NEGATIVE ISOLATION ROOM STANDARDS

CLEVELAND CLINIC

Prepared for

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PURPOSE

This document was developed for Cleveland Clinic to provide a standard basis of design for all negative isolation rooms. Detailed information including specifications is provided in this document. Any variation from this standard shall be submitted and reviewed with Cleveland Clinic Facilities and Engineering Group. This document is intended to be used for design of all isolation rooms at Cleveland Clinic.

GENERAL OVERVIEW

Negative air pressure rooms shall be designed in accordance with the most recent edition of the Guidelines for Design and Construction of Health Care Facilities (currently 2010), Center for Disease Control and American Society for Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) standards. These guidelines and standards provide a safe environment for hospital staff treating patients that require an airborne infection isolation room, as well as protecting the surrounding patients, general public, and staff outside the airborne infection isolation rooms.

In addition to the minimum criteria, other "architectural" recommendations of an isolation room are needed. Features that make a room "airtight" are door sweeps, caulking windows, gasketed lighting fixtures, gasketed ceiling tiles (or solid ceilings), gasketed medical gas, electrical and data outlets, and sealing "unseen" holes and penetrations behind casework and in the walls above the ceiling. These room construction items greatly affect the ability to maintain room static pressure.

Mechanical system features include room pressurization monitors connected to the Building Automation System (BAS) and redundant exhaust fans. A connection to the BAS from the isolation room monitors alerts the engineering staff to problems which may be able to be fixed from the BAS computer. It also allows the staff to be proactive and identify problems before they cause alarms. This BAS feature automatically tracks and monitors the room pressures and can provide printouts for inspectors wishing to check for room pressure compliance. A redundant exhaust fan will allow the isolation rooms to stay in operation upon a failure of one fan or for maintenance. HEPA filters are required. HEPA filters may not be required if the fans are at the top of the building but this issue must be reviewed and approved by Facilities Engineering.

All operations and maintenance personnel will need training in the use and maintenance of the isolation rooms. Site specific programming, alarms, procedures and maintenance schedules will need to be established along with updating or creating new operational procedures. The commissioning, training, and start-up will be done during and at the end of the project.

SUMMARY OF GENERAL ISOLATION ROOM DESIGN REQUIREMENTS

The isolation room design requirements are established based on Healthcare Design Construction Guidelines (2010 Version), CDC Guidelines, and ASHRAE standards.

a. Minimum of 2 outside air changes
b. Minimum of 12 total room air changes (design for 15 total room air changes)
c. Minimum pressure differential of 0.02"
d. All air exhausted to the outdoors
e. Visual Monitoring of airflow
f. Self-closing devices on doors
g. Exhaust air discharged through HEPA filters if fan is below roof line
h. Exhaust fan on emergency power
i. Exhaust grille located in the ceiling and near the head of the bed
j. No positive/negative switch allowed
k. Room is sealed (ceilings, light fixtures, etc.)
l. No gravity type heating devices except radiant panels

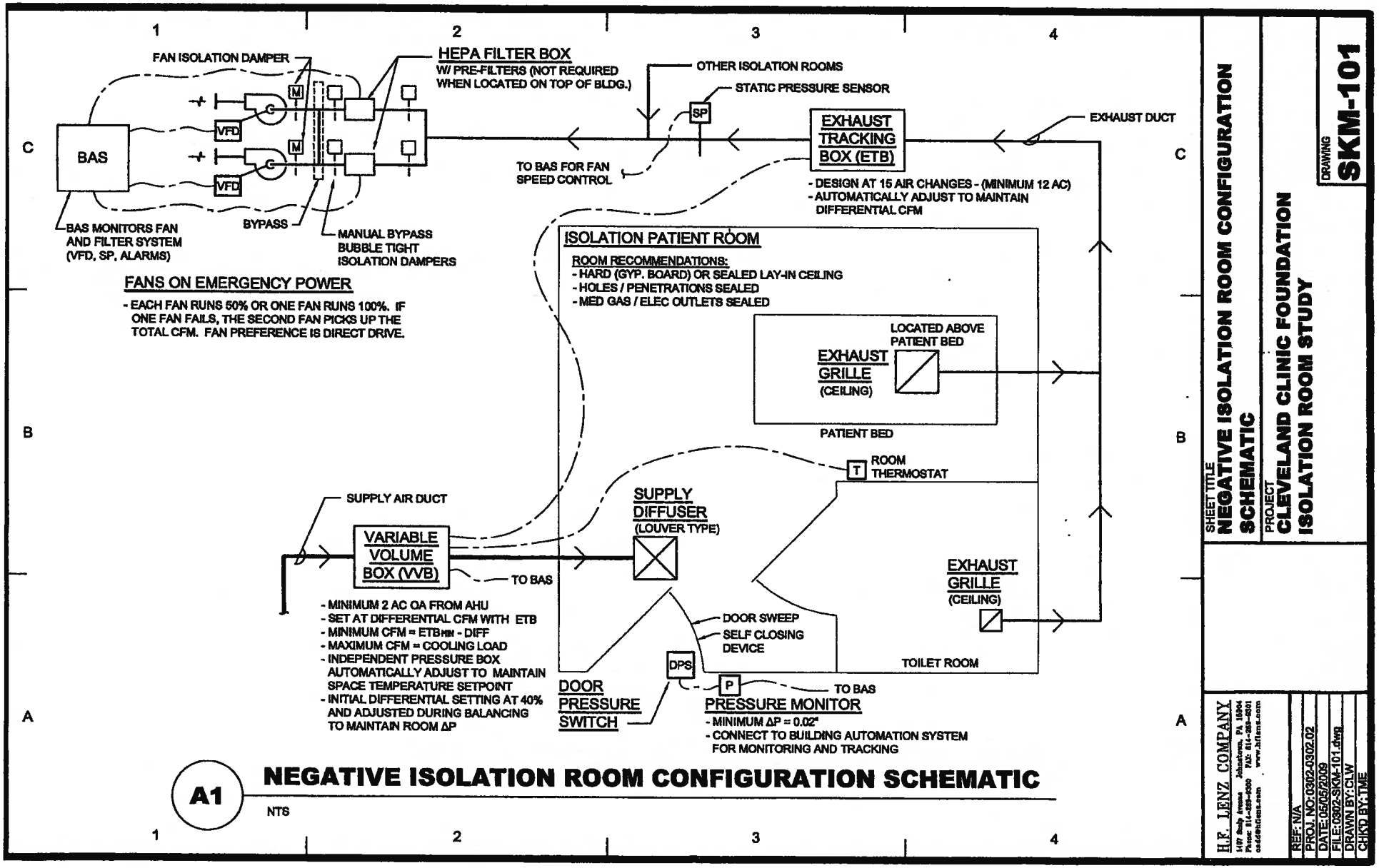
SPECIFIC DESIGN ISSUES

Cleveland Clinic requires specific items for the isolation room systems. These items are on the schematic or in the specifications and are highlighted below for emphasis. Deviation from these items must be approved by the Cleveland Clinic. The specifications in the appendices are for reference and shall be incorporated into the project specifications. Other specifications sections shall be provided as required for the project.

1. Provide redundant fan systems with bypass. The bypass may be excluded if field conditions do not permit a side-by-side installation.
2. Fans shall be Loren Cook and shall be direct drive.
3. Air terminal devices shall be Naylor.
4. Air terminal boxes shall have reheat coils.
5. Pressure monitors shall be Siemens or TSI.
6. Provide Photohelic gages with the pre and HEPA filter sections.
7. Variable frequency drives shall be ABB.

APPENDIX A

Schematic Diagram of Negative Isolation Room Configuration



A1 **NEGATIVE ISOLATION ROOM CONFIGURATION SCHEMATIC**

NTS

SHEET TITLE
NEGATIVE ISOLATION ROOM CONFIGURATION SCHEMATIC

PROJECT
CLEVELAND CLINIC FOUNDATION ISOLATION ROOM STUDY

DRAWING
SKM-101

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FILE: 0302-SKM-101.dwg
DRAWN BY: CLW
CHK'D BY: TME

APPENDIX B

Architectural Specifications

SECTION 08 71 05

DOOR SEALS

PART 1 GENERAL

1.01 SCOPE

A. Finish door seals for existing doors. Included is:

1. Door sweeps on swing doors.
2. Jamb and head seals on existing doors.

1.02 SUBMITTALS

A. Product Data Sheets: Submit copies of manufacturer's catalog cut sheets for every item that is specified.

1.03 DELIVERY, STORAGE AND HANDLING

A. Package each item of hardware, complete with all necessary screws and instructions.

B. Store, handle and install hardware in accordance with manufacturer's recommendations to prevent damage, soiling and deterioration.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Furnish all door seals of a specific item from only one manufacturer. All numbers and symbols used in the preparation of the following schedule have been taken from the current catalogs of NATIONAL GUARD (NGP) and MD BUILDING PRODUCTS.

B. Other Manufacturers: Door seals of the same type and function, approved by Architect, and as manufactured by PEMKO or REESE may be bid.

2.02 MATERIALS AND COMPONENTS

A. Door Sweep: NGP 100V; surface mount type; mill finish aluminum with vinyl insert.

1. Location: Manual swing doors.

B. Perimeter Seals: MD BUILDING PRODUCTS 5/16 x 23/64 All Climate Weatherstrip D Strip; EPDM cellular rubber; self-adhering type.

1. Location: Jambs, head or bottom of existing doors.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install door seal items in compliance with manufacturer's instructions. Adjust and as required for proper installation and operation.

END OF SECTION

SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide acoustical lay-in panel ceiling system as shown and specified.

1.02 QUALITY ASSURANCE

A. Workmanship: Comply with Ceilings & Interior Systems Contractors Association (CISCA) Code of Practices.

B. Installation: Performed by an experienced authorized installer approved by acoustical material manufacturer.

C. Fire Hazard Classification: Provide acoustical materials which have been UL tested, listed and labeled Class 0-25, when tested in accordance with ASTM E84, Class A flame spread rating in accordance with ASTM E1264 requirements.

D. Reference Standards: Wherever the following abbreviations are used herein, they shall refer to the corresponding standards.

1. ASTM: American Society for Testing and Materials.
2. CISCA: Ceilings and Interior Systems Contractors Association.

1.03 SUBMITTALS

A. Product Data

1. Submit manufacturer's product data and installation instructions for each type of acoustical material and suspension system required.
2. Submit manufacturer's written instructions for recommended maintenance practices for each type of acoustical ceiling system required. Include recommendations for cleaning and refinishing acoustical units and precautions against materials and methods that may be detrimental to finishes and acoustical performances.

B. Certification: Submit manufacturer's certification of acoustical units fire hazard classification rating and performance requirements.

C. Maintenance Materials: Provide 2% each type and color of acoustical material supplied for replacement and maintenance purposes. Provide full size units, matching units installed, in properly labeled unopened or resealed boxes.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unopened protective packaging, with manufacturer's labels indicating brand name, pattern size, thickness and fire rating as applicable, legible and intact.

B. Store materials in original protective packaging to prevent soiling, physical damage or wetting.

C. Store cartons open at each end to stabilize moisture content and temperature.

D. Do not begin installation until sufficient materials to complete a room are received.

PART 2 PRODUCTS

2.01 SUSPENSION SYSTEM

A. Exposed "Tee" Grid System

1. Description: Extruded aluminum with factory applied white PVC face. 15/16" exposed face. Comply with ASTM C635. Provide systems adequate to support light fixtures, ceiling diffusers, and other normal accessories. Maximum deflection 1/360 of the span. All components of interlocking system from one manufacturer.
   a. Structural Class: Intermediate duty.
   b. Type of System: Direct Hung.
   c. Attachment Devices: Size for five times design load indicated in ASTM C635, Table 1 direct hung.
   d. Hanger Wires: ASTM A641 galvanized carbon steel, soft temper, prestretched not less than 12 gauge.
2. Edge Moldings: Extruded aluminum to match main beams and cross tees.
3. Model and Manufacturer: ARMSTRONG Clean Room Grid System or equal by DONN (USG INTERIORS) or CHICAGO METALLIC

2.02 ACOUSTICAL UNITS

A. Acceptable Manufacturers: The following models listed are by ARMSTRONG. Equal products by CELOTEX or U.S. GYPSUM are acceptable.

B. Panel: #870 Clean Room VL Unperforated – Class 5 (Class 100), 24" x 48"; CAC 40, light reflectance LR-.80 with white vinyl facing.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine substrates, structure and installation conditions. Do not proceed with acoustical ceiling systems work until unsatisfactory conditions have been corrected.

B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling.

1. Avoid use of less than half widths units at borders.

B. Coordinate with ceiling layout on drawings.

C. Notify Architect of discrepancies between ceiling layout on drawings and ceiling layout proposed. Do not proceed until approved by Architect.

3.03 INSTALLATION

A. Suspension System: Comply with ASTM C636 requirements and be water or laser leveled, maximum deflection of 1/360 of span and maximum surface leveling tolerance 1/8" in 12'-0".

B. Rough Suspension

1. Hangers: Ceiling suspension systems shall not be supported from ductwork, electrical conduit, heating or plumbing lines or any other utility lines. Each utility and the ceiling suspension system shall be a separate installation and each shall be independently supported from the building structure. Where interferences occur, employ trapeze hangers or supports to avoid interferences with appurtenances requiring servicing. Support all four corners of suspension systems at fluorescent light fixtures.
2. Wall Molding
   a. Provide edge trim molding at perimeter of acoustical ceiling installation and intermediate vertical surfaces. Use maximum lengths. Miter trim corners to provide tight, accurate joint. Connect moldings securely to substrate surfaces.
   b. Connect moldings to substrate at intervals not over 16" on center and not more than 3" from ends, leveling with ceiling suspension system to tolerance of 1/8" in 12'-0".

C. Acoustical Units

1. Install acoustical lay-in panels level, in uniform plane, with joints snug and square and panels free from damage or soiling.
   a. Fit border units accurately at borders and penetrations.
2. Coordinate suspension systems grid layout with electrical lighting fixture lay-out and installation.

3.04 CLEANING

A. After installation, clean soiled or discolored surfaces of acoustical units and exposed suspension members. Comply with manufacturer's recommendations for cleaning and touch-up of minor finish damage.

B. Adjust all sags and twists which develop in ceiling systems. Remove and replace units which are improperly installed and damaged units which cannot be successfully cleaned and repaired to eliminate evidence of damage.

END OF SECTION

APPENDIX C

Mechanical Specifications

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Air Systems:

a. Variable-air-volume systems.

2. Hydronic Piping Systems:

a. Variable-flow systems.

3. HVAC equipment quantitative-performance settings.
4. Space pressurization testing and adjusting.
5. Smoke-control systems testing and adjusting.
6. Indoor-air quality measuring.
7. Existing systems TAB.
8. Verifying that automatic control devices are functioning properly.
9. Reporting results of activities and procedures specified in this Section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

C. Testing and balancing work shall be performed by Kahoe Air Balance.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

H. Terminal: A point where the controlled medium, such as fluid or air, enters or leaves the distribution system.

I. Test: A procedure to determine quantitative performance of a system or equipment.

J. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

K. AABC: Associated Air Balance Council.

L. AMCA: Air Movement and Control Association.

M. NEBB: National Environmental Balancing Bureau.

N. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

E. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB. Agent shall function as a subcontractor responsible to the HVAC Contractor.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, ATC System Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. Contract Documents examination report.
c. Testing, adjusting, and balancing plan.
d. Work schedule and Project site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, ATC System Installer, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms or on NEBB forms stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Verify that balancing devices, such as balancing valves and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine equipment performance data, including fan curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

E. Examine system and equipment test reports.

F. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as balancing valves and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

H. Examine terminal units to verify that they are accessible and their controls are connected and functioning.

I. Examine equipment for installation and for properly operating safety interlocks and controls.

J. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Automatic modulating control valves are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.

8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

K. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance dampers are open.
6. Balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR VARIABLE-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

B. Variable-Air-Volume Systems: Adjust the variable-air-volume systems as follows:

1. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units.
2. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.8 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected. Conduct a pressure test in the space before the ceiling is installed to verify the integrity of the envelope. Portable fans or the equipment installed for the project may be used.

B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.

1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust airflow to achieve the indicated pressure or airflow difference.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.9 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
4. Air balance each air outlet.

3.10 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: +10% to minus 5 percent.
3. Heating-Water Flow Rate: +10% to minus 5 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a

separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fan performance forms including the following:

    a. Settings for exhaust-air dampers.

b. Conditions of filters.
c. Fan drive settings including settings and percentage of maximum pitch diameter.
d. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of supply and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Fan Test Reports: For exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

G. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft..
    g. Indicated airflow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual airflow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Test apparatus used.
    d. Area served.
    e. Air-terminal-device make.
    f. Air-terminal-device number from system diagram.
    g. Air-terminal-device type and model number.
    h. Air-terminal-device size.
    i. Air-terminal-device effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Air velocity in fpm.
    c. Preliminary airflow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final airflow rate in cfm.
    f. Final velocity in fpm.
    g. Space temperature in deg F.

I. System-Coil Reports: For water coils of terminal units, include the following:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.

b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Measure space pressure of at least 10 percent of locations.
    e. Verify that balancing devices are marked with final balance position.
    f. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units, isolation fan systems, room pressure monitors, door switches, and other components as indicated on the drawings.

B. Related Sections include the following:

1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

C. Contractors/Suppliers:

1. ATC contractors shall be Siemens or Johnson and limited to those personnel approved by Cleveland Clinic.

1.3 SEQUENCE OF OPERATION

A. Refer to sequence on the drawings.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. Include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Device address list.
2. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

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 ASHRAE 135 for DDC system components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units.

C. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

D. Coordinate equipment with Division 26 Section "Variable Frequency Motor Controllers" to achieve compatibility with starter coils and annunciation devices.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturers:

1. Johnson Controls, Inc.; Controls Group.
2. Siemens Building Technologies, Inc.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.

D. Equipment shall be as manufactured by Johnson or Siemens and following the standard used at Cleveland Clinic.

2.2 ROOM PRESSURE MONITOR

A. A room pressure monitor system shall be furnished and installed to monitor the measured room pressure in the isolation room. The system shall include a room pressure monitor, a pressure sensor, a low voltage control transformer, all low voltage control wiring, and a door switch.

B. All components of the room pressure controller shall be part of a completely designed, tested, cataloged, and factory coordinated package by Siemens or TSI Inc.

C. The system shall continuously measure and display the room pressure to comply with the requirement set forth in Section 6-4.2 of the NFPA 45 Standard.

D. Room Pressure Monitor:

1. A room pressure monitor shall be provided to measure, and display the room pressure. It shall provide access to menu driven programming options through a keypad.
2. The room pressure monitor shall be factory fabricated with an industrial grade metal case for mounting on a snap-on bracket provided by the manufacturer. The controller shall mount to the bracket attached to a single gang electrical box on a wall inside the controlled space.
3. The room pressure monitor shall have the following characteristics:

a. An alphanumeric digital display indicating the measured room pressure in inches of H2O. The display shall have a range of -0.20000 to +0.20000 with a resolution of 5% of reading and shall be updated every one half second.

b. A smooth, spill-proof membrane switch keypad to operated menu-driven programming.
c. Minimum of two indicator lights shall be shown on the front of the controller indicating the following conditions:

1) Red ALARM light
2) Green NORMAL light

d. An audible alarm that sounds when the room is in an alarm condition assuming it has not been previously muted.
e. Alarm silent switch
f. Alarm contacts for low, high, general and no-flow alarms which shall be SPST (N.C.). The contacts shall close in alarm conditions and loss of power.
g. A 0-10 VDC or 4-20 mA linear analog output with variable range. The type of analog output must be specified at the time of order.
h. A keyswitch to change from negative to neutral. The neutral position shall disengage the alarm.
i. A LAN communications port for connection to the Building Automation System. The BAS shall be capable of monitoring and setting the alarm points.
j. A port for connection to a portable or fixed computer for configuring room pressure monitors with similar setpoints, alarm conditions, and menu options.
k. Door Switch contact.

4. All wiring to the room pressure monitor shall be wired to a terminal strip which plugs into the back of the monitor for easy installation.

E. Pressure Sensor/Transmitter:

1. The pressure sensor shall consist of two velocity sensing elements mounted in-line with each other and a temperature compensating element. Constant temperature thermal anemometry shall be used to make the air velocity measurement. Pressure transducers are not acceptable.
2. A hard molded plastic "dumbbell" assembly shall be used to mount the pressure sensor. The "dumbbell" shall consist of two wall-mounted plastic housings and PVC tubing. One housing shall be mounted on the wall in the controlled space, one in the referenced space, with the PVC tubing between them through the wall. The wall thickness shall not exceed two feet. Ceiling mounted units may be used in rooms with anterooms when measuring room pressure relative to the corridor.
3. Mounting hardware shall be provided for installation of the pressure sensor in the plastic housing mounted on the wall of the controlled space. A bell-shaped air inlet design shall be used for smooth laminar airflow across the sensing elements.
4. The velocity sensing elements shall be ceramic coated platinum RTD for corrosion resistance and easy cleaning.
5. The sensor shall be temperature compensated over a range of 55 Deg. F. to 95 Deg. F.
6. The sensor shall accurately measure room pressure in the range of -0.20000 to +0.20000 inches H2O. The sensor shall be bi-directional to determine the proper direction of pressure. Uni-directional sensors are not acceptable.

7. A 6 foot, 4-conductor, 22 AWG cable with 4-pin, polarized plug-in connectors at both ends shall be provided for the wiring connection between the sensor and the pressure controller for easy connections.

F. Transformer:

1. A low voltage transformer shall be provided to power to the room pressure controlling system.
2. The transformer shall have a primary-side voltage of 120 VAC and a secondary-side voltage of 24 VAC.
3. The transformer shall be UL listed.
4. The transformer shall have a rating of 20 VA with a 0.5 amps maximum.
5. The transformer shall be installed in a standard 4" x 4" electrical box.
6. A 25 foot, 2-conductor, 22 AWG cable shall be provided as the electrical interface between the transformer and the pressure controller.

Door Switch: Provide a door switch to monitor the door position.

G. Sequence of Operation: Room pressure monitor shall function as indicated on the drawings

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.

3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**,** test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

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

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check DDC system as follows:

a. Verify that DDC controller power supply is from emergency power supply, if applicable.
b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
c. Verify that spare I/O capacity has been provided.
d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

5. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

6. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

7. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
8. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
9. Provide diagnostic and test instruments for calibration and adjustment of system.
10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 230900

SECTION 233423 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Utility set fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting

2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705.

1.9 COORDINATION

A. Coordinate fan with the Fan/Filter system.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide:

1. Loren Cook Company (no substitutes)

B. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to position as required for the fan/filter system package. Refer to Section 23 41 33 HIGH EFFICIENCY PARTICULATE FILTRATION.
2. Coating: Steel fan components shall have electrostatically applied, baked polyester powder coating. Paint must exceed 1,000 hour salt spray under ASTM B117 test method

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel
2. Blade Type: Forward curved

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9.

1. Extend grease fitting to accessible location outside of unit.

F. Direct Drive: Fan shall be direct drive.

G. Accessories:

1. Inlet and Outlet: Flanged
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Access Door: Gasketed door in scroll with latch-type handles.
4. Inlet Screens: Removable wire mesh.
5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
6. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

H. Capacities and Characteristics:

1. Refer to drawings for fan information.

I. Vibration Isolators:

1. Type: Spring isolators.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment".

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Motors shall be inverter rated duty for use with variable frequency drives.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using on structure with the HEPA filter system as part of the Fan/Filter System.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment".

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories".

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Lubricate bearings.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Constant and variable volume air terminals.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating air outlets with other items installed in ceilings.

D. Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide to include in the maintenance manuals.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

B. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

C. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.1 AIR TERMINAL BOXES

A. General: Provide single duct, constant and variable volume air terminal units of the sizes and capacities shown on the drawings.

B. Casing: The unit casing shall be 22 gauge galvanized steel, internally lined with 1/2", 1-1/2 PCF density fiberglass insulation which complies with UL 181 and NFPA 90A. Exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent erosion.

C. Hospital Grade Unit Casing: The unit casing shall be minimum 22 gauge galvanized steel, internally lined with 3/4" thick, 4 lb/cu. ft density fiberglass ductboard insulation with a hospital-grade lining which complies with UL 181 and NFPA 90A. The lining shall be a reinforced foil facing that is smooth, non-porous, and cleanable. Exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent erosion. Insulation shall have flame spread and smoke development ratings not greater than 25 and 50 respectively (UL 723). Mastic or sealant-coated fiberglass or elastomeric type insulation is not acceptable.

D. Damper: Heavy gauge metal, with shaft rotating in Delrin self-lubricating bearings. Shaft shall be marked on the end to indicate the damper blade position. The damper shall have a built-in stop to prevent overstroking and shall seal against a closed-cell foam gasket.

E. DDC Controls:

1. All controls including a DDC controller/actuator shall be furnished and installed at each box by the Building DDC System Supplier as specified in Division 23 Section, "Instrumentation and Control for HVAC." Boxes shall be factory furnished complete with a controls enclosure and multi-point center-averaging sensor with flow measurement and balancing taps to amplify velocity pressure signals and provide accurate flow sensing regardless of air inlet duct configuration. Coordinate control component requirements with the Building DDC System Supplier.

F. Coils: Where scheduled on the drawings, the air terminal units shall be factory furnished with hot water heating coils constructed of copper tubes mechanically expanded to aluminum fins to 150 psig working pressure, or electric resistance coils with disconnect switches, contactors and safety and operating controls required by NEC.

G. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Nailor Industries (No Substitutes)

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."

B. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance. Support terminals from overhead building structural steel. Do not support from ceiling grid.

B. Duct installations and connections are specified in Division 23 Section “Metal Ducts”.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union.

D. Electrical: Comply with applicable requirements in Division 26 Electrical.

E. Ground equipment.

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

3.3 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.5 COMMISSIONING

A. Verify that installation of each air terminal is according to the Contract Documents.

B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

C. Check that controls and control enclosure are accessible.

D. Verify that control connections are complete.

E. Check that nameplate and identification tag are visible.

F. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals.
3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 233600

SECTION 234133 – HIGH-EFFICIENCY PARTICULATE FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The containment filtration/fan exhaust system shall be a built up system consisting of dampers, transitions, filters and fan on a pre-built or build in place skid. The entire system shall be redundant. Each system shall include:

1. Inlet bubble tight damper with manual operator.
2. Inlet transition with 1 ¼" stainless steel decontamination valve.
3. Dedicated pre filter section with 0-1 Photohelic gage.
4. Dedicated HEPA filter section with 0-3 Photohelic gage.
5. Dedicated Precision scan housing downstream of the HEPA filters.
6. Outlet transition with 1 ¼" stainless steel decontamination valve.
7. Outlet bubble tight damper with manual operator.
8. Flex connection to fan inlet.
9. Bubble tight damper for isolation of fan with and automatic operator.
10. Structural stainless steel skid with lifting lugs.
11. Upstream DOP and sample ports.
12. Drilled inlet flange.
13. Stainless steel weather cap.

B. The HEPA filter exhaust system including the items as listed above shall be manufactured by a single source manufacturer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
3. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one (1) complete set(s) of filters, both prefilters and HEPA filters, for each filter bank. Temporary filters shall be provided during installation, cleaning and start up.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.

B. ASHRAE Compliance:

1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Comply with IEST-RP-CC001.3.

D. Comply with UL 586.

E. Comply with IEST-RP-CC007.1.

F. Comply with NFPA 90A and NFPA 90B.

G. The filter system shall be manufactured under a quality assurance program that meets the basic requirements of ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities. The manufacturer shall submit documented evidence that they have been independently audited by customers at least 3 times within the past six (6) years to ASME NQA-1 requirements, and successfully passed all three audits.

1.8 COORDINATION

A. Coordinate entire fan/filter system components with proposed locations and provide as a single unit or components built in place. The manufacturer/supplier of the system shall assemble the fan system or as a minimum shall supervise the installation,

PART 2 - PRODUCTS

2.1 SIDE-SERVICE HOUSINGS

A. Description: The filter shall be bag-in/bag-out design and the downstream test housing shall be a side servicing design arrangement that will allow air to enter and exit the housing without changing direction. All housings shall be manufactured from unpainted 14 and 11 gage type 304 stainless steel. The housing shall be adequately reinforced to withstand a negative or positive pressure of ten (10) inches water gage.

1. Basis-of-Design Product: Subject to compliance with requirements, provide this or comparable product:
   a. Flanders-Precisionaire CSC-Series
2. All pressure retaining weld joints and seams shall be continuously welded with no pores allowed. Joints and seams requiring only intermittent welds, such as reinforcement members, shall not be continuously welded. As a minimum, joints and seams shall be wire brushed and/or buffed to remove heat discoloration, burrs and sharp edges. All weld joints and seams that are a portion of any gasket sealing surface {e.g. filter seal surface, duct connecting flanges} shall be ground smooth and flush with the adjacent base metal.
3. The upstream and downstream flanges shall have a 1 ½ inch minimum flange width. Flanges shall be turned to the outside of the airstream to prevent contamination buildup and allow the customer to connect mating ductwork from outside the housing.
4. All welding procedures, welders and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Cole Section IX. All production welds shall be visually inspected per the workmanship of ANSI/AWS D9.1-1990, “Specifications for Welding Sheet Metal.”
5. All hardware on the housing and all mechanical components of the filter sealing mechanism shall be 300 series stainless steel, except for the cast aluminum access door knobs and brass pivot blocks in the filter sealing mechanism.

B. Filter Housing: To accommodate gasket seal filters, the housing shall incorporate a sealing surface that mates with the face of the filter. Access to the filter shall be on the side of the housing. Each tier of filters shall be fitted with a filter clamping mechanism that is operated from inside the housing. The filter clamping mechanism shall include independent pressure bars with pre-loaded springs that exert a minimum sealing force of 1400 pounds per full width filter and 1050 pounds per half width filter, applied as an even, uniform load along at least 80% of the top and bottom of each filter frame. If a multi-wide housing is specified, the housings shall be equipped with filter removal rods to draw the filters to the change-out position. The removal rods shall be operated from inside the change-out bag and shall remove the filter by pulling against the top and/or bottom of the filter frame. All change-out operations shall be within the bag so there is a barrier between the worker and the filter at all times.

1. The housing shall have a bagging ring around each filter access port. The bagging ring shall have two (2) continuous ribs to secure the PVC change-out bag. The outer edge of the ring shall be hemmed to prevent the bag from tearing. Each access port and bagging ring shall be covered by a door having an extruding neoprene gasket that is manually replaceable after the door has been

removed. When closed, the door shall not press against the bag-out port and PVC bag, thus eliminating the possibility of damage to the bag.

2. One (1) PVC change-out bag shall be furnished for each filter access port. Each bag shall have its stock number rolled into the hem. The PVC bag material shall be either (8) mil thick, yellow in color, with a translucent taffeta texture finish and shall not stick together. For visibility during change-out, the bag shall include approximately sixteen (16) inches of clear PVC at the mouth. Three (3) glove sleeves shall be built into the bag to facilitate handling of the filter during change-out. The PVC bags shall have been tested by an independent laboratory to evaluate their performance at extreme temperature ranges (0°F ¾ 130°F). The elastic shock cord shall be hemmed into the mouth of the bag so that it fits securely when stretched around the bagging ring. To prevent the bag from sliding off the bagging ring during the change-out operation, one (1) nylon security strap shall be provided with each filter access port. A nylon cinching strap shall also be provided with each access port to tie off the slack in the bag while the ventilation system is operating.
3. The housing shall be tested for filter fit, operation of the filter clamping mechanism, sealing surface and leak tightness before leaving the factory. Both the filter sealing surface and the complete assembly pressure boundary shall be leak tested by the “Pressure Decay Method,” in accordance with ASME N510-1995 “Reaffirmed,” “Testing of Air Cleaning Systems,” Paragraphs 6 and 7. Pressure readings are recorded once a d minute for five (5) minutes. There shall be a maximum leak rate of 0.0005 CFM per cubic foot of housing volume at ten (10) inches water gage.
4. The standard filter housing modules are seismically qualified, based upon comparison to previous shake table testing and by analysis. The housing modules are qualified in accordance with the criteria of the Uniform Building Code (1994 and 1997) up to Seismic Zone 3 levels; higher levels are available.
5. A minimum of four (4) feet clearance in front of the filter access door is suggested for filter change-out.

C. The Downstream Test Housing:

1. The downstream test housing shall incorporate a track for the installation, movement, and control of the probe assembly.
2. The probe assembly shall provide the ability to effectively scan the adjacent upstream filters in the system. The assembly shall be engineered to provide isokinetic sampling at 1,000 CFM per filter and provide satisfactory readings at 500 CFM to 2,000 CFM per filter.
3. The probe assembly shall be attached to an interior connection by a flexible tygon tubing. The interior connection shall penetrate the pressure boundry via pipe welded in place, which, in turn, joins to an exterior mounted 1/4" stainless steel ball valve with a brass plug. The ball valve functions as the exterior tube connection leading to the test instrument.
4. The scan assembly shall be positioned to allow the prove to make overlapping passes approximately one (1) inch from the filter face. The adjacent HEPA filter housing shall have a downstream seal location to allow the scan probe to completely scan the full face of the filter and the filter seal without obstruction.
5. All two wide and larger housings shall include an extension rod that will allow the test technician to position the probe assembly when testing the interior filters.

D. Prefilters: Each system shall have integral racks to accommodate 24x24x2 MERV-8 pleated pre filters.

E. HEPA Filters: Each system shall accommodate 24 x 24 x 11 1/2, 99.99% Absolute 2K High capacity separator-less filters. Each filter shall be sized and rated for a maximum approach velocity of 500 FPM @ 1.1" w.g based on the system CFM. Filter frame shall be 16 g. galvanized steel with neoprene gasket downstream for scan testing. Each filter shall incorporate an 8" deep separator-less filter pack sealed to the downstream side of the filter frame to enhance scan testing. (V-bed type filters are not acceptable). All systems shall have down stream gasket seal to facilitate scan testing.

F. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:

1. Prefilter.
2. HEPA filter.
3. Downstream test section.

G. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

H. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Fans: Fans shall be as specified in Section 23 34 23 HVAC Power Ventilators.

J. Quality Assurance and Factory Testing**:** The filter system shall be manufactured under a Quality Assurance program. The filter locking mechanism, differential pressure gage, and fan shall all be tested at the factory to ensure that the system functions properly.

2.2 FILTER GAGES

A. Diaphragm type Photohelic with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Manufacturers: Subject to compliance with requirements,
2. Basis-of-Design Product: Subject to compliance with requirements, provide manufacturer as noted below or comparable product:

    a. Dwyer Instruments, Inc.

3. Diameter: 4-1/2 inches (115 mm)
4. 120V or 24V power as coordinated with ATC and electrical.
5. High static pressure signal to BAS for alarm.

B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

2.3 CAPACITIES AND CHARACTERISTICS

A. Refer to drawings for capacities.

2.4 Round Bubble-Tight Isolation Dampers (Flat Blade Type)

A. Dampers shall be positive seal, isolation type which shall be bubble-tight at the differential pressure of 10" water gage. The blade shall consist of two (2) 3/16" thick type 304 stainless steel plates with replaceable solid silicone gasket between them. Blade seal shall occur when the gasket seats against the inside of the 11 gage housing wall. The damper shall be all welded design.

B. All "Pressure Retaining" weld joints and seams shall be continuously welded with no pores allowed. Weld joints and seams requiring only intermittent welds, such as reinforcement members, shall not be continuously welded. As a minimum, all weld joints and seams shall be wire brushed and\or buffed to remove heat discoloration, burrs, or sharp edges.

C. Flanges shall be minimum 1-1/2" wide by 3/16" thick. Factory drilled holes (7/16" diameter) shall be o more than 4" apart as recommended in DOE-HDBK-1169-2003, Nuclear Cleaning Handbook, Chapter 4, 4-23. The frame material shall be minimum 11 gage unpainted Type 304 Stainless Steel. All linkage components shall be manufactured from 300-Series stainless steel. Shafts are minimum 3/4" diameter stainless steel rod with shaft seals.

D. The damper shall be tested in the closed position at 10" water gage and shall be bubble-tight when tested in accordance with ASME N509-1996 "Reaffirmed" paragraph 5.9.7.3. The complete pressure boundry (damper housing) shall be leak tested by the "Pressure Decay Method" in accordance with ASME N510-1995 "Reaffirmed", Testing of Nuclear Air Treatment Systems", Paragraphs 6 and 7. Pressure readings are recorded once a minute until pressure decays to 75% of the test pressure or for 5 minutes. There shall be a maximum leak rate of 0.0005 CFM per cubic foot of housing volume at 10 inches water gage.

E. Actuators

1. Manual: Manual actuators shall be worm geared actuator with handwheel. Actuator has aluminum base and cover. Rated output torque shall be 2,000 inch pounds up to 22" diameter size dampers with a gear ratio of 30:1 (7,000 inch pounds on dampers 24" to 36" diameter size, with gear ratio of 40:1). Actuator shall be fully lubricated and self-locking to hold at any position, and equipped with a visual indicator to show the damper position.
2. Electric: Electric rotary actuator shall have rugged, high torque, integral single phase reversible capacitor motors and shall be equipped with factory set limit switches. The actuator shall also be equipped with a motor brake. The actuator shall have spring return to close upon loss of power. Provide a manual wheel override and digital damper position transmitter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Position each filter unit with clearance for normal service and maintenance.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gage for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters that were used during construction and testing with new, clean filters.

E. Install filter-gage static-pressure tips upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Test for leakage of unfiltered air while system is operating.
2. HEPA Filters: Pressurize housing to a minimum of 3.0-inch w.g. (750 Pa) or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter for air leaks according to pressure-decay method in ASME N510.

D. Air filter will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234133

APPENDIX D

Electrical Specifications

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFC.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

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

G. 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.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

D. 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.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

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

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C.
2. Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.

1.8 COORDINATION

A. Coordinate layout and installation of VFCs 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 features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB. (No Substitutes)

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency. The variable speed controller shall be 6 pulse with line harmonic filters. Harmonic filter shall be integral or stand alone consisting of input series reactors, L-C harmonic filter circuit, bleeder resistors, for capacitor discharge and cooling fans. VFD's shall have integral or standalone line and load reactors.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 66 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.

2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
4. Critical (skip) frequency avoidance with three selectable, adjustable deadbands.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.
10. Snubber Networks to protect against malfunction due to system voltage transients.
11. Manual Hand-Off-Auto Bypass Controller
12. Harmonic filters (load side filter where cable length exceeds 65').

H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

M. Input Line Reactor – Provide 5% reactor integral to enclosure or adjacent to unit. (Not required on 18 pulse drives)

N. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

O. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

P. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

Q. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.

3. Output Signal Interface:

   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

R. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for

VFC to retain these settings within the nonvolatile memory. The VFC must be able to integrate to the existing campus-wide Automated Logic System via BACnet, level 4 interperability.

S. Manual Bypass: For duty/standby pumps, bypass is not required. Refer to mechanical equipment connection chart on drawing for more information. Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

T. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode for motors up to 40 HP. Larger than 40 hp motors shall utilize reduced voltage bypass controllers in lieu of full voltage. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

U. Integral Disconnecting Means with lockable handle.

V. Isolating Switch: Non-load-break switch arranged to isolate VFC and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

W. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

A. VFDs shall be in NEMA 250, type 1 enclosures.

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.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).

5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard painted finish applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

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

3.3 INSTALLATION

A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems".

C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses".

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems".

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power 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 control 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.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

3.7 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. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

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. 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.

3.8 ADJUSTING

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

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training".

END OF SECTION 262923