be made with the minimum inside radius equal to 1.5 times the duct diameter or centerline radius (R/W=1.5), where possible. If field conditions do not allow 1.5 inside radius, provide elbow and bend radius as long as possible. Elbow and bend radius shall be no less that that shown on the drawings. All

conditions with less than 1.5 inside radius must be approved by the District, prior to fabrication and/or installation.

d. Ducts are to be sealed so as to conform to SMACNA Duct Seal Class C. Duct tape as a sealant is not acceptable. A brush applied, high pressure duct sealant is to be utilized, MEI or approved equal. Sealant is to be verified that it is suitable for painting. Sealant is to be applied in a neat manner in exposed duct locations. Duct sealant is to be applied in complete accordance with the manufacturer's application instructions.

e. Flexible Duct - Genflex SLR-181 or approved equal low pressure pre-insulated flexible duct may be used for final connection between ducts, grilles, and diffusers where shown on the drawings. Maximum length of flexible duct to be six (6) feet. Duct is to be carefully supported to provide smooth air flow path and to prevent sagging. Flexible duct must meet Class 1, factory made, air duct requirements. Flexible duct is to have mounting collars. Joints of flexible ducts with other ducts or registers are to be made with sheet metal screws.

f. All roof-mounted ductwork and/or ductwork exposed to weather to be constructed using roll-formed flanges with corner angles, gasket and cleats. Ductmate, TDC, TDF, or equal.

2. General:

a. Access Doors: Doors in sheet metal ducts and plenums for access to dampers, extractors and equipment shall be No. 18 gauge, and made airtight by means of felt strips. Doors shall be sized as required for reasonable service access. Minimum size shall be 12" x 12" unless limited by duct size.

1) Fabricate in accordance with SMACNA Duct Construction Standards and as indicated.
2) Review locations prior to fabrication.
3) Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening looking devices. For insulated ductwork, install minimum 1 inch thick insulation with metal cover.
4) Access doors smaller than 12 inches square may be secured with sash locks.
5) Provide 2 hinges and 2 sash locks for sizes up to 18 inches square, 3 hinges and 2 compression latches with outside and inside handles for sizes up to 24" x 18" inches.
6) Access doors with sheet metal screw fasteners are not acceptable.

b. Balancing Dampers: Shall be furnished and installed where required to completely balance and otherwise adjust the air quantities to each supply and return outlet, branch duct and exhaust grille. Manual balance dampers shall be provided in each branch duct. Balancing dampers shall not be installed in the collar of any flexible duct.

1) Balancing dampers in rectangular ducts:
   a) Ruskin Model CD50 or equal low leakage damper with airfoil type extruded aluminum blade with a maximum depth of 6" and with an integral structural reinforcing tube running full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket. Linkage shall be concealed in frame damper manufacturer's literature shall include performance data developed from testing in accordance with AMCA Standard 500 in an AMCA approved laboratory showing pressure drop for all sizes of dampers required at all anticipated airflow rates.

2) Balancing dampers in round ducts:
   a) Fabricate in accordance with SMACNA Duct Construction Standards and as indicated.
   b) Shall be furnished and installed where required to completely balance and otherwise adjust the air quantities to all supply and return outlets, branch ducts, and exhaust grilles. Manual balance dampers shall be provided in each branch duct. Damper to be one gauge heavier than the duct gauge. Provide Jiffy Bearings JB-1 damper hardware or equal.
   c) Except in round ductwork 12 inch and smaller, provide end bearings. On multiple blade dampers, provide oil impregnated nylon or sintered bronze bearings.
   d) On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases or adaptors

c. Painting: Paint the inside of all backs of diffusers, registers and grilles extending as far as visible with flat black paint.

d. Flexible connections for supply and return air ducts at air handling units, fan coil units, exhaust fans, and at all seismic building joints shall be 16 oz. Airtight "Ventglass" non-combustible fabric with fire retardant neoprene coating on outside. Attach to ductwork by lock seam. Install not more that 6" long. Provide sheet metal rain cover over flexible connections exposed to the weather.

e. Ducts exposed to the weather are to be completely weatherproofed. All joints and seams are to be sealed using Hardcast Galva-Grip or approved equal weatherproof duct sealant. The manufacturer's installation instructions are to be followed closely.

f. Duct test holes: Cut or drill temporary test holes in duct as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

g. Duct Access Doors:
   1) Fabricate in accordance with SMACNA Duct Construction Standards and as indicated.
   2) Review locations prior to fabrication.
   3) Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1 inch thick insulation with sheet metal cover.
   4) Access doors smaller than 12 inches square may be secured with sash locks.
   5) Provide 2 hinges and 2 sash locks for sizes up to 18 inches square, 3 hinges and 2 compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
   6) Access doors with sheet metal screw fasteners are not acceptable.

h. Duct Test Holes: Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

3. Laboratory Exhaust Systems:

a. Galvanized steel duct: (2500) FPM, +3.0" SP to -3.0" SP).

b. For this specification, galvanized steel laboratory exhaust ducts shall be defined as all ductwork connected to or served by laboratory exhaust fans LEF-2 and LEF-3.

c. Laboratory exhaust ductwork shall be Class 5 as defined by Section 502.1 of the 2001 California Mechanical Code for product-conveying ducts. Duct construction shall meet Class 5 requirements as a minimum.

d. Round Ductwork:
   1) Longitudinal transverse seams shall be continuously butt-welded construction. Install with longitudinal seams at top of duct. Seal joints for zero leakage.
   2) Ductwork and fittings to be fabricated with welded galvanized steel.
   3) Fabricate ducts and fittings 100% watertight.
   4) Round Fittings:
      a) Elbows: Elbows shall have a centerline radius of minimum 1.5 times the duct diameter. Elbows up to 15 degrees shall be 3 pieces, 30 degrees 4 pieces, and 5 pieces between 31 to 90 degrees. Elbows shall be fabricated from continuously butt-welded gore sections. Gore sections shall be welded and finish ground to eliminate internal and external projections.
      b) Increasers and reducers: ASME short flow nozzle shape, continuously butt-welded.
      c) Round ducts to be 16 GA.
      d) If field conditions do not allow 1.5 inside radius, provide elbow and bend radius as long as possible. Elbow and bend radius shall be no less than that shown on the drawings. All conditions with less than 1.5 inside radius must be approved by the architect, prior to fabricaton and/or installation.

e. Rectangular Ductwork:
   1) Ductwork and fittings to be fabricated with welded galvanized steel.
   2) Fabricate 100% watertight.
   3) Rectangular Fittings:

a) Elbows: Elbows shall have a centerline radius of minimum 1.5 times the duct width (R/W = 1.5 minimum).
b) If field conditions do not allow 1.5 inside radius, provide elbow and bend radius as long as possible. Elbow and bend radius shall be no less than that shown on the drawings. All conditions with less than 1.5 inside radius must be approved by the District, prior to fabrication and/or installation.

f. Rectangular ducts to be 16 gauge.
g. Manual Balancing Damper:
   1) Manual balancing dampers are to be Ruskin CDRS82 or equal. Damper is to be suitable for a static pressure of +4.0" SP to -4.0" SP.
   2) The damper blade is to be a minimum of 16 gauge galvanized steel. The damper is to be 16 gauge x 8" deep for duct sizes up to 18" and larger. The damper flange is to be constructed of galvanized steel. The shaft is to be a minimum of 1/2" continuous plated steel.
   3) Install dampers in separate, flanged, bolted, removable duct sections.
   4) Provide hand quadrant operator.
h. Prior to construction of ductwork, coordinate Pitot transverse hole locations and requirements with the testing and balancing contractor. Locate sensor holes for fume hood Magnehelic gauges.
i. Closely coordinate with all trades in the layout of ductwork in the laboratory areas. Exercise extreme care in making field measurements to determine location of ducts.

B. Supports and Anchors where not detailed on the drawings:
1. Hanger rods: Steel, threaded both ends, threaded one end, or continuous threaded.
2. Flashing:
   a. Follow the roof manufacturer's recommendations for all roof penetrations, curbs, platforms, and sleepers.
3. Sleeves:
   a. Sleeves for pipes through nonfire rated floors: Form with 18 gauge galvanized steel.
   b. Sleeves for pipes through nonfire rated beams, walls, footings, and potentially wet floors: Form with steel pipe or 18 gauge, 1.2 mm thick galvanized steel.
   c. Sleeves for pipes through fire rated and fire resistive floors and walls, and fireproofing: Prefabricated fire rated sleeves, including seals, UL Listed.
   d. Sleeves for round ductwork: Form with galvanized steel.
   e. Sleeves for rectangular ductwork: Form with galvanized steel or wood.
   f. Stuffing fire stopping insulation: Glass fiber type, noncombustible.
   g. Caulk: Acrylic sealant.

C. Mechanical Systems and Equipment Insulation
1. Duct:
   a. General:
      1) Adhesives and insulation materials: Composite fire and smoke hazard ratings maximum 25 for Flame Spread and 50 for Smoke Developed. Adhesives to be waterproof.
      2) Anti-microbial agent surface coating: EPA-registered biocide, ASTM C-1338, ASTM G-21, ASTM G-22.
   b. Insulation shall be provided on all ductwork where shown on the drawings, all roof mounted supply and return ductwork, and all concealed supply and return ductwork.
   c. Concealed ductwork: Cover all sides with 1-1/2 inch thick, 3/4 pounds per cubic foot density duct wrap with foil scrimkraft or equal, applied per the manufacturer's application specification. Duct wrap insulation is to have a minimum installed R-value of 4.2. Note that foil scrimkraft is not required to be sealed as a vapor barrier. Johns Manville Microlite XG formaldehyde-free Type 75 FSK, Certainteed SoftTouch Type 75 FSK, or equal.
   d. 2" Duct liner: Supply duct upstream of terminal reheat units and all return air ducts where shown on the drawings to be internally lined with 2

inch thick fiberglass duct liner; NRC=1.00 acoustical performance (Type "A" mounting) with a minimum R-value of 8.0. Duct liner shall be installed in complete accordance with the manufacturer's installation instructions. Ducts shall be increased in size to accommodate lining without loss of area. Lined ducts need not be covered. Liner to be Johns Manville Permacote Linacoustic Standard, Certainteed Type 150 ToughGard R with Enhanced Surface, or equal.

e. 1" Duct liner: Supply duct downstream of terminal reheat units and exhaust air ducts where shown on the drawings to be internally lined with 1" liner are to be internally lined with 1 inch thick, 1.5 pounds per cubic foot duct liner with a minimum R-value of 4.2. Liner to be Johns Manville Permacote Linacoustic HP, Certainteed Type 150 ToughGard R with Enhanced Surface, or equal.

D. Vibration Isolation
1. Refer to the drawings for vibration isolation requirements.
2. Vibration isolation is to be Mason Industries or equal.

E. Mechanical Identification
1. Materials:
a. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
b. Plastic nameplates: Laminated 3-layer plastic with engraved black 2 inch letters on light contrasting background color.
c. Metal tags: Brass aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
d. Plastic pipe markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

F. Temperature Controls System
1. Furnish and install a complete system of temperature controls as described herein and as indicated on the drawings.
2. All low voltage wiring (24 volt) is to be furnished and installed under this section of the specifications.
3. All time switches as scheduled on the drawings are to be furnished and installed under this section of the specifications.
4. All electrical disconnects, circuit breakers, fuse protection, magnetic starters (unless specifically shown otherwise), all line voltage wiring and all conduit (for both line and low voltage) will be furnished and installed under the "Electrical" section of the specification.
5. The contractor shall be responsible for ensuring that all wiring (including the line voltage interlock wiring by the electrical contractor) is connected so as to provide the sequence of operation required. The contractor shall provide the necessary information and supervision to the electrical contractor.
6. All low voltage wiring and conduit is to be concealed. No exposed wiring or conduit is allowed in any location.
7. Obtain the wiring diagrams for the HVAC equipment to be furnished and submit six (6) sets of temperature control diagrams, heating and ventilating control panel diagram, sequence of operation, and data sheets for each control device.
8. Calibrate all devices, make final settings, and test the control system under operating conditions for satisfactory operation as approved by the District.
9. The control systems shall be guaranteed for a period of one (1) year from the date of acceptance against defects in workmanship and materials. Provide any service incidental to the proper performance of the temperature control systems under the guarantee.
10. The mechanical contractor may perform all required temperature control functions in lieu of hiring an independent temperature control contractor, provided the contractor has the necessary experience and qualified personnel to handle the installation.

G. Testing, Adjusting, And Balancing

1. Scope includes but is not limited to:
   a. Testing, adjustment, and balancing of air systems.
   b. Testing, adjustment, and balancing of hydronic systems.
   c. Measurement of final operating condition of HVAC systems.
2. References:
   a. AABC: National standards for field measurement and instrumentation, total system balance.
   b. ASHRAE: Systems handbook: Testing, adjusting, and balancing.
   c. NEBB: Procedural standards for testing, balancing, and adjusting of environmental systems.
3. Submittals:
   a. Submit name of adjusting and balancing agency for approval.
   b. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
4. Report forms:
   a. Submit reports on AABC National Standards for Total System Balance or NEBB forms.
   b. Forms shall include the following information:
      1) Title page:
         a) Company name
         b) Company address
         c) Company telephone number
         d) Project name
         e) Project location
         f) Project engineer
         g) Project engineer
         h) Project contractor
         i) Project altitude
      2) Instrument list:
         a) Instrument
         b) Manufacturer
         c) Model
         d) Serial number
         e) Range
         f) Calibration date
      3) Electric motors:
         a) Manufacturer
         b) HP/BHP
         c) Phase, voltage, amperage; nameplate, actual, no load.
         d) RPM
         e) Service factor
         f) Starter size, rating, heater elements
      4) V-belt drive:
         a) Identification/location
         b) Required driven RPM
         c) Driven sheave, diameter and RPM
         d) Belt, size, and quantity
         e) Motor sheave, diameter, and RPM
         f) Center to center distance, maximum, minimum, and actual
      5) Package heat pump unit data:
         a) Manufacturer
         b) Identification/number
         c) Location
         d) Model
         e) Design external static pressure
         f) Actual external static pressure

g) Design air flow
h) Actual air flow
i) Design inlet static pressure
j) Actual inlet static pressure
k) Design discharge static pressure
l) Actual discharge static pressure
m) Filter type
n) Filter static pressure drop
o) Design outside air quantity
p) Actual outside air quantity
q) Actual outside air temperature
r) Actual mixed air temperature, heating and cooling
s) Actual supply air temperature, heating and cooling

6) Roof-mounted Centrifugal Exhaust Fan Data:
a) Location
b) Manufacturer
c) Model
d) Air flow, specified and actual
e) Total static pressure (total external), specified and actual
f) Inlet pressure
g) Discharge pressure
h) Fan RPM

7) Side wall-mounted exhaust fan data:
a) Location
b) Manufacturer
c) Model
d) Air flow, specified and actual
e) Total static pressure (total external), specified and actual
f) Inlet pressure
g) Discharge pressure
h) Fan RPM

8) Laboratory exhaust fan data:
a) Location
b) Manufacturer
c) Model
d) Airflow, design and actual
e) Total external static pressure design and actual.
f) Inlet pressure, actual only
g) Discharge pressure, actual only

5. Air Balance Tolerances:
a. All laboratories are to be air balanced to provide a negative pressure relationship between the laboratory areas and the adjoining corridors or office areas. Negative pressure to be in the range of -0.02" WC to -0.10" WC.
b. Air balance shall be made with least possible friction.
c. Allowances shall be made for air filter resistance at the time of the tests. The main air supplies shall be at design air quantity with pressure drop across the air filter bank at simulated dirty condition. The room air supply shall be plus 10%, minus 0% from the design air quantity for rooms with an air supply of under 1000 cfm and plus or minus 5% where the air supply is 1000 cfm or more. In rooms with multiple supply outlets, the air supplied shall be within plus 5%, minus 0% of the design air quantity.

6. Project Record Documents:
a. Comply with Division 1 requirements.
b. Accurately record actual locations of flow measuring stations and balancing valves and rough setting.
c. Adjust hydronic systems to plus or minus 5% of design conditions indicated.

7. Quality assurance:
   a. Agency shall be company specializing in the adjusting and balancing of systems specified with a minimum of 3 years experience. Perform work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing, and Adjusting Supervisor.
   b. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE Systems Handbook, or NEBB Procedural Standards for Testing, Balancing, and Adjusting of Environmental Systems.
   c. Schedule and sequence work to ensure completion of work before substantial completion of Project.
8. Agencies: The following agencies are acceptable for this Project: National Air Balance, Company Mechanical Environmental Systems (MESA) and Air Metrics.
9. Examination:
   a. Before commencing work, verify that systems are complete and operable. Ensure the following:
      1) Equipment is operable and in a safe and normal condition.
      2) Temperature control system is installed complete and operable.
      3) Proper thermal overload protection is in place for electrical equipment.
      4) Final filters are clean and in place. If required, install temporary media in addition to final filters.
      5) Duct systems are clean of debris.
      6) Correct fan rotation.
      7) Fire and volume dampers are in place and open.
      8) Coil fins have been cleaned and combed.
      9) Access doors are closed and duct end caps are in place.
      10) Air outlets are installed and connected.
      11) Duct system leakage has been minimized.
      12) Hydronic systems have been flushed, filled, and vented.
      13) Correct pump rotation.
      14) Proper strainer baskets are clean and in place.
      15) Service and balance valves are open.
   b. Report any defects or deficiencies noted during performance of service to the architect/engineer.
   c. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.
   d. If, for design reasons, system cannot be properly balanced, report as soon as observed.
   e. Beginning of work means acceptance of existing conditions.
10. Preparation:
   a. Provide instruments required for testing, adjusting, and balancing operations.
   b. Provide additional balancing devices as required.
11. Adjusting:
   a. Recorded data shall represent actually measured or observed condition.
   b. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
   c. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
   d. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
   e. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the District's representative.
12. Air system procedure:
   a. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at all locations.
   b. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

c. Measure air quantities at air inlets and outlets.
d. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
e. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
f. Vary total system air quantities by adjustment of fan speeds. Install drive changes as required. Contractor will be reimbursed for the cost of any drive changes required. Vary branch air quantities by damper regulation.
g. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
h. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
i. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
j. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

13. Schedule:

EQUIPMENT	AIR BALANCE
Package heat pump units	X
Roof-mounted Centrifugal Exhaust Fans	X
Side Wall-mounted exhaust fans	X
Air Filters	X
Air Inlets and Outlets	X
Exhaust Inlets	X
Laboratory Exhaust Fans	X

PART 3 - EXECUTION

3.01 GENERAL

A. For the actual fabrication, installation, and testing of work under this Section, use only thoroughly trained and experienced workmen who are properly qualified for the work they perform. All installers are to be completely familiar with the manufacturer's current recommended methods of installation and shall so execute.

3.02 EQUIPMENT

A. All equipment is to be installed to meet the manufacturer's installation instructions, guidelines, and recommendations.

3.03 DUCT AND ACCESSORIES

A. Installation
1. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
2. Connect terminal units to main supply air with galvanized steel duct.
3. Connect diffusers to low pressure ducts in concealed locations with 5 feet maximum length of flexible duct. Hold in place with strap or clamp to prevent duct from collapsing above diffuser.
4. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.
5. Provide balancing dampers on medium pressure systems where indicated.

6. Provide fire dampers at locations indicated. Install with required perimeter mounting angles, sleeves, breakaway duct connection, corrosion resistant springs, bearings, bushings, and hinges.
7. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
8. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.
9. Provide duct test holes where indicated and required for testing and balancing purposes.
10. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
11. Install diffusers to ductwork with airtight connection.
12. Paint ductwork visible behind air outlets and inlets matte black.

3.04 MECHANICAL SYSTEM AND EQUIPMENT INSULATION

A. Install all insulation, including duct liner, in strict accordance with the manufacturer's installation instructions and specifications.

B. Duct
1. Do not install covering before ductwork and equipment has been tested, and accepted by the tenant's representative.
2. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.
3. Ensure insulation in continuous through inside walls. Pack around ducts with fireproof, self-supporting insulation material, properly sealed.
4. Finish insulation neatly at hangers, supports, and other protrusions.
5. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

3.05 MECHANICAL IDENTIFICATION

A. Installation
1. Degrease and clean surfaces to receive adhesive for identification materials.
2. Plastic nameplates: Install with corrosive-resistant mechanical fasteners or adhesive.
3. Plastic or metal tags: Install with corrosive-resistant chain.
4. Plastic pipe markers: Install in accordance with manufacturer's instructions.
5. Equipment: Identify all equipment with plastic nameplates. Small devices may be identified with plastic metal tags.
6. Controls: Identify control panels and major control components' outside panels with plastic nameplates.
7. Balancing Dampers: Identify all balancing dampers in concealed areas with fluorescent colored plastic flagging tape, min. 1-3/16" wide. Tape to be long enough so that it can be seen from the access location.
8. Provide valve chart and schedule in aluminum frame with clear plastic shield. In-stall at location as directed.

3.06 SUPPORTS AND ANCHORS

A. Fabrication
1. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
2. Design hangers without disengagement of supported pipe.
3. Prime coat exposed steel hangers and supports per Section 09900. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

B. Pipe Hangers and Supports

1. Support horizontal piping as follows:

PIPE SIZE (INCHES)	MAX. HANGER SPACING (FEET)	HANGER DIAMETER (INCHES)
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and over	20	1

2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
3. Place a hanger within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment.
5. Support grooved pipe and fittings in accordance with manufacturer's requirements.
6. Support vertical piping at every floor and at roof penetrations.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Support riser piping independently of connected horizontal piping.

C. Equipment Bases and Supports
   1. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

D. Flashing
   1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, and roofs in accordance with roofing manufacturer's recommendations.
   2. Provide acoustical lead flashing around ducts and pipes penetrating building wall from roof-mounted equipment. Flashing to be installed in accordance with manufacturer's instructions for sound control.

E. Sleeves
   1. Where piping or ductwork penetrates ceiling or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
   2. Install steel escutcheons at finished surfaces.

3.07 SYSTEM TEST AND STARTUP

A. Check the installation and connection requirements for conformance with the manufacturer's installation instructions for each piece of equipment. Perform the step-by-step checkout and startup procedures for each piece of equipment in accordance with the manufacturer's startup instructions.

B. Coordinate the control requirements with the electrical contractor.

C. The mechanical contractor is to coordinate the efforts of the Test and Balance contractor and the electrical contractor to ensure that all systems are tested and performing as intended.

D. Make all necessary control and system adjustments and operate the system in its final configuration for a period of ten (10) working days for the purpose of proving satisfactory performance. During this period, instruct such persons as District may designate in proper operation, care, and maintenance of the systems.

END OF SECTION

SECTION 16051 *A1

BASIC ELECTRICAL MATERIALS AND METHODS – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

1.4 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

3.3 FIELD QUALITY CONTROL

A. Inspect installed firestopping for damage and faulty work.

END OF SECTION

SECTION 16061 *A1

GROUNDING AND BONDING – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by10 feet (19 mm by 3 m) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16073 *A1

ELECTRICAL SUPPORTS – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IBC: International Building Code.

C. IMC: Intermediate metal conduit.

D. NBC: National Building Code.

E. OSHPD: Office of Statewide Health Planning and Development.

F. RMC: Rigid metal conduit.

G. SBC: Standard Building Code.

H. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

I. UBC: Uniform Building Code.

1.4 SUBMITTALS

A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.

1. Manufacturers:

a. Cooper B-Line; a division of Cooper Industries.
b. ERICO International Corporation.
c. Allied Support Systems; Power-Strut Unit.
d. GS Metals Corp.
e. Michigan Hanger Co., Inc.; O-Strut Div.
f. National Pipe Hanger Corp.
g. Thomas & Betts Corporation.
h. Unistrut; Tyco International, Ltd.
i. Wesanco, Inc.

2. Finishes:

a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.

3. Channel Dimensions: Selected for structural loading.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers:

a. Allied Support Systems; Aickinstrut Unit.
b. Cooper B-Line; a division of Cooper Industries.
c. Fabco Plastics Wholesale Limited.
d. Seasafe, Inc.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 for installation requirements, except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.

B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

END OF SECTION

SECTION 16076 *A1

ELECTRICAL IDENTIFICATION – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY 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. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the 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 (915 MM)."

2.4 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 9 "Paints and Coatings".

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.
4. Security System: Blue and yellow.
5. Mechanical and Electrical Supervisory System: Green and blue.
6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.

C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

   a. Power transfer switches.
   b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

F. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchgear and switchboards.
   d. Transformers.
   e. Emergency system boxes and enclosures.
   f. Disconnect switches.
   g. Enclosed circuit breakers.
   h. Motor starters.
   i. Push-button stations.
   j. Contactors.
   k. Remote-controlled switches, dimmer modules, and control devices.
   l. Battery inverter units.
   m. Battery racks.
   n. Voice and data cable terminal equipment.
   o. Fire-alarm control panel and annunciators.
   p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
   q. Monitoring and control equipment.
   r. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

E. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors to match existing system.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.

2. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

G. Painted Identification: Prepare surface and apply paint according to Division 9 "Paints and Coatings."

END OF SECTION

SECTION 16121 *[A1]

CONDUCTORS AND CABLES – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

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

B. Field Quality-Control Test Reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:

1. Alcan Aluminum Corporation; Alcan Cable Div.
2. American Insulated Wire Corp.; a Leviton Company.

3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THHN-THWN.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

G. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable, 2-conductor, #16 AWG solid twisted shielded cable, in raceway.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Firestopping."

G. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 16131 *A1

RACEWAYS AND BOXES – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. LFMC: Liquidtight flexible metal conduit.

D. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, power poles, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
6. LTV Steel Tubular Products Company.
7. Manhattan/CDT/Cole-Flex.
8. O-Z Gedney; Unit of General Signal.
9. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

D. EMT and Fittings: ANSI C80.3.

1. Fittings: Compression type.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe & Plastics Group.
6. Condux International.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.
13. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color indicated on the drawings.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Thomas & Betts Corporation.
   b. Walker Systems, Inc.; Wiremold Company (The).
   c. Wiremold Company (The); Electrical Sales Division.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 POWER POLES

A. Power Poles: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color indicated on the drawings.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Thomas & Betts Corporation.
   b. Walker Systems, Inc.; Wiremold Company (The).
   c. Wiremold Company (The); Electrical Sales Division.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet-PLM Division.

10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Floor Boxes: Nonmetallic, nonadjustable, round.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel.
2. Concealed: Rigid steel.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R.

B. Indoors:

1. Exposed: EMT.
2. Concealed: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

C. Minimum Raceway Size: 1/2-inch trade size (DN 16).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

3.2 INSTALLATION

A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 16 Section "Electrical Supports."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors.

K. Tighten set screws of threadless fittings with suitable tools.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

N. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

O. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

P. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

Q. Set floor boxes level and flush with finished floor surface.

R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 16141 *[AI]

WIRING DEVICES – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles and ground-fault circuit interrupter receptacles.
2. Single- and double-pole snap switches.
3. Device wall plates.
4. Floor service outlets and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. 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.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wiring Devices:

   a. Bryant Electric, Inc./Hubbell Subsidiary.
   b. Eagle Electric Manufacturing Co., Inc.
   c. Hubbell Incorporated; Wiring Device-Kellems.
   d. Leviton Mfg. Company Inc.
   e. Pass & Seymour/Legrand; Wiring Devices Div.

2. Multioutlet Assemblies:

   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Wiremold Company (The).

3. Floor Service Outlets:
   a. Square D/Groupe Schneider NA.
   b. Thomas & Betts Corporation.
   c. Wiremold Company (The).

4. Power Pole:

   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Pass & Seymour/Legrand; Wiring Devices Div.
   c. Square D/Groupe Schneider NA.
   d. Thomas & Betts Corporation.
   e. Wiremold Company (The).

2.2 RECEPTACLES

A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.

B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.

C. GFCI Receptacles: Straight blade, non-feed-through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.

D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, single receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.

1. Devices: Listed and labeled as isolated-ground receptacles.

2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

2.3 SWITCHES

A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.

B. Snap Switches: Heavy-Duty grade, quiet type.

2.4 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: Stainless Steel.
3. Material for Unfinished Spaces: Stainless Steel.
4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.5 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.

E. Data Outlet: Refer to telecommunications specifications and plans.

2.6 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles. Wiremold G4000 with cover plate G4047BB or approved equal.

B. Raceway Material: Steel.

C. Wire: No. 12 AWG.

2.7 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: As indicated on the plans or required by NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.

B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

C. Remove wall plates and protect devices and assemblies during painting.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 16146 *[A1]

LIGHTING CONTROL DEVICES – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Indoor occupancy sensors.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS – NOT USED REFER TO DRAWINGS

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

SECTION 16411*[A1]

ENCLOSED SWITCHES AND CIRCUIT BREAKERS – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Nonfusible switches.
2. Molded-case circuit breakers.
3. Enclosures.

1.3 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Qualification Data: For testing agency.

C. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Submittal Procedures," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two 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; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Moeller Electric Corporation.
4. Siemens Energy & Automation, Inc.
5. Square D/Group Schneider

B. Molded-Case Circuit Breaker: NEMA AB 1, 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.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases.

B. Concrete base is specified in Division 16 Section "Electrical Supports," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

SECTION 16421 *[A1]

ENCLOSED CONTROLLERS – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify the District no fewer than two days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without the District's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Danfoss Inc.; Danfoss Electronic Drives Div.
3. Eaton Corporation; Cutler-Hammer Products.
4. General Electrical Company; GE Industrial Systems.

5. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
6. Siemens/Furnas Controls.
7. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10, 20 or 30 tripping characteristic, as required by the motor. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10, 20, 30 tripping characteristic, as required by the motor, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. 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.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard grey paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 16 Section "Electrical Supports and Seismic Restraints."

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports."

D. Enclosed Controller Fuses: Install fuses in each fusible switch

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 16 Section "Electrical Supports," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 16 Section "Electrical Identification."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 16 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION

SECTION 16512 *A1

LIGHTING – SWING SPACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
1. Division 16 Section "Lighting Control Devices" for automatic control of lighting.

1.2 SUMMARY

A. This Section includes the following:

1. Lighting fixtures, lamps, and ballasts.
2. Lighting fixture supports.

1.3 DEFINITIONS

A. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Ballast.
3. Energy-efficiency data.
4. Life, output, and energy-efficiency data for lamps.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lighting Fixtures:

1. Manufacturers of individual light fixtures shall be as scheduled on Drawings, and indicate quality and design features required.

2. Products of other manufactures will be considered upon submittal of proper data.

B. Lamps:

1. General Electric.

2. North America Philips.

3. Osram/Sylvania.

C. Ballasts:

1. Advance.

2. Universal/Magnetek.

3. Osram/Sylvania.

4. Or equal.

2.2 GENERAL

A. Provide lighting fixtures of the size, type and rating indicated, complete with lamps, lampholders, reflectors, ballasts, starters, trim, wiring and accessories.

B. It is the intent of the Drawings and Specifications to indicate the type of fixture for each intended use. It is generally intended that rooms of similar usage and configuration will have similar fixture types. When fixture type is not indicated, it is the duty of the Contractor to request clarification prior to proceeding with the work.

2.3 LUMINAIRES-REFER TO DRAWINGS

2.4 LAMPS

A. Linear Fluorescent Lamps (T-8):

1. 17 watts, nominally rated 1,300 lumens, 4100K, nominal 85 CRI, low-mercury.

2. 32 watts, nominally rated 3,000 lumens, 4100K, nominal 85 CRI, low-mercury.

B. Compact Fluorescent Lamps:

1. 32 watts, nominally rated 2,400 lumens, 4100K, triple tube, nominal 82 CRI, low mercury.

2.5 FLUORESCENT BALLASTS

A. Fluorescent Ballasts: Electronic; one, two, or three lamp, ballasts factor not less than 0.95. Total harmonic distortion not greater than 10 percent.

B. 430 ma lamp ballasts: Rapid start.

C. Minus 20 degrees F rating when used in exterior or unheated areas.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION