PROJECT MANUAL

Lab N2004 Fan Addition

Solvay Specialty Polymers
4500 McGinnis Ferry Rd
Alpharetta, GA 30005

Issue for Bid and Construction

May 5, 2021

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SECTION 230010 – HVAC GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. These heating, ventilating and air conditioning (HVAC) provisions specified herein apply to all Sections of Division 23.

B. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 23.

1.2 QUALITY ASSURANCE

A. Conform to the codes as listed on the drawings.

B. Codes, standards and regulations specified herein refer to the latest edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.

C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.

D. HVAC/Electrical Design Coordination:

1. The power ratings of motors and other HVAC equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
2. Reasonable efforts have been made to coordinate the electrical requirements of the HVAC equipment with the electrical systems serving that equipment. Differences among manufacturers of HVAC equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall

coordinate the electrical requirements of the HVAC equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the HVAC equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the HVAC equipment actually furnished shall be provided at no additional cost to the Owner.

E. Adhesives and Sealants:

1. Adhesives, sealants, and sealant primers used inside the building (defined as inside the weatherproofing envelope and applied on site) shall comply with SCAQMD Rule 1168-1989, Amendments 1990-2005 for volatile organic compound content limits.
2. Aerosol adhesives shall comply with GS 36-2000 for volatile organic compound content limits.

F. Paints and Coatings:

1. Anti-corrosive and anti-rust paints applied to interior ferrous metal shall not exceed a volatile organic compound content limit of 250 g/L per GS 11-1993.

G. If equipment is used for temporary conditioning of the building before Owner turnover, ductwork system equipment casings and coils will be cleaned per SMACNA and ASHRAE standards.

H. Comply with Georgia Tech document, Architecture and Engineering Design Standards for Building Technology.

1.3 SPACE CONDITIONS

A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.

B. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.

C. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms, data rooms, ITS, MDF, hub rooms, elevator equipment rooms, or elevator shafts unless specifically indicated on the Drawings. In addition, piping, ductwork, or mechanical equipment shall not be installed in the space equal to the width and depth of

switchgear, switchboards, panelboards, and motor control centers from floor to structure above nor within the working space in front, rear and/or side (where rear and/or side access is required to work on equipment) of electrical equipment (switchgear, switchboards, panelboards, motor control centers, variable frequency drives, transformers, and starters). Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater.

1.4 ASBESTOS MATERIALS

A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.5 CONTINUITY OF EXISTING SERVICE AND SYSTEMS

A. Schedule work so existing systems will not be interrupted when they are required for normal usage of the existing building. Obtain approval from the Owner and Architect at least 7 days prior to any utility interruption or connection.

B. Perform work at such time and in such manner as to cause minimum inconvenience to the Owner and as approved by the Architect. No allowance will be made for lack of knowledge of existing conditions.

C. The Contractor shall make every effort to maximize the amount of preparation/fabrication needed outside of the occupied space to minimize downtime in the lab.

1.6 RELATED WORK DESCRIBED IN OTHER DIVISIONS

A. Electric power, interlock, and control wiring, except as specified herein.

B. Fire alarm initiating devices, control modules, and monitoring modules.

C. Structural work.

1.7 SUBMITTALS

A. Within 15 days after notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.

B. The HVAC submittal shall be submitted as one complete package. Submittals of individual equipment or systems will not be reviewed until the entire submittal package has been received. Exceptions will be considered for long-lead items where expedited submittal review is warranted.

C. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.

1. In addition to any other transmittals or cover sheets used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to DLS Laboratory Consultants included at the end of this Section.
2. Indicate manufacturer's installation instructions.
3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
4. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
5. Shop drawings shall be provided in PDF format.
6. Submittals in 3-ring binders shall include an index of contents and divider tabs.

D. Shop drawings shall include the following:

1. Trade shop drawings (i.e., HVAC equipment room drawings, HVAC ductwork system drawings, BAS, etc.) shall be submitted within 15 days after award of contract.
2. Reviewed trade shop drawings shall be utilized as the basis for the coordination drawings. Coordination drawings shall be submitted within 15 days after approval of trade shop drawings.
3. Coordination drawings shall utilize electronic means of analyzing the work of each trade in spatial relationship with other trades. Locations of conflicts between trades, and the proposed resolution for each conflict, shall be noted on the coordination drawings submitted.
4. No work shall be fabricated and/or installed prior to receipt by the Contractor of reviewed trade shop drawings and reviewed coordination drawings without specific written authorization from the Architect. No change orders will be approved or design assistance provided for remedial field coordination activities for work fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings.

E. HVAC submittals shall include the following:

1. Coordination drawings, with dimensions and elevations, of HVAC work, including ductwork, actual equipment, required maintenance areas, piping with fittings, valves, dampers, accessories and sleeves coordinated with the work of other trades, including

plumbing, fire suppression, electrical, structural, and architectural, minimum 1/4" = 1'-0" scale.

2. Automatic temperature controls with information as specified in Section 23 80 00, Automatic Temperature Controls.
3. Air distribution and all associated appurtenances.
4. Ductwork rooftop supports.
5. Variable frequency drives.
6. Ductwork system drawings, showing air distribution, actual equipment with maintenance access spaces, including required clearances around control panels and other components, ductwork, fittings, dampers, plenums, elevations, dimensions, offsets, and transitions coordinated with piping, building conditions, and other trades, minimum 1/4". Include pressure class, fittings, reinforcement/spacing, code compliance, joint/seam construction and sealing methods, and hangers and supports.
   = 1'-0" scale. The piping and sheet metal systems may be combined onto one drawing.
7. Test and Balance.

1.8 EQUIPMENT AND INSTALLATION REQUIREMENTS

A. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.

B. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.

PART 2 – PRODUCTS NOT USED

2.1 VARIABLE FREQUENCY DRIVES

A. Variable frequency AC motor controllers shall be designed for use with new inverter duty motors.

B. Variable frequency drives for exhaust fans located on the roof shall be installed in accordance with the manufacturer's recommendations and shall include provisions for removing excess heat and be resistant to exterior elements. Manufacturer shall fully warrant the installation as specified herein and indicated on the Drawings. Coordinate with the air handling unit manufacturer.

C. Controllers:

1. NEMA 3 enclosure, wall- or floor-mounted, UL 508C-2002 listed, with integral power disconnect with door interlock, completely factory-wired, ready for field connection of incoming and outgoing power, and control signal, in compliance with NEMA ICS 1-2000 (R2005, R2008), NEMA ICS 6-1993 (R2001, R2006), and NEMA ICS 7.1-

2006. Drives shall be rated a minimum of 100,000 A RMS symmetrical AIC.

2. Controllers shall be of the pulse width modulation type, and shall have the following features and functions contained in the cabinets unless otherwise specified herein:

   a. Current limiting fuses or semi-conductor protection on the incoming line side.
   b. Speed regulation within 3% accuracy.
   c. Integral manual bypass complete with interlocked contactors to completely isolate the controller when in the bypass mode, face- mounted controller-off-bypass switch with pilot lights, solid state motor overload relays with phase loss protection for motor protection in both the controller and bypass modes, auxiliary relays to allow remote start- stop commands in both modes, door interlocked lockable disconnect switch to provide means of disconnecting power to both bypass circuitry and controller, and a second door interlocked disconnect or contactor switch to allow troubleshooting and testing of the controller by disconnecting the input power to the controller but not disconnecting the bypass circuitry. Labels shall be clearly posted on the device warning of the electrical shock hazards that exist when performing troubleshooting and testing on the controller while the bypass circuitry is energized. Manual bypass components shall mount within the controller enclosure or enclosure extension. A separate starter shall not be required to operate the motor in the bypass mode. Power supply to the bypass contactors and relays shall be provided by a single-phase power conditioner with sufficient rating and capacity to prevent contactor dropout during power sags.
   d. Controllers shall have mod bus serial communications capabilities, through a data port, for:

      1) All data available at the drive.

   e. Interface connections for remote controls shall be wired to terminal strips as follows:

      1) Dry contacts for remote enable/disable.
      2) Process transducers for 4-20 mA speed adjustment signal.
      3) Terminals for connection of normally closed remote safety devices.
      4) Dry contact for external alarm, to open on internal drive fault, power supply fault, process transducer signal fault, or operation of remote safety devices.

   f. Harmonic distortion control:

      1) The variable frequency drive manufacturer shall perform a harmonic analysis study in accordance with IEEE 399-

1997. The study shall establish the requirements for harmonic distortion control. Harmonic analysis study report shall be submitted concurrently with the variable frequency drive submittals.

2) Variable frequency design shall be such that the maximum contribution from all variable frequency drives does not exceed the following:

a) IEEE 519-1992 voltage and current distortion limits for general systems applications at the point of common coupling.

3. Where specified herein, controllers shall be provided with damped low pass DV/DT drive output filters. Filters shall have K-rated line reactor, gapped iron core, inductor, copper windings and 40°C ambient temperature rating with a 155°C maximum operating temperature. Filters shall allow mounting of variable frequency drives up to 3000' from motor loads by filtering voltage spikes.
4. Controllers shall have the following internal protective functions for the protection of the controller modules and motors:

a. DV/DT (voltage transient) and DI/DT (short circuit) protection.
b. Inverse time overcurrent protection.
c. Full time current limit to limit maximum speed for prevention of overload.
d. Phase sequence (if phase sensitive), phase loss, overvoltage, undervoltage, electronic thermal overload, abnormal temperature, DC overvoltage, and internal fault protection.
e. Motor winding ground fault.
f. Motor and variable frequency drive overtemperature protection.
g. Input power line surge protective device.

5. Integral EMI/RFI filter. Controllers shall be designed to avoid RF interference with other electronic equipment internal or external to the building.
6. Diagnostic module shall identify faults as they occur, storing them in nonvolatile memory for recall, including:

a. Overcurrent.
b. Overvoltage.
c. Undervoltage.
d. Ground fault.
e. Electronic motor overload, UL listed for this function.

7. Operator panels shall include digital display and keyboard for entry of set-up parameters, recall of faults from diagnostic module, and display of current operating values including:

a. Output frequency.
b. Motor speed.

c. Motor current.
d. Output voltage.
e. Analog input values.
f. Digital input status.
g. Elapsed time meter.
h. Power on indication.

8. Provide nameplate engraved with system identification and hand-off- automatic switch. The hand position shall start the drive and shall have a manual means of speed adjustment. In the automatic position, the drive shall be started and adjusted remotely.
9. Controller design shall permit operation at full load with ambient conditions between 0□C and 40□C, with capacity to handle 110% overload torque for 1 minute. Printed circuit boards shall be tested under full rated load at 10□C above rated ambient temperature for at least 20 hours, and failures corrected prior to shipment. Submit factory burn-in test reports.
10. When enabled by remote controls, controller shall start at zero speed and ramp to the current speed setting. Speed range shall be adjustable between 0 Hz and 66 Hz, with separately adjustable maximum and minimum speeds, and adjustable rate of acceleration and deceleration. Provide at least 2 lockout speed ranges with adjustable minimum and maximum speed settings to prevent operation at driven equipment resonant vibration frequencies.
11. Controllers shall restart automatically upon restoration of stable electric service after power supply faults, with adjustable time delay before restart. Operating parameters shall be stored in nonvolatile memory. Controllers shall continue to operate at the minimum speed setpoint on loss of remote control signal, and activate the remote alarm contact.
12. Variable frequency drives shall be designed for starting into a spinning motor. The variable frequency drive shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the variable frequency drive shall drive start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Drives shall be designed for starting into a rotating motor, or shall be provided with a time delay to prevent such occurrence.
14. Drive displacement power factor shall be between 0.95 and 1.0 lagging over the entire operating speed range.
15. Drive efficiency shall be greater than 96% at 100% speed full load.

D. Service: manufacturer shall maintain a parts and service facility within 4 hours of this Project, which shall have inventory to cover not less than 80% parts service within 24 hours, and 95% within 48 hours. Further, the facility shall have a factory-trained service representative to furnish installation, test, and start-up supervision necessary for final approval and

acceptance, as well as to perform maintenance and repairs on components.

E. Warranty: in addition to other warranties specified herein, equipment shall be guaranteed against defective parts and workmanship under terms of the manufacturer's standard warranty, but in no event shall it be for a period of less than 2 years from date of initial start-up of the system and shall include labor and travel time.

F. Manufacturer: ABB, AC Tech, Allen-Bradley, Cutler-Hammer, Danfoss, GE Fuji, Hitachi, Reliance, Square D, Toshiba, US Drives, or Yaskawa.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

A. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.

B. Store equipment and material under cover, and off the ground or floors exposed to rain.

C. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.

D. Protect coils against damage by installing temporary closure panels over exposed coil faces. Panels shall be minimum 24 gauge sheet metal or 0.375" plywood.

E. Close open ends of fans, terminal units, energy recovery units, and ductwork with temporary closures of sheet plastic taped in place.

F. Provide dust and debris protection for ductwork, coils, fans, equipment, motors, and bearings operated during construction up to date of Substantial completion.

G. Cover open ends of exhaust and return ducts with temporary filter media while fan systems are operating.

3.2 EQUIPMENT AND INSTALLATION REQUIREMENTS

A. Air systems shall operate without aerodynamic noise generated from the faulty installation of ductwork or any component of the air distribution system.

B. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.

1. Refer to manufacturer's or equipment supplier's shop drawings for exact type, number, location, dimensions and size of connections to equipment such as printers.

C. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.

D. Where water connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe- equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

3.3 IDENTIFICATION OF EQUIPMENT

A. Identification shall consist of upper case letters.

B. Each starter, variable frequency drive, contactor, push button station, control switch, disconnect, thermal overload switch, insertion type thermostats, filter gauges, and pump pressure gauges shall be appropriately identified by nameplates with 0.25" high letters.

1. Identification shall include the equipment designation and device function, e.g., CT-1 Water Level Control Disable.

C. Each piece of equipment and access door shall be stenciled with its equipment number in a prominent location with minimum 2" high letters.

D. Access panels and doors in ductwork and plenums shall be stenciled with minimum 1" high letters to indicate the type of devices accessible therein and the system or fan identification number associated with that ductwork or plenum.

E. Provide engraved nameplate, white background and black letters, for each piece of HVAC equipment located above the ceiling. The nameplate shall be attached to the metal ceiling tile grid directly below the respective equipment.

3.4 EQUIPMENT

A. Remove dust, dirt, rust, stains, and temporary covers.

B. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from new equipment, piping, ductwork, pumps, fans, motors, bearings, devices, switches, controls, and panels.

C. Clean and polish identification plates.

D. In equipment rooms, clean equipment, ductwork, insulation, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.

E. Remove excess material from the Project site.

3.5 PAINTING

A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.

B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.

C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.

D. Exterior ferrous equipment, piping and supports shall be painted with 2 coats of rust-preventive paint, color selected by the Architect.

E. Exposed interior uninsulated black steel piping, and exposed nongalvanized ferrous accessories, hangers, rods, inserts, and mechanical supports shall be prepared and painted with 1 coat of rust-preventive paint prior to other painting or identification, or 2 coats of rust-preventive paint if no other painting is specified.

F. Ductwork, conduits, insulation, pipe and structure visible through architectural return air openings, grilles, registers and diffusers shall be painted flat black.

3.6 COORDINATION

A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including plumbing, fire protection, electrical, structural, and architectural.

3.7 OPERATION AND MAINTENANCE MANUALS

A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.

B. Operation and maintenance documentation, in hardback 3-ring loose-leaf

binders except full size drawings and CDs, shall cover the HVAC and automatic temperature control systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents. In addition, provide a CD with a PDF of the entire O&M manual.

C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 1 month before systems start-up, and shall be updated, revised and completed at completion of, construction.

D. Compile and coordinate the documentation for equipment and systems installed. Documentation shall be typewritten and shall contain, at a minimum, the following information.

1. Introduction:

    a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
    b. Index.

2. Operations and Maintenance Documentation Directory:

    a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names.

3. Operating Manual:

    a. Technical Information:

        1) System description.
        2) Operating routines and procedures.
        3) Seasonal start-up and shutdown.
        4) Special procedures.
        5) Basic troubleshooting.

4. Maintenance Manual:

    a. Descriptions (specifications) of the equipment and components.
    b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
    c. Recommended maintenance and lubrication procedures and their recommended frequency for this Project.
    d. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.

e. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
f. Installation information.
g. Other information needed for the preparation of documents supporting the management of operation and maintenance programs.

5. Test Reports and Certifications:

a. Copies of tests and certifications performed during manufacture and construction, including but not limited to the following:

1) Receipt for spare fuses.
2) Receipt for instruction of operating personnel.
3) Certification test report for rooftop air conditioning unit.
4) Certification of DDC system calibration and testing.
5) Receipt for DDC system training.
6) Receipt acknowledging no DDC system failures during test period.
7) Receipt for pressurization controls system training.
8) Receipt acknowledging no pressurization control system failures during test period.
9) Certification of ductwork testing results.
10) Seasonal adjustment reports.
11) Air distribution systems cleaning.

6. Construction Documents:

a. Record drawings.
b. Approved submittals, including revised shop drawings indicating as- installed conditions.
c. Equipment identification charts and schedules.
d. Warranty certificates.
e. Inspection certificates.
f. Test, adjust and balance report.

E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.

3.8 CONTRACTOR COMMISSIONING

A. The contractor shall fully test the HVAC system and shall provide a written attestation that all HVAC control sequence of operations have been tested and are working in accordance with the requirements of the contract documents.

3.9 RECORD DRAWINGS

A. Concurrent with the Architect's final certificate, submit 2 sets of prints indicating field and as-installed conditions of piping, ductwork, and equipment, and incorporating changes made during construction.

B. A record of field and as-installed conditions shall be maintained at the site, shall be kept current throughout the Project, and shall be used in the preparation of the final record drawings.

C. Record drawings shall, as a minimum, include:

1. The manufacturer and model number of each piece of equipment.
2. Equipment location and orientation.
3. Major utility and header locations and sizes.
4. Valve and damper locations and types.

3.10 MAINTENANCE

A. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturer's recommendations. In addition, provide complete water treatment for hydronic and steam systems operated prior to date of substantial completion.

B. Prepare and submit a lubrication chart listing for each piece of equipment:

1. Points requiring lubrication.
2. Recommendations for a single manufacturer's lubricants with brand name and designation.
3. Frequency of lubrication required.

C. Lubricate each item of apparatus requiring lubrication prior to start-up in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 230553 IDENTIFICATION FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

1.2 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 1996 (Reaffirmed 2002).

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.
1. Letter Color: Black.
2. Letter Height: 1/2 inch.
3. Size when located on ceiling grid: 3/8 inch high letters unless noted otherwise.
4. Background Color: Light.

2.2 TAGS

A. Manufacturers: Brimar, Kolbi, Seton.

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Identify exhaust fans and air valves with plastic nameplates.

D. Where equipment is located above ceilings; Apply nameplate to ceiling grid for equipment located above accessible ceilings or to access panel for non-accessible ceilings.

E. Identify control panels and major control components outside panels with plastic nameplates.

F. Tag automatic controls, instruments, and relays. Key to control schematic.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Duct leakage testing of 3-inch WG pressure class or higher ducts.

B. Initial testing, adjustment, and balancing of air systems.

C. Winter and Summer Seasonal testing, adjustment, and balancing of air systems.

D. Measurement of final operating condition of HVAC systems.

E. Testing of control sensors, controllers and safeties.

F. Support of Commissioning activities.

1.2 RELATED REQUIREMENTS

A. Section 230510 - General Mechanical Requirements.

B. Section 237000 - Air Distribution.

C. Section 238000 - Automatic Temperature Controls.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

B. SMACNA HVAC Duct Leakage Test Manual.

1.4 SUBMITTALS

A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Diversified Laboratory Sciences, Inc.
   2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with Diversified Laboratory Sciences, Inc. and other installers to sufficiently understand the design intent for each system.
   4. Include at least the following in the plan:
      a. Preface: An explanation of the intended use of the control system.
      b. List of all air flow, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      c. Copy of field checkout sheets and logs to be used, listing

each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

e. Final test report forms to be used.

f. Details of how TOTAL flow will be determined; for example:
   1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA), and exhaust air (EA), pitot traverse, etc..

g. Specific procedures that will ensure that air side are operating at the lowest possible pressures and methods to verify this.

h. Method of checking space static, exhaust fan bypass air damper capacity, and exhaust fan discharge velocity.

i. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

D. Submit results of adjusting and balancing agency examination of documents and systems within 30 days after Notice to Proceed.

E. Initial Report: Submit prior to request for Final Observation.

F. Seasonal Reports: Submit seasonal report within 14 days of completion of seasonal adjustments. Include test reports for any equipment that could not be tested at the initial report due to season, temperature or other conditions.
   1. List of deficiencies noted, adjustments made and corrective action taken.
   2. Temperature of each conditioned space and dry bulb setting of controlling thermostat.
   3. Temperature at all sensors in equipment, space duct or pipe and settings of controllers.
   4. Differential pressure of N2004 across each ingress/egress door.
   5. Date and outdoor DB and WB range during the time of the seasonal test.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC MN-1, AABC National Standards for Total System Balance.
   2. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work and submit Report prior to the Final Observation of the project.

C. Pre-Qualified TAB Agencies: Testing and Balancing shall be

performed by one of the following firms:
1. TAB Services.
2. Other as approved by Solvay.

3.2 EXAMINATION

A. Review the contract documents and existing conditions for appurtenances and arrangement for balancing prior to the installation of any equipment or material. The Contractor shall notify the Diversified Laboratory Sciences, Inc. of any omissions noted within 30 days of the Contractor's notice to proceed.

B. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. All filters are clean and in place. If required, install temporary media in addition to filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. All dampers and operators function smoothly from shut-off to full open.
8. Access doors are installed at specified components are accessible, are closed and duct end caps are in place.
9. Air outlets are installed and connected.
10. Duct system leakage is minimized.
11. Service and balance valves are open.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Diversified Laboratory Sciences, Inc. to facilitate spot checks during testing.

B. Testing of equipment shall be simultaneous where components of a systems are connected; e.g. DX coil and condensing unit.

3.4 INSTALLATION TOLERANCES

A. Air Outlets and Inlets

1. Outlets: Adjust total to within minus 10 percent of design.

2. Inlets: Adjust total to within plus 10 percent of design.

3. Record space pressurization of each space in relation to pressurization arrows shown on drawings.

3.5 AIR SYSTEM QUALITY CONTROL

A. Pressure test ducts in accordance with “SMACNA HVAC Air Duct Leakage Test Manual”. Refer to specification section Air Distribution, 237000 for additional details.

B. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

C. Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct. Close openings after measurement with permanent manufactured plugs.

D. Measure air quantities at air inlets and outlets.

E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

G. Vary total system air quantities by adjustment of fan speeds by VFD. Provide drive changes required to place belt in mid-position at final RPM. Vary branch air quantities by damper regulation.

H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

I. Adjust automatic bypass air dampers for design conditions. Adjust operators on bypass air dampers to ensure tight seal when shut.

J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate and at minimum air flow rate, full heating.

K. Measure space static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.6 CONTROL SYSTEM PROCEDURE

A. Low Limit Thermostats, Fire Thermostats, Smoke Detectors and other Safety devices: Test and verify operation. Record setpoint.

B. Sequence of Operation: Operate systems thru specified Sequence and confirm system function.

3.7 BALANCE UNDER SEASONAL OPERATING CONDITIONS

A. After the initial balance has been completed, reviewed and accepted; the contractor shall balance the system under seasonal operating conditions by performing operational tests over a minimum period of eight hours under both cooling and heating conditions.

B. These tests shall be performed only after each piece of equipment has been individually tested, and is verified to be in correct operating condition, and shall be made at times when outdoor dry bulb temperatures are above 85 F for cooling, or below 50 F for heating.

C. When test is run during the cooling cycle the building must be occupied, and all lights shall be turned on for a minimum of six (6) hours. Doors to all spaces shall be closed and all space thermostats set at its normal setpoint.

D. Purpose: Prove correctness of installation; prove functioning of capacity and safety controls; prove calibration of operating controls; and prove stability of operation under actual loading conditions.

3.8 SCOPE

A. Test, adjust, and balance the following:
   1. Rooftop exhaust fans
   2. Chemical fume hoods
   3. Air Terminal Units
   4. Air Inlets and Outlets

3.9 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer
   2. Model/Frame
   3. HP/BHP
   4. Phase, voltage, amperage; nameplate, actual, no load
   5. RPM
   6. Service factor
   7. Starter size, rating, heater elements
   8. Sheave Make/Size/Bore

B. V-Belt Drives:
   1. Identification/location
   2. Required driven RPM
   3. Driven sheave, diameter and RPM
   4. Belt, size and quantity
   5. Motor sheave diameter and RPM
   6. Center to center distance, maximum, minimum, and actual

C. Exhaust Fans:
   1. Location
   2. Manufacturer
   3. Model number
   4. Serial number
   5. Air flow, specified and actual
   6. Total static pressure (total external), specified and actual
   7. Inlet pressure
   8. Discharge pressure
   9. Sheave Make/Size/Bore
   10. Number of Belts/Make/Size
   11. Fan RPM
   12. Plot actual operating point on pump curve chart.

D. Duct Traverses:
   1. System zone/branch
   2. Duct size
   3. Area
   4. Design velocity
   5. Design air flow
   6. Test velocity
   7. Test air flow

8. Duct static pressure
9. Air temperature
10. Air correction factor

E. Duct Leak Tests:
1. Description of ductwork under test
2. Duct design operating pressure
3. Duct design test static pressure
4. Duct capacity, air flow
5. Maximum allowable leakage duct capacity times leak factor
6. Test apparatus
   a. Blower
   b. Orifice, tube size
   c. Orifice size
   d. Calibrated
7. Test static pressure
8. Test orifice differential pressure
9. Leakage

F. Terminal Unit Data:
1. Manufacturer
2. Type, constant, variable, single, dual duct
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum design air flow
9. Maximum design air flow
10. Maximum actual air flow
11. Inlet static pressure

G. Air Distribution Tests:
1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow
11. Relative position of balancing damper

END OF SECTION

SECTION 237000 – AIR DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. General provisions and other HVAC systems are specified in other Sections of Division 23.

B. This Section covers air distribution systems and equipment.

C. Testing, adjusting and balancing is specified in Section 230093, Testing, Adjusting and Balancing.

1.2 QUALITY ASSURANCE

A. Air conditioning systems shall conform to the following:

1. International Energy Conservation Code with Georgia State Amendments.
2. International Mechanical Code with Georgia State Amendments
3. NFPA 90A.
4. SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

1.3 PERFORMANCE

A. Ductwork shall have the following static pressure classifications, unless otherwise specified herein:

1. From exhaust fan to airflow control devices: 3” - 6”
2. From airflow control devices to grilles, registers and diffusers: less than 3".

B. Structural Performance: Duct Hangers and supports shall withstand the effects of gravity loads and stresses under operating conditions.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1.

PART 2 - PRODUCTS

2.1 PVC DUCTS AND FITTINGS

A. Duct and Fittings:
1. Round Duct: Comply with cell Classification 12454-B in ASTM D 1784, with external loading properties of ASTM D 2412.
2. Round Fittings: Socket end molded of same material, pressure class, and joining method as duct.

B. Joining Materials: PVC solvent cement complying with ASTM D 2564.

C. Fabrication:
1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Chapter 3, "Standards of Construction for PVC Duct Systems.”
2. Mitered elbows are not allowed. Radius elbows shall have a

minimum 1.0 radius.

3. Drains: PVC drain pockets with a minimum NPS1 threaded PVC pipe connections.

2.2 HANGERS AND SUPPORTS:

A. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

B. Ductwork, except where otherwise specified herein, including factory-fabricated round and flat oval, and apparatus casings shall be constructed of PVC in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2013.

2.3 PVC BUTTERFLY MANUAL DAMPERS

A. PVC 1120, ASTM D-1784, Type 1, Grade 1, Cell Class 12454-B.

B. All internal parts are PVC including the body, damper, plate and shaft.

C. Dampers are furnished with a locking quadrant, to permanently the damper position.

D. Damper allows for less than 5% airflow restriction when open and 95% seal when closed.

E. Temperature range 33F to 140F

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts with fewest possible joints.

B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

C. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches.

D. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

E. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials.

F. Install PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual”.

3.2 HANGERS AND SUPPORT INSTALLATION

A. Install hangers and supports for PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Chapter 3, "Standards of Construction for PVC Duct Systems.

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

3.3 FIELD QUALITY CONTROL

A. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit test report for each test.
   2. Duct with a Pressure Class Higher than 3" W.G.: Test all accessible duct sections.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Provide a minimum seven (7) days advanced notice of testing.
   5. Ductwork failing the leakage tests shall be repaired, reworked or rebuilt until satisfactory, before additional ductwork is installed and before ductwork is concealed.

B. Visually inspect duct system to ensure that no visible contaminants are present.

C. Ensure dust system and fan are clean and free of debris, dirt, and/or other foreign matter prior to system start-up.

D. Entire air system installation shall be rigid, and free from rattles and air noises. Interior of ducts shall be smooth.

E. Provide offsets, elbows, and transitions to coordinate with other work.

F. Provide transitions to connect ductwork to equipment.

G. Seal wall penetrations as specified in Section 23 00 10, General.

3.4 HANGERS AND SUPPORTS

A. Adjust hangers and supports so that loading is uniform.

B. Unless otherwise specified herein or indicated on the Drawings, duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Support horizontal ductwork not more than 8' on center, unless specified otherwise by manufacturer. Ductwork shall be directly suspended from or supported by the building structure, but not from metal deck.

D. Support round ductwork with straps and hangers as recommended by the manufacturer and SMACNA.

3.5 MANUAL DAMPERS

A. Install dampers in accordance with manufacturer's instructions to operate freely.

END OF SECTION

SECTION 238000 – AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General provisions and HVAC systems are specified in other Sections of Division 23.

B. This Section covers automatic temperature control systems and equipment.

1.2 SCOPE

A. This project consists of connecting a new exhaust fan to the existing DDC Honeywell Tridium system.

B. This Section includes:

1. Relays, wiring, equipment, and connections necessary to accomplish the specified interfaces, and shall include programming of software and color graphics to include the variable volume pressurization control systems into the DDC system.

1.3 QUALITY ASSURANCE

A. Installation shall be by mechanics trained by the control manufacturer.

B. DDC system layout and performance: the DDC system shall be engineered and equipment selected by the manufacturer as required to meet the performance specified herein. The location and quantity of DDC controllers shall be as determined by the DDC system manufacturer. Sensors and control points for each system shall be connected to its associated stand-alone controller. An alarm condition shall be reported to the appropriate operator device no more than 10 seconds following the occurrence of that condition. Sensor and control values displayed to the operator in graphics displays shall be dynamically updated within 30 seconds of significant change of value.

C. This Project involves integration with an existing DDC system including new DDC equipment, software, programming and controls. The new DDC controllers shall be connected to the existing DDC central station. The existing DDC central station shall be reprogrammed to include the new systems. New DDC system components shall be 100% hardware and software compatible with the existing system and shall be by the same manufacturer. Programming logic, database definition, and point identifiers shall conform to, and be a logical extension of, the existing system.

1.4 SUBMITTALS

A. Submit a single comprehensive submittal package including the following items.

1. DDC system data: including control manufacturer's data sheets on DDC controllers, sensors, meters, relays, actuators, motors, terminal unit controllers, protection devices, and other devices specified herein. Include data on software and illustrations of proposed graphics displays.
2. Diagrams: separate field wiring diagrams for each system, including motor starting and interlock wiring, ladder diagrams, control wiring, interior electrical circuits of control instruments with terminal and control device designations, actuators and motors, colors of wires, locations of instruments and remote elements, interfaces with communications equipment provided with equipment specified in other Sections, and normal position of relays. Each diagram shall have terminals labeled as they will be marked on the installed equipment. Each diagram shall delineate between existing piping, wiring or equipment, and new piping, wiring, and equipment.
3. System architecture: provide a drawing of the proposed system architecture showing configuration and locations for DDC controllers, terminal unit controllers, existing DDC central station, power and control wiring for each device, and hardware and wiring for connections to networks external to the building. Provide floor plans locating equipment coordinated with the work of other trades.
4. Sequences of operation: complete detailed sequences of operation, including: a narrative of the system operation and interactions and interlocks with other systems; notations indicating whether interlock or interaction is accomplished through software or hard wired connections; detailed delineation of control between packaged controls and the DDC system; and sequences of operation for packaged controlled equipment that interfaces with the DDC system.
5. Existing DDC system expansion data: proposed central station modifications if any are required to support this addition; complete field wiring diagrams showing interconnection with existing controllers, devices, and central station equipment; illustrations of proposed graphics displays if specified herein; and proposed database and software additions or modifications, if required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Licensed contractor for Honeywell Tridium Niagara platform.

2.2 EXISTING DDC CENTRAL STATION MODIFICATIONS

A. Central station software, general: Upgrade the existing DDC system central station software to the current version and provide additional updates at no additional cost during the one year warranty period. Modify existing database information and add additional database information as required to interface existing and new DDC system components into a single, integrated and fully functioning system.

2.3 MATERIALS

A. Sensor piping: seamless copper tubing with sweat fittings, or nonmetallic tubing with barbed brass fittings.

1. Exposed copper tubing shall be hard drawn. Concealed tubing may be hard drawn or annealed.
2. Nonmetallic tubing shall be tested in accordance with UL 1820-2004, and shall meet NFPA 90A-2002 requirements for use in return air plenums. and be approved for plenum use by the code authorities having jurisdiction.

B. Wiring: low voltage control wiring shall be not less than #18 AWG, 600 V plastic covered, color-coded. Line voltage wiring shall be not smaller than #16 AWG, 600
V. Sensor wiring shall be not less than #20 AWG twisted, shielded.

C. Labels: as specified in Section 23 00 10, General.

2.4 DUCT STATIC PRESSURE SENSORS

A. Duct Insertion Static Pressure Sensor.
1. Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
2. Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
3. Mounting flange shall suitable for flat oval, rectangular, and round duct configurations.
4. Material: All parts of the sensor exposed to the airstream shall be compatible with the chemicals listed on G001.

PART 3 - EXECUTION

3.1 GENERAL

A. Wiring and tubing shall be identified with the same numbers and symbols as used on the corrected, approved record diagrams.

B. Label control apparatus with nameplates or tags bearing the functional designations shown on approved control diagrams.

C. Where control devices are exposed outside the building, provide weather shield enclosures.

D. DDC Sensors:

1. Sensor calibration: calibration of sensors shall be included as part of the pre-functional checklists according to the following procedures:

a. General: verify that sensors with shielded cable are grounded only at one end.
b. Sensors without external transmitters: take a reading with a calibrated test instrument within 6" of the sensor

installation and verify the sensor reading is within the specified tolerance. If not, install offset, calibrate, or replace sensor to obtain required accuracy.

c. Sensors with external transmitters: disconnect sensor from transmitter input and connect a signal generator in place of sensor. Using manufacturer's data, simulate minimum measured value. Adjust transmitter potentiometer zero until minimum signal is read. Repeat for the maximum measured value and adjust transmitter until maximum signal is read. Reconnect sensor. Make a reading with a calibrated test instrument within 6" of the sensor installation. Verify that the sensor reading is within the specified tolerance. If not, repeat process until specified accuracy is achieved, or replace the sensor and repeat process.

d. Paired sensors: for sensor pairs that are used to determine a temperature or pressure difference, calibrate both sensors to a common measurement and verify they are reading within ±0.25°F for temperature and within a tolerance equal to ±2% of the sensor reading for pressure.

E. DDC System Start-up and Check-out:

1. Provide the services of control technicians at start-up to check-out the system, verify and calibrate sensors and outputs, input data supplied by the Owner, and place the system in operation. Verify proper operation of each item in the sequences of operation, including hardware and software.
2. Check-out each system for control function through the entire sequence. Check actuator travel on dampers for action and extent. Verify that control dampers open and close completely. Check calibration of instruments. Calculate and verify instrument setpoints.
3. Calibration and testing: calibrate sensors and monitoring inputs and verify proper operation of outputs before the system is placed on-line. Check each point within the system by making a comparison between the operator console and field device. DDC control loops, failure modes, interlocks, sequences, energy management programs, and alarms shall be debugged, tested, and stable operation verified. Control loop parameters and tuning constants shall be adjusted to produce accurate, stable control system operation. Before obtaining permission to schedule the acceptance test, provide written documentation of system calibration and certification that the installed complete system has been calibrated, verified, and is ready to begin testing.

F. DDC System Acceptance Conditions:

1. Acceptance test: conduct final acceptance test, with the Owner on site, on the complete and total installed and operational system to demonstrate that it is functioning in accordance with requirements specified herein. Demonstrate the correct operation of monitored and controlled points as well as the operation and capabilities of sequences, reports, specialized control algorithms, diagnostics, and software.
2. System shall demonstrate the following minimum acceptable

levels of performance, within the physical limitations of the controlled equipment:

a. Control loops shall maintain stable, nonhunting, nonoscillating control, with minimum overshoot in response to transient and upset conditions.
b. Space and air temperatures shall be maintained within ±1°F of setpoint.

3. Final system acceptance will be based upon the completion of the following items:

a. Completion of the installation of hardware and software items. Demonstrate complete operation of the system, including hardware and software, with no failures during a 10 consecutive day period. Obtain receipt from the Owner acknowledging no failures within the test period. Submit a daily log documenting failures.
b. Satisfactory completion of functional performance testing, including deferred testing as specified herein.
c. Satisfactory completion of the record drawings, and operating and maintenance manuals.
d. Satisfactory completion of training programs.

4. Upon final acceptance, the warranty period shall begin.

G. Control System Operation and Maintenance Manual Requirements:

1. In addition to documentation specified elsewhere herein, compile and organize operation and maintenance manuals in labeled 3-ring binders. The manual shall be organized and subdivided with permanently labeled indexed tabs, containing at minimum:

a. Full as-built sequence of operations for each piece of equipment.
b. Full as-built set of control drawings, including the marking of system components, sensors, and thermostats, and power sources on the as- built floor plans and mechanical drawings, identified with their control system designations.
c. Full point list. In addition to the as-built points list for the major equipment identified in the I/O summary, provide a listing of rooms served by DDC terminal controls, with the following information for each room:

1) Floor.
2) Room number.
3) Room name.
4) Air handling unit identification.
5) Reference drawing number.
6) Terminal unit tag identification.
7) Heating and/or cooling valve tag identification.
8) Space cfm.

d. Controller/module data shall include specific instructions

on how to perform and apply functions, features, and modes specified herein and other features of this system. These instructions shall be step-by-step.

Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.

e. Control equipment component submittals and parts lists.
f. Thermostats, sensors, switches, and timers, including maintenance instructions and sensor calibration requirements and methods by sensor type.
g. Full as-built documentation of software programming, including commented software program printouts, and a full print out of all schedules and set points after testing and acceptance of the system. Provide an electronic copy of programming and database information for this facility.
h. Warranty requirements.

3.2 SENSOR PIPING

A. Tubing shall be concealed except in mechanical rooms.

B. Fasten tubing with clips at regular intervals and run parallel to building lines. Attach concealed tubing above suspended ceilings to structure or ductwork supports.

C. Copper bends shall be tool made. Provide unions at final connections to apparatus. Provide separation between dissimilar metals.

D. Nonmetallic tubing run in mechanical rooms and concealed in inaccessible locations shall be run in metallic raceways. Make connections to hot equipment with copper tubing.

E. Tubing installed inside control panels and equipment enclosures, and above ceilings shall be tied and supported.

F. Provide sleeves where tubing passes through concrete or masonry.

G. Test tubing at 30 psig for pressure loss of not more than 1 psig in 1 hour.

3.3 DUCT STATIC PRESSURE SENSORS

A. Seal penetrations in ductwork to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
B. Install sensors using manufacturer's recommended upstream and downstream distances.
C. Route tubing from the sensor to transmitter.
D. Use compression fittings at terminations.
E. Install sensor in accordance with manufacturer's instructions.
F. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure

3.4 WIRING

A. Materials and installation of wiring and electrical devices shall be in accordance with NFPA 70-2008 with Georgia State Amendments-2009 NFPA 70-2008 and Division 26.

B. Control and sensor wiring shall be installed in conduits and shall be separate from AC wiring of any voltage. Conduits to devices in finished spaces shall be concealed.

C. Exposed control and sensor wiring shall be installed in conduits and shall be separate from power wiring. Plenum rated cable may be used in concealed spaces if run parallel to structural grid and supported by cable trays or tie wraps, and identified in a manner consistent with the documentation of the system every 30'. Conduits to devices in finished spaces shall be concealed.

D. Provide transformers or filters for operation of automatic temperature controls from building power circuits.

E. Provide relays, transformers, fuses and interlock wiring as required to accomplish the sequences specified herein.

F. Provide power wiring to DDC controllers, terminal unit controllers, flow measuring devices, and other power consuming control devices.

G. Branch circuit wiring and conduit furnished under this Section for control equipment power shall be separate from other power wiring. Each circuit shall be extended to 120 V branch circuit panel, and identified 120 V, 20 A, single-pole branch circuit breaker furnished in the panel to serve the circuit. No more than 2 DDC controller installations shall operate from a single 120 V branch circuit.

H. Low voltage control and sensor wiring shall be continuous without splicing.

END OF SECTION

SECTION 260500

ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.1 SCOPE OF WORK:

A. Contractor shall install all electrical work covered by the below specifications and approved drawings. Provide all material, labor transportation, tools, supervision, etc., necessary to complete the total electrical job. All items not specifically mentioned herein which are obviously necessary to make a complete working installation shall be provided by the contractor, including any necessary field engineering and/or detail drawings required. Drawings shall be submitted for approval as provided for in Paragraph 1.4 Shop Drawings.

B. The work shall consist of, but shall not be limited to, the installation of the following systems:

1. Interior electrical systems for power, lighting, miscellaneous systems and new electrical power into the space as indicated on the Drawings.

2. Power connections to equipment specified in specifications and on the approved drawings.

3. Temporary Power as required for the project.

4. Fire seal all floor, wall or ceiling penetrations in any rated assembly. Coordinate the method and materials with the Architectural Specifications.

1.2 CODES AND FEES:

A. All work shall be done in accordance with the requirements of the National Electrical Code, NFPA #70, 2020 Edition and all local and state codes.

B. The contractor shall obtain and pay for all inspections required by the building and safety codes and ordinances and the rules and regulations of any legal body having jurisdiction.

C. All electrical items covered by this specification shall be U.L. labeled and listed for the purpose.

1.3 DRAWINGS:

A. The drawings indicate the general arrangement of electrical equipment. The contractor shall review architectural drawings for door swings, cabinets, counters and other built-in equipment; conditions indicated on architectural plans shall govern for this work. Coordinate installation of

electrical equipment with the structural and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness.

B. Do not scale drawings. Dimensions for layout of equipment shall be obtained from architectural and/or mechanical unless specifically indicated on electrical drawings.

C. Discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions shall be promptly brought to the attention of the architect.

1.4 SHOP DRAWINGS:

A. The contractor shall submit for review by the architect, eight sets of complete schedules and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive materials, such as catalog sheets, product data sheets, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements, model numbers alone will not be acceptable. Data submitted for review shall contain all information required to indicate compliance with equipment specified. Complete electrical characteristics shall be provided for all equipment. The architect reserves the right to require sample of any equipment to be submitted for approval.

B. Each individual submittal item for materials and equipment shall be marked to show specification section and paragraph number which pertains to the item.

C. Prior to submitting shop drawings, the contractor shall review the submittal for compliance with the contract documents and place a stamp or other confirmation thereon which states that the submittal complies with contract requirements. Submittals without such verification will be returned without review.

D. Submittals shall be made for each of the following items:

Fire Sealing Materials, Instructions and UL Certifications

Disconnect Switches and Fuses

1.5 RECORD DRAWINGS:

A. At the time of final inspection, provide three (3) sets of complete data on electrical equipment used in the project and Reproducible As-Built drawings reflecting all field changes. This data shall be in bound form and shall include the following items:

1. Test results required by these specifications.

2. Data sheets indicating electrical characteristics of all devices and equipment.

3. The As-Built Drawings shall have the Contractor's name, address, telephone number, fax number, date and indicate that the drawings are "As-Built".

1.6 ELECTRICAL SERVICES:

A. Electrical power shall be as indicated on the drawings.

1.7 SITE INVESTIGATION:

A. Prior to submitting bids of the project, the contractor shall visit the site of the work to become aware of existing conditions which may affect the cost of the project.

1.8 EQUIPMENT CONNECTIONS:

A. All equipment requiring electrical connections shall be connected under this section of these specifications. Where electrical connections to equipment require specific locations, such location shall be obtained from shop drawings. Do not scale drawings for location of conduit stub-ups or boxes mounted in wall or floor to serve specific equipment, unless dimensioned on the electrical drawings.

B. Equipment furnished under other divisions of these specifications to be connected under this section of the specifications shall consist of, but not be limited to, the following:

1. Owner furnished equipment

2. HVAC and Mechanical Equipment

C. The contractor's attention is directed to other sections of these specifications, where equipment requiring electrical service is specified, to become fully aware of the scope of the work under this section of these specifications requiring electrical service and connections to equipment specified elsewhere.

1.9 MECHANICAL SYSTEMS:

A. Review plumbing and HVAC drawings and Divisions 22 and 23 of these specifications for mechanical and plumbing equipment requiring electrical service. Provide service to and make connections to all such mechanical and plumbing equipment requiring electrical service.

1.10 COOPERATION:

A. The contractor shall coordinate his electrical activities with other trades so as to avoid delays, interference's, and any unnecessary work.

1.11 GUARANTEE:

A. For guarantee of work under Division 26, refer to the general and special conditions.

PART 2 – PRODUCTS

2.1 MATERIALS:

A. Materials or equipment specified by manufacturer's name shall be used,unless approval of other manufacturers is listed in addendum to these specifications. Request for approval of substitute materials shall be submitted in writing to the architect at least ten working days prior to bid openings. Faxed request will not be accepted or reviewed.

B. Where substitution of materials alters space requirement indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein, and clearances between equipment.

C. All material shall be new and shall conform to the applicable standard or standards where such have been established for the particular material in question. Publications and standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM).

2. Underwriters' Lab (UL).

3. National Electrical Manufacturer Association (NEMA).

4. Insulated Cable Engineers Association (ICEA).

5. Institute of Electrical and Electronic Engineers (IEEE).

6. Edison Electric Institute (EEI).

7. National Fire Protection Association (NFPA).

8. American Wood Preservers Association (AWPA).

9. American National Standards Institute (ANSI).

D. Material of the same type shall be the product of one manufacturer.

E. All cost incurred by the acceptance of substitutions shall be borne by the contractor. Proof for all substitution shall be by the contractor.

PART 3 – EXECUTION

3.1 WORKMANSHIP:

A. All work shall be neatly, orderly, and securely installed with conduits, panels, boxes, switches, etc., perpendicular and/or parallel with the principle structural members. Exposed raceways shall be offset where they enter surface mounted equipment. Wiring installed in panels and other enclosures shall be looped and laced and not wadded or bundled.

3.2 TESTS:

A. At final inspection, a test will be made and the entire system shall be shown to be in proper working order as per these specifications and the approved drawings.

B. Contractor shall provide all instruments, labor and materials for any essential intermediate and final testing.

C. Equipment covers (i.e., panelboard trims, device plates, and junction box covers) shall be removed, as directed, for inspection of internal wiring. All circuits throughout project shall be energized and shall be tested for operation and equipment connections in compliance with contract requirements. Accessible ceiling shall be removed, as directed, for inspection of equipment installed above ceilings.

D. Perform the following test after the installation but prior to energizing equipment:

1. Megger test all feeders and branch circuits 50 Amps or greater and all high voltage circuits. Allowances for leakages shall be within the manufacturers recommend tolerances. Testing methods shall be per the cable manufacturer’s recommendations. Certified test results and the manufacturers data/recommendations shall be provided to the Engineer as indicated below.

2. The Contractor shall perform any other test which may be required by any legal authority having jurisdiction to verify this installation meets that requirement or requirements.

3.3 IDENTIFICATION:

A. Contractor shall identify each device such as circuit breakers, panelboards, controllers, etc. with Black on White Phenolic Tags using machine cut letters, 1/4" minimum height, unless otherwise noted. Permanently attach to each device as required, do not use screws for any NEMA 3R device. For all panelboards, switchboards, transformers, fusible disconnecting motor starters and fusible disconnect switches include name, voltage, phase, number of wires, ampacity

rating, short circuit rating and name/location of feed to the device.

3.4 CLEANING AND PAINTING:

A. Oil, dirt, grease, and other foreign materials shall be removed from all raceways, fittings, boxes, panelboard trims, and cabinets to provide a clean surface for painting. Scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, or other equipment enclosures shall be touched up with paint furnished by the equipment manufacturers specifically for that purpose. Painting in general is specified under other sections of the specifications.

B. Trim covers for pull boxes, junction boxes and control cabinets shall not be painted unless specifically required by the architect. Where such painting is required, trim covers shall be removed for painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

C. Unless specifically indicated to the contrary, all painting shall be done under Painting of these specifications.

END OF SECTION

SECTION 260530

BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.1 GENERAL:

A. Provide complete conduit system including boxes, fittings and supports. All empty conduits shall be left with fiber polyline pull cord. Conduits shall be concealed except in unfinished spaces such as areas without ceilings or on existing precast concrete walls. Refer to the Architectural Drawings for wall designations.

1.2 RACEWAYS:

A. Contractor shall install all conduits as per the below requirements.

1. Intermediate Metal Conduit (IMC) shall be ferrous galvanized conduit and shall comply with Article 342 of the National Electrical Code.

2. Rigid steel conduit shall be ferrous galvanized conduit and shall comply with Article 344 of the National Electrical Code.

3. Electrical Metallic Tubing (EMT) shall be ferrous galvanized conduit and shall comply with Article 358 of the National Electrical Code. EMT conduit shall be used only in areas with concealed conduits. No exposed EMT will be allowed.

4. Liquid tight flexible metal conduit shall comply with Article 350 of the National Electrical Code.

5. Flexible metal conduit shall comply with Article 348 of the National Electrical Code.

6. Rigid nonmetallic conduit shall be polyvinyl chloride Schedule 40 (PVC) and comply with Article 352 of the National Electrical Code. Schedule 40 (PVC) conduits shall be used only in underground conduit runs, use rigid steel or IMC 90 degree bend below grade to transition to above grade. No exposed Schedule 40 (PVC) conduits will be allowed.

B. Coordinate all raceways with the mechanical ductwork and plumbing work installed in the job.

C. See Architectural Specifications for additional information on materials and methods for the repair of all floors, walls and ceilings that are disturbed during the installation of the interior electrical systems. Seal all penetrations through any rated floor, wall, or ceiling as per the

requirements of the Architectural Specifications and/or as specified herein.

PART 2 – PRODUCTS

2.1 CONDUCTORS:

A. All conductors shall be copper and have 600-volt type THHN/THWN insulation except where noted on drawings. Conductors installed where fixtures are used as raceway shall be 90°C Type THHN or XHHN.

B. All branch circuits shall be a minimum of #12 AWG solid or stranded copper except for motor leads, which shall be a minimum #12 AWG stranded copper, unless otherwise noted on drawings.

C. All branch circuit and feeder conductors, No. 6 AWG and smaller shall be color coded as follows: 208Y/120 volt, three phase system, Phase A--Black, Phase B--Red, Phase C--Blue, Neutral--White, Ground--Green. 120/240 volt single phase system, Phase A--Black, Phase B--Red, Neutral--White, Ground--Green. 480Y/277 volt, three phase system, Phase A--Brown, Phase B--Orange, Phase C--Yellow, Neutral--Gray, Ground--Green with stripe.

2.2 PULLBOXES:

A. All pull boxes shall be constructed of code gauge galvanized sheet steel and comply with Article 314 of the National Electrical Code, for the number, size and position of conduits entering the box, size of box and maximum number of conductors in a box.

PART 3 – EXECUTION

3.1 RACEWAYS:

A. Exposed conduits shall be installed parallel or at right angles to existing walls, ceilings, and structural members. Support exposed conduits at not more than ten foot intervals and within three feet of outlets, junction boxes, cabinets and fittings. Individual runs of conduits shall be supported by one hole conduit straps; groups of conduits shall be supported on 1 1/2" X 1 1/2" fourteen gauge channel; Kindorf, Unistrut or Powers, suspended from structure with 3/8" threaded steel rods with spring steel conduit supporters. Attach rods to structure with swivel type clamps. Individual runs of exposed conduits attached to structural steel shall be supported by beam clamps. Where conduits must pass through structural members obtain approval of architect with respect to location and size of hole prior to drilling.

B. Concealed branch circuit conduits shall be supported at intervals not exceeding ten feet and within three feet of each outlet, junction box, cabinet or fitting. Individual branch circuit conduits shall be attached to structural steel

members with spring steel type conduit clips and to non-metallic structural members with one hole conduit straps. Where branch circuit conduits must be suspended below structure, conduits shall be supported by trapeze type support, typical to the type for exposed conduits indicated above. Conduits shall not be attached to channels of ceiling suspension system or suspension wires. Concealed feeder conduits larger than one inch trade diameter, above ceiling, shall be attached to structure on intervals not exceeding twelve feet with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with conditions encountered.

C. Conduit support device shall be attached to structure with wood screws on wood, toggle bolts on hollow masonry, lead shield on solid masonry and machine bolts, clamps, or spring steel clips on steel. Nails are not acceptable.

D. Rigid conduit shall be attached to sheet metal enclosures with two bonding type lock nuts and insulated bushing. EMT connectors and couplings shall be watertight compression type and manufactured by Thomas and Betts or Appleton. All connectors shall be of the insulated throat type. Rigid conduit stub ups not attached to enclosure shall be terminated with steel insulated throat, grounding type bushing. All connectors and couplings shall be approved for the purpose.

E. Expansion fittings shall be provided in all feeder conduits where conduits pass through building expansion joints. All conduits penetrating rated fire walls or rated fire floors shall be installed with devices to maintain the fire rating of the wall or floor penetrated. Use O.Z. Gedney "Fire-Seal" or approved alternate. Contractor shall caulk holes on both sides of smoke walls where conduits penetrate.

F. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry work is complete.

G. All conduits entering buildings from below grade shall be sealed with fiber and insulating electrical putty to prevent entrance of moisture.

H. Conduit seals shall be used where noted on drawings and per Article #300-5 and #300-7 of the National Electrical Code. Seals shall be Crouse-Hinds Type "EYS", Appleton Type "EYF" or O.Z. Gedney Type "EY" or "EYA".

I. Flexible conduit shall comply with the above and below specifications.

1. Flexible conduit shall be used for connection to vibrating equipment, electric duct heaters, unit heaters and rotating machinery and for connection from junction box to corresponding recessed lighting fixture.

2. Flexible liquidtight conduit connecting motors, duct heaters, unit heaters and other electrical equipment subject to vibration not less than eighteen inches in length or as permitted by the NEC.

3. Flexible metal conduit from outlet box to recessed lighting fixture shall not exceed six feet in length.

4. Flexible conduit used for other than connections to lighting fixtures shall not be less than one-half inch trade size and in no case shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed therein. three-eighths inch flexible conduit may be used for connection to light fixtures providing conduit fill requirements of National Electrical Code are not exceeded.

5. Ground continuity through flexible conduit shall be maintained with green equipment grounding conductor, do not use flexible conduit for ground continuity.

6. When exposed to weather, when specifically indicated, or when installed in areas subject to moisture, flexible conduit shall be liquidtight type.

7. All connectors for flexible conduit shall be standard set screw type, cast connectors, bushed as required for flexible conduit. When used with liquid type flexible conduit, connectors shall be standard compression type.

3.2 PULL OR JUNCTION BOXES:

A. Pull boxes shall be provided where specifically indicated and where required to facilitate the installation of conductors. Pull boxes shall be installed exposed only in unfinished spaces, unless otherwise specifically indicated, and shall be installed to be fully accessible.

B. Where pull boxes are installed in finished spaces, boxes shall be standard screw cover
j-boxes and galvanized switch boxes, gangable, where not exposed to the weather. Surface mounted boxes shall be cast metal Type "FD" with blank covers.

C. Pull boxes required for horizontal feeders containing more than one feeder shall be provided with reinforced flange and removable 12 gauge 1 1/2" X 1 1/2" galvanized channel for support of conductors. Wood supports within pull boxes are not acceptable.

D. Splices shall not be permitted in pull boxes except when specifically approved in writing by the Architect or where specifically shown on the drawings. Where splices are permitted, splices shall be made with splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull

boxes.

E. Feeders within pull boxes shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each feeder within pull box.

F. Minimum pull or junction box size shall be as per the NEC.

3.3 CONDUCTORS:

A. All feeder and branch circuit conductors No. 4 AWG and larger shall be phase identified in each accessible enclosure by 1" wide plastic tape attached to conductors in a readily visible location. Tape colors shall match color requirements specified herein.

B. All branch circuit conductors shall be connected as indicated on the drawings. Common neutrals and ground wires may be pulled in conduits where only opposite phase conductors are run. All conduits shall have a ground wire pulled and shall comply with Article 250 of the National Electrical Code.

C. Conductors within enclosures, i.e., panels, terminal cabinets, control cabinets shall be grouped and laced with nylon tie straps. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.

D. Splices in conductors shall be made only within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code, 2014 Edition. Do not splice conductors in panelboards, safety switches, or motor control enclosures. Splices in conductors No. 10 AWG or smaller shall be made with Skotchlok insulated spring connectors, Ideal wing nuts, or Ideal steel crimp connectors with wrap-cap insulating caps. Splices in conductors No. 8 AWG and larger shall be made with split bolt connectors taped with No. 88 plastic electrical tape or Ideal Type GP or GT tap connectors and insulating cover unless splices are specifically indicated to be made with crimping sleeve applied to conductors with hydraulic operated crimping tool.

E. Conductors used only for 120 volt control wiring systems shall be minimum No. 14 AWG stranded type MTW 600 volt insulation. Control conductors to be J.I.C. color coded. Where control conductors terminate on terminal strip, make termination with lug applied to conductor with crimping tool.

F. Phase rotation established at service equipment shall be maintained throughout entire project.

G. Pull wires shall be 500# minimum test continuous fiber polyline.

END OF SECTION

SECTION 262800

ELECTRICAL SERVICE AND DISTRIBUTION EQUIPMENT

PART 1 – GENERAL

1.1 GENERAL:

A. Provide and install all electrical distribution equipment as specified, scheduled, or indicated on the approved drawing and these specifications.

PART 2 – PRODUCTS

2.1 DISCONNECT SWITCHES:

A. Fusible or Non-Fusible disconnect switches shall be Heavy Duty type and be provided for all motors located out of sight of motor controller and where specifically indicated on the drawings. Disconnect switches shall disconnect all underground conductors. When exposed to weather, enclosure shall be NEMA 3R (Raintight); otherwise, enclosure shall be NEMA-1. Switches shall be installed to be fully accessible in accordance with Article 110.26 of the National Electrical Code.

B. Disconnect switches for single phase motors shall be horsepower rated, motor switches without overload protection, voltage rating as per motor nameplate voltage or greater.

C. Fusible disconnect switch shall disconnect all ungrounded conductors and shall be supplied with the proper sized fuse clips and fuses. Fuse size over frame size will be noted on drawings. Fuses shall be current limiting, time delay, dual element Type RK-5 fuses.

D. Disconnect switches shall be Square D, ABB (GE), Siemens or Cutler- Hammer. All disconnect switches shall be identified in accordance with the Paragraph 16010 – 3.3 Identification of these specifications and Article 110-22 of the National Electrical Code.

E. All disconnect switches shall be marked with Arc Flash Warning Labels as required by Article 110.16 of the NEC.

PART 3 – EXECUTION

3.1 MANUFACTURERS' RECOMMENDATIONS:

A. The contractor shall install all electrical distribution equipment in accordance with the manufacturer's recommendations and these specifications.

END OF SECTION

SECTION 260526

GROUNDING

PART 1 – GENERAL

1.1 GROUNDING:

A. Shall comply with Article 250 of the National Electrical Code and all state and local codes and the requirements of the utility company serving the site.

B. Grounding shall be provided as per these specifications and the approved drawings.

C. The electrical system shall be a grounded wye supplemented with equipment grounding systems. All non-current carrying parts of the electrical system i.e., raceways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in proximity with electrical circuits, shall be grounded to provide a low impedance path for potential ground faults.

D. The neutral conductor of the 480Y/277 Volt, Three Phase, 4 Wire or 208Y/120 Volt, Three Phase, 4 Wire or 120/240 Volt, Single Phase, 3 Wire systems shall be grounded to the ground system as indicated on the drawings. Grounding conductor shall be copper sized in accordance with Table 250.66 of the National Electrical Code and as indicated on the drawings. Conductor shall be installed in PVC Conduit to the ground point connection.

PART 2 – PRODUCTS

2.1 PRODUCTS:

A. Ground rods shall be 3/4" copperweld sectional rods 10'-0" in length. Top of the ground rod shall be twelve (12) inches below finished grade. Connection to the ground rod shall be made by chemical weld process. Resistance to ground shall not exceed twenty-five (25) ohms.

PART 3 – EXECUTION

3.1 GROUNDING:

A. A grounding conductor shall be installed in all power and lighting conduit installations. All circuit grounding conductors shall be sized as per Table 250.122 of the National Electrical Code.

B. All motors shall be grounded by drilling and tapping the bottom of the motor junction box and attaching the conductor to the box with a round head bolt used for no other purpose.

Conductor attachment shall be by a lug attached to conductor with crimping tool.

END OF SECTION