PROJECT MANUAL

REPAIR BUILDING 100 ENVELOPE MOISTURE BARRIER

ADMINISTERING DEPARTMENT:

Alaska VA Healthcare System

PREPARED BY:

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Engineering and Construction Services

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DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS

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SECTION 00 01 15
LIST OF DRAWING SHEETS

The drawings listed below accompanying this specification form a part of the contract.

Drawing No.	Title
GENERAL	
G1.00	COVER AND GENERAL INFORMATION SHEET
G1.01	KEY PLANS
G1.02	KEY ELEVATIONS
ARCHITECTURE	
A100	AIR HANDLING ROOM PENTHOUSES
A110	STAIR 04 PANEL REPLACEMENT
A120	ATRIUM CURTAIN WALL AND PARAPET
A130	GLAZED CURTAIN WALL
A140	SEISMIC JOINT DETAILS
MECHANICAL	
ME001	MECH & ELEC.LEGEND, SCHED, CONTROLS
ME101	MECH & ELEC FLOOR PLANS AND DETAILS

- - - END - - -

SECTION 01 00 00
GENERAL REQUIREMENTS

1.1 SAFETY REQUIREMENTS

Refer to section 01 35 26, SAFETY REQUIREMENTS for safety and infection control requirements.

1.2 GENERAL INTENTION

A. Contractor shall completely prepare site for building operations, including demolition and removal of existing structures, and furnish labor and materials and perform work for **Repair Building 100 Envelope and Moisture Barrier** as required by drawings and specifications.

B. Visits to the site by Bidders may be made only by appointment with the COR.

D. Before placement and installation of work subject to tests by testing laboratory retained by Department of Veterans Affairs, the Contractor shall notify the Resident Engineer in sufficient time to enable testing laboratory personnel to be present at the site in time for proper taking and testing of specimens and field inspection. Such prior notice shall be not less than three work days unless otherwise designated by the Resident Engineer.

E. All employees of general contractor and subcontractors shall comply with VA security management program and obtain permission of the VA police, be identified by project and employer, and restricted from unauthorized access. All contractors must have photo ID visible while on site. All contractors must obtain a government PIV badge.

F. Prior to commencing work, general contractor shall provide proof that an OSHA certified "competent person" (CP) (29 CFR 1926.20(b)(2) will maintain a presence at the work site whenever the general or subcontractors are present.

G. Training:

1. All employees of general contractor or subcontractors shall have the 10-hour OSHA certified Construction Safety course.

2. All employees of general contractor or subcontractors shall attend a 1-hour Contractors Orientation training at the VA prior to commencing work. This is an annual requirement.

3. Submit training records of all such employees for approval before the start of work.

H. Qualified Firestopping, refer to 078400.

1.3 STATEMENT OF BID ITEM(S)

A. ITEM I, Work includes general demolition and construction, electrical, mechanical work, alterations, necessary removal of existing structures and construction and certain other items per the plans and specifications.

1.4 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

A. Drawings and contract documents may be obtained from the website where the solicitation is posted. Hard copies will be at Contractor's expense.

1.5 CONSTRUCTION SECURITY REQUIREMENTS

A. Security Plan:

1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.

2. The General Contractor is responsible for assuring that all sub-contractors working on the project and their employees also comply with these regulations.

B. Security Procedures:

1. General Contractor’s employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.

2. Before starting work the General Contractor shall give one week’s notice to the Contracting Officer so that security can be provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.

4. VA reserves the right to close down or shut down the project site and order General Contractor's employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

C. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the Contracting Officers Representative (COR) Resident Engineer for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.

2. The General Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation. See Section 08 71 00, DOOR HARDWARE and coordinate.

D. Document Control:

1. Before starting any work, the General Contractor/Sub Contractors shall submit an electronic security memorandum describing the approach to following goals and maintaining confidentiality of "sensitive information".

2. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.

3. Certain documents, sketches, videos or photographs and drawings may be marked "Law Enforcement Sensitive" or "Sensitive Unclassified". Secure such information in separate containers and limit the access to only those who will need it for the project. Return the information to the Contracting Officer upon request.

4. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.

5. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA.

6. Notify Contracting Officer and Site Security Officer immediately when there is a loss or compromise of “sensitive information”.

7. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).

   a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.

   b. “Sensitive information” including drawings and other documents may be attached to e-mail provided all VA encryption procedures are followed.

F. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.

1.6 OPERATIONS AND STORAGE AREAS

A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.

B. Temporary buildings, (e.g., storage sheds, shops, offices), and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. Only with the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.

C. The Contractor shall (under regulations prescribed by the Contracting Officer) use only established roadways, or use temporary roadways constructed by the Contractor only as authorized by the Contracting

Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

D. Working space and space available for storing materials shall be determined by the Resident Engineer.

E. Workmen are subject to rules of Medical Center applicable to their conduct. Execute work in such a manner as to interfere as little as possible with work being done by others. Keep roads clear of construction materials, debris, standing construction equipment and vehicles at all times.

F. Execute work so as to interfere as little as possible with normal functioning of Medical Center as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. Use of equipment and tools that transmit vibrations and noises through the building structure, are not permitted in buildings that are occupied, during construction, jointly by patients or medical personnel, and Contractor's personnel, except as permitted by Resident Engineer where required by limited working space.

1. Do not store materials and equipment in other than assigned areas.

2. Schedule delivery of materials and equipment to immediate construction working areas within buildings in use by Department of Veterans Affairs in quantities sufficient for not more than two work days. Provide unobstructed access to Medical Center areas required to remain in operation.

3. Where access by Medical Center personnel to vacated portions of buildings is not required, storage of Contractor's materials and equipment will be permitted subject to fire and safety requirements.

G. Utilities Services: Where necessary to cut existing pipes, electrical wires, conduits, cables, etc., of utility services, or of fire protection systems or communications systems (except telephone), they shall be cut and capped at suitable places where shown; or, in absence

of such indication, where directed by COR. All such actions shall be coordinated with the COR or Utility Company involved:

1. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.

H. Phasing:

The Medical Center must maintain its operation from 6am-5pm, 5 days a week. Therefore, any interruption in service must be scheduled and coordinated with the COR to ensure that no lapses in operation occur. It is the CONTRACTOR'S responsibility to develop a work plan and schedule detailing, at a minimum, the procedures to be employed, the equipment and materials to be used, the interim life safety measure to be used during the work, and a schedule defining the duration of the work with milestone subtasks. The work to be identified shall include, that shown on the plans and specifications. To ensure such executions, Contractor shall furnish the Resident Engineer with a schedule of approximate dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof. In addition, Contractor shall notify the Resident Engineer two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such dates to insure accomplishment of this work in successive phases mutually agreeable to Medical Center Director, COR and Contractor.

I. Building(s) will be occupied during performance of work.

1. Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in the Medical Centers operations will not be hindered, per VA ICRA requirements. Contractor shall permit access to Department of Veterans Affairs personnel and patients through other construction areas which serve as routes of access to such affected areas and equipment. These routes whether access or egress shall be isolated from the construction area by temporary partitions and have walking surfaces, lighting etc to facilitate

patient and staff access. Coordinate alteration work in areas occupied by Department of Veterans Affairs so that Medical Center operations will continue during the construction period.

K. Utilities Services: Maintain existing utility services for Medical Center at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services or of fire protection systems and communications systems (including telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by Resident Engineer.

1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of Resident Engineer [Chief Engineer][Chief of Facilities Management]. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished, work on any energized circuits or equipment shall not commence without a detailed work plan, the Medical Center Director’s prior knowledge and written approval. Refer to specification Sections 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY for additional requirements.

2. Contractor shall submit a request to interrupt any such services to Resident Engineer, in writing, 7 days in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.

3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Medical Center. Interruption time approved by Medical Center may occur at other than Contractor's normal working hours.

4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the Resident Engineer.

5. In case of a contract construction emergency, service will be interrupted on approval of Resident Engineer. Such approval will be confirmed in writing as soon as practical.

6. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.

L. Abandoned Lines: All service lines such as wires, cables, conduits, ducts, pipes and the like, and their hangers or supports, which are to be abandoned but are not required to be entirely removed, shall be sealed, capped or plugged at the main, branch or panel they originate from. The lines shall not be capped in finished areas, but shall be removed and sealed, capped or plugged in ceilings, within furred spaces, in unfinished areas, or within walls or partitions; so that they are completely behind the finished surfaces.

M. To minimize interference of construction activities with flow of Medical Center traffic, comply with the following:

1. Keep roads, walks and entrances to grounds, to parking and to occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles.

N. Coordinate the work for this contract with other construction operations as directed by Resident Engineer. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

1.7 ALTERATIONS

A. Survey: Before any work is started, the Contractor shall make a thorough survey with the Resident Engineer and a representative of VA Supply Service, of buildings areas of buildings in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by both, to the Contracting Officer. This report shall list by rooms and spaces:

1. Existing condition and types of resilient flooring, doors, windows, walls and other surfaces not required to be altered throughout affected areas of buildings.

3. Shall note any discrepancies between drawings and existing conditions at site.

4. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and Resident Engineer.

C. Re-Survey: Thirty days before expected partial or final inspection date, the Contractor and Resident Engineer together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, of resilient flooring, doors, windows, walls and other surfaces as compared with conditions of same as noted in first condition survey report:

1. Re-survey report shall also list any damage caused by Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of Contractor to restore damage caused by Contractor's workmen in executing work of this contract.

D. Protection: Provide the following protective measures:

2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.

3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

1.8 DISPOSAL AND RETENTION

A. Materials and equipment accruing from work removed and from demolition of buildings or structures, or parts thereof, shall be disposed of as follows:

2. Items removed shall become property of the Contractor and be removed by Contractor from Medical Center.

3. Items of portable equipment and furnishings located in rooms and spaces in which work is to be done under this contract shall remain the property of the Government. When rooms and spaces are vacated by the Department of Veterans Affairs during the alteration period, such items which are NOT required by drawings and specifications to be either relocated or reused will be removed by the Government in advance of work to avoid interfering with Contractor's operation.

1.9 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

A. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

B. A National Pollutant Discharge Elimination System (NPDES) permit is required for this project. The Contractor is considered an "operator" under the permit and has extensive responsibility for compliance with permit requirements. VA will make the permit application available at the (appropriate medical center) office. The apparent low bidder, contractor and affected subcontractors shall furnish all information and certifications that are required to comply with the permit process and permit requirements. Many of the permit requirements will be satisfied by completing construction as shown and specified. Some requirements involve the Contractor's method of operations and operations planning and the Contractor is responsible for employing best management practices. The affected activities often include, but are not limited to the following:

- Designating areas for equipment maintenance and repair;

- Providing waste receptacles at convenient locations and provide regular collection of wastes;
- Locating equipment wash down areas on site, and provide appropriate control of wash-waters;
- Providing protected storage areas for chemicals, paints, solvents, fertilizers, and other potentially toxic materials; and
- Providing adequately maintained sanitary facilities.

1.10 RESTORATION

A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the Resident Engineer. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the Resident Engineer before it is disturbed. Materials and workmanship used in restoring work shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.

C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are not scheduled for discontinuance or abandonment.

D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown may be covered by adjustment to the contract at the discretion and determination of the Contracting Officer.

1.11 AS-BUILT DRAWINGS

A. The contractor shall maintain two full size sets of as-built drawings which will be kept current during construction of the project, to include all contract changes, modifications and clarifications.

B. All variations shall be shown in the same general detail as used in the contract drawings. To ensure compliance, as-built drawings shall be made available for the Resident Engineer's review, as often as requested.

C. Contractor shall deliver two approved completed sets of as-built drawings in the electronic version (AUTOCAD DWG) to the Resident Engineer within 15 calendar days after each completed phase and after the acceptance of the project by the Resident Engineer.

D. Paragraphs A, B, & C shall also apply to all shop drawings.

1.12 USE OF ROADWAYS

A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the Resident Engineer, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed and restoration performed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

1.13 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to written approval and compliance with the following provisions:

1. Permission to use each unit or system must be given by Resident Engineer in writing. If the equipment is not installed and maintained in accordance with the written agreement and following provisions, the Resident Engineer will withdraw permission for use of the equipment.

2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers and their

overload elements shall be properly sized, coordinated and adjusted. Installation of temporary electrical equipment or devices shall be in accordance with NFPA 70, National Electrical Code, (2014 Edition), Article 590, *Temporary Installations.* Voltage supplied to each item of equipment shall be verified to be correct and it shall be determined that motors are not overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.

3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be eliminated.

4. Automatic temperature control systems for preheat coils shall function properly and all safety controls shall function to prevent coil freeze-up damage.

5. The air filtering system utilized shall be that which is designed for the system when complete, and all filter elements shall be replaced at completion of construction and prior to testing and balancing of system.

6. All components of heat production and distribution system, metering equipment, condensate returns, and other auxiliary facilities used in temporary service shall be cleaned prior to use; maintained to prevent corrosion internally and externally during use; and cleaned, maintained and inspected prior to acceptance by the Government.

B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.

C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.

D. Any damage to the equipment or excessive wear due to prolonged use will be repaired replaced by the contractor at the contractor’s expense.

1.14 TEMPORARY USE OF EXISTING ELEVATORS

A. Use of existing elevators for handling building materials and Contractor's personnel will be permitted subject to following provisions:

1. Contractor makes all arrangements with the Resident Engineer for use of elevators. The Resident Engineer will ascertain that elevators are in proper condition. Contractor may use elevators and for special nonrecurring time intervals when permission is granted. Personnel for operating elevators will not be provided by the Department of Veterans Affairs.

2. Contractor covers and provides maximum protection of following elevator components:

   a. Entrance jambs, heads soffits and threshold plates.

   b. Entrance columns, canopy, return panels and inside surfaces of car enclosure walls.

   c. Finish flooring.

3. Government will accept hoisting ropes of elevator and rope of each speed governor if they are worn under normal operation. However, if these ropes are damaged by action of foreign matter such as sand, lime, grit, stones, etc., during temporary use, they shall be removed and replaced by new hoisting ropes at the contractor’s expense.

4. If brake lining of elevators are excessively worn or damaged during temporary use, they shall be removed and replaced by new brake lining at the contractors expense.

5. All parts of main controller, starter, relay panel, selector, etc., worn or damaged during temporary use shall be removed and replaced with new parts at the contractor’s expense, if recommended by elevator inspector after elevator is released by Contractor.

6. Place elevator in condition equal, less normal wear, to that existing at time it was placed in service of Contractor as approved by Contracting Officer.

1.15 TEMPORARY TOILETS

A. Contractor may have for use of Contractor's workmen, such toilet accommodations as may be assigned to Contractor by Medical Center. Contractor shall keep such places clean and be responsible for any

damage done thereto by Contractor's workmen. Failure to maintain satisfactory condition in toilets will deprive Contractor of the privilege to use such toilets.

1.16 AVAILABILITY AND USE OF UTILITY SERVICES

A. The Government shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The amount to be paid by the Contractor for chargeable electrical services shall be the prevailing rates charged to the Government. The Contractor shall carefully conserve any utilities furnished without charge.

B. The Contractor, at Contractor's expense and in a workmanlike manner, in compliance with code and as satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of electricity used for the purpose of determining charges. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia and repair restore the infrastructure as required.

C. Contractor shall install meters at Contractor's expense and furnish the Medical Center a monthly record of the Contractor's usage of electricity as hereinafter specified.

D. Heat: Furnish temporary heat necessary to prevent injury to work and materials through dampness and cold. Use of open salamanders or any temporary heating devices which may be fire hazards or may smoke and damage finished work, will not be permitted. Maintain minimum temperatures as specified for various materials.

E. Electricity (for Construction and Testing): Furnish all temporary electric services.

1. Obtain electricity by connecting to the Medical Center electrical distribution system. The Contractor shall meter and pay for electricity required for electric cranes and hoisting devices, electrical welding devices and any electrical heating devices providing temporary heat. Electricity for all other uses is available at no cost to the Contractor.

F. Water (for Construction and Testing): Furnish temporary water service.

1. Obtain water by connecting to the Medical Center water distribution system. Provide certified reduced pressure backflow preventer at each connection as per code. Water is available at no cost to the Contractor.

2. Maintain connections, pipe, fittings and fixtures and conserve water-use so none is wasted. Failure to stop leakage or other wastes will be cause for revocation (at Resident Engineer's of use of water from Medical Center's system.

1.17 NEW TELEPHONE EQUIPMENT

The contractor shall coordinate with the work of installation of telephone equipment by others. This work shall be completed before the building is turned over to VA.

1.18 TESTS

A. As per specification section 23 05 93 the contractor shall provide a written testing and commissioning plan complete with component level, equipment level, sub-system level and system level breakdowns. The plan will provide a schedule and a written sequence of what will be tested, how and what the expected outcome will be. This document will be submitted for approval prior to commencing work. The contractor shall document the results of the approved plan and submit for approval with the as built documentation.

B. Pre-test mechanical and electrical equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.

C. Conduct final tests required in various sections of specifications in presence of an authorized representative of the Contracting Officer. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests.

D. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire system which must be coordinated to work together during normal operation to produce results for which the system is designed. For example, air conditioning supply

air is only one part of entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam, chilled water, refrigerant, hot water, controls and electricity, etc. Another example of a system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.

E. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonably period of time during which operating and environmental conditions remain reasonably constant and are typical of the design conditions.

F. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.

1.19 INSTRUCTIONS

A. Contractor shall furnish Maintenance and Operating manuals (hard copies and electronic) and verbal instructions when required by the various sections of the specifications and as hereinafter specified.

B. Manuals: Maintenance and operating manuals and one compact disc (four hard copies and one electronic copy each) for each separate piece of equipment shall be delivered to the Resident Engineer coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals

must reference the exact model, style and size of the piece of equipment and system being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.

C. Instructions: Contractor shall provide qualified, factory-trained manufacturers' representatives to give detailed training to assigned Department of Veterans Affairs personnel in the operation and complete maintenance for each piece of equipment. All such training will be at the job site. These requirements are more specifically detailed in the various technical sections. Instructions for different items of equipment that are component parts of a complete system, shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. All instruction periods shall be at such times as scheduled by the COR and shall be considered concluded only when the COR is satisfied in regard to complete and thorough coverage. The contractor shall submit a course outline with associated material to the COR for review and approval prior to scheduling training to ensure the subject matter covers the expectations of the VA and the contractual requirements. The Department of Veterans Affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the COR, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

1.20 GOVERNMENT-FURNISHED PROPERTY

A. The Government shall deliver to the Contractor the Government-furnished property shown on the Schedule and/or drawings.

B. Equipment furnished by Government to be installed by Contractor will be furnished to Contractor at the Medical Center.

C. Contractor shall be prepared to receive this equipment from Government and store or place such equipment not less than 90 days before Completion Date of project.

D. Notify Contracting Officer in writing, 60 days in advance, of date on which Contractor will be prepared to receive equipment furnished by

Government. Arrangements will then be made by the Government for delivery of equipment.

1. Immediately upon delivery of equipment, Contractor shall arrange for a joint inspection thereof with a representative of the Government. At such time the Contractor shall acknowledge receipt of equipment described, make notations, and immediately furnish the Government representative with a written statement as to its condition or shortages.

2. Contractor thereafter is responsible for such equipment until such time as acceptance of contract work is made by the Government.

E. Equipment furnished by the Government will be delivered in a partially assembled (knock down) condition in accordance with existing standard commercial practices, complete with all fittings, fastenings, and appliances necessary for connections to respective services installed under contract. All fittings and appliances (i.e., couplings, ells, tees, nipples, piping, conduits, cables, and the like) necessary to make the connection between the Government furnished equipment item and the utility stub-up shall be furnished and installed by the contractor at no additional cost to the Government.

F. Completely assemble and install the Government furnished equipment in place ready for proper operation in accordance with specifications and drawings.

G. Furnish supervision of installation of equipment at construction site by qualified factory trained technicians regularly employed by the equipment manufacturer.

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SECTION 01 32 16.15
PROJECT SCHEDULES
(SMALL PROJECTS – DESIGN/BID/BUILD)

PART 1- GENERAL

1.1 DESCRIPTION:

A. The Contractor shall develop a Critical Path Method (CPM) plan and schedule demonstrating fulfillment of the contract requirements (Project Schedule),and shall keep the Project Schedule up-to-date in accordance with the requirements of this section and shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). Conventional Critical Path Method (CPM) technique shall be utilized to satisfy both time and cost applications.

1.2 CONTRACTOR'S REPRESENTATIVE:

A. The Contractor shall designate an authorized representative responsible for the Project Schedule including preparation, review and progress reporting with and to the Contracting Officer's Representative (COTR).

B. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the requirements of this specification section.

C. The Contractor’s representative shall have the option of developing the project schedule within their organization or to engage the services of an outside consultant. If an outside scheduling consultant is utilized, Section 1.3 of this specification will apply.

1.3 CONTRACTOR'S CONSULTANT:

A. The Contractor shall submit a qualification proposal to the COTR, within 10 days of bid acceptance. The qualification proposal shall include:

1. The name and address of the proposed consultant.
2. Information to show that the proposed consultant has the qualifications to meet the requirements specified in the preceding paragraph.
3. A representative sample of prior construction projects, which the proposed consultant has performed complete project scheduling services. These representative samples shall be of similar size and scope.

B. The Contracting Officer has the right to approve or disapprove the proposed consultant, and will notify the Contractor of the VA decision within seven calendar days from receipt of the qualification proposal. In case of disapproval, the Contractor shall resubmit another consultant within 10 calendar days for renewed consideration. The Contractor shall have their scheduling consultant approved prior to submitting any schedule for approval.

1.4 COMPUTER PRODUCED SCHEDULES

A. The contractor shall provide monthly, to the Department of Veterans Affairs (VA), all computer-produced time/cost schedules and reports generated from monthly project updates. This monthly computer service will include: three copies of up to five different reports (inclusive of all pages) available within the user defined reports of the scheduling software approved by the Contracting Officer; a hard copy listing of all project schedule changes, and associated data, made at the update and an electronic file of this data; and the resulting monthly updated schedule in PDM format. These must be submitted with and substantively support the contractor’s monthly payment request and the signed look ahead report. The COTR shall identify the five different report formats that the contractor shall provide.

B. The contractor shall be responsible for the correctness and timeliness of the computer-produced reports. The Contractor shall also responsible for the accurate and timely submittal of the updated project schedule and all CPM data necessary to produce the computer reports and payment request that is specified.

C. The VA will report errors in computer-produced reports to the Contractor’s representative within ten calendar days from receipt of reports. The Contractor shall reprocess the computer-produced reports and associated diskette(s), when requested by the Contracting Officer’s representative, to correct errors which affect the payment and schedule for the project.

1.5 THE COMPLETE PROJECT SCHEDULE SUBMITTAL

A. Within 45 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the interim schedule on sheets of paper 765 x 1070 mm (30 x 42 inches) and an electronic file in the previously approved CPM schedule program. The submittal shall also include three copies of a computer-produced activity/event ID schedule showing project

duration; phase completion dates; and other data, including event cost. Each activity/event on the computer-produced schedule shall contain as a minimum, but not limited to, activity/event ID, activity/event description, duration, budget amount, early start date, early finish date, late start date, late finish date and total float. Work activity/event relationships shall be restricted to finish-to-start or start-to-start without lead or lag constraints. Activity/event date constraints, not required by the contract, will not be accepted unless submitted to and approved by the Contracting Officer. The contractor shall make a separate written detailed request to the Contracting Officer identifying these date constraints and secure the Contracting Officer’s written approval before incorporating them into the network diagram. The Contracting Officer’s separate approval of the Project Schedule shall not excuse the contractor of this requirement. Logic events (non-work) will be permitted where necessary to reflect proper logic among work events, but must have zero duration. The complete working schedule shall reflect the Contractor's approach to scheduling the complete project. **The final Project Schedule in its original form shall contain no contract changes or delays which may have been incurred during the final network diagram development period and shall reflect the entire contract duration as defined in the bid documents.** These changes/delays shall be entered at the first update after the final Project Schedule has been approved. The Contractor should provide their requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

B. Within 30 calendar days after receipt of the complete project interim Project Schedule and the complete final Project Schedule, the Contracting Officer or his representative, will do one or both of the following:
   1. Notify the Contractor concerning his actions, opinions, and objections.
   2. A meeting with the Contractor at or near the job site for joint review, correction or adjustment of the proposed plan will be scheduled if required. Within 14 calendar days after the joint review, the Contractor shall revise and shall submit three blue line copies of the revised Project Schedule, three copies of the revised

computer-produced activity/event ID schedule and a revised electronic file as specified by the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.

C. The approved baseline schedule and the computer-produced schedule(s) generated there from shall constitute the approved baseline schedule until subsequently revised in accordance with the requirements of this section.

D. The Complete Project Schedule shall contain approximately _____work activities/events.

1.6 WORK ACTIVITY/EVENT COST DATA

A. The Contractor shall cost load all work activities/events except procurement activities. The cumulative amount of all cost loaded work activities/events (including alternates) shall equal the total contract price. Prorate overhead, profit and general conditions on all work activities/events for the entire project length. The contractor shall generate from this information cash flow curves indicating graphically the total percentage of work activity/event dollar value scheduled to be in place on early finish, late finish. These cash flow curves will be used by the Contracting Officer to assist him in determining approval or disapproval of the cost loading. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.

B. The Contractor shall cost load work activities/events for guarantee period services, test, balance and adjust various systems in accordance with the provisions in Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.232 –Article 70 Without NAS-CPM for (PAYMENTS UNDER FIXED PRICE CONSTRUCTION).

C. In accordance with FAR 52.236 – 1 (PERFORMANCE OF WORK BY THE CONTRACTOR) and VAAR 852.236 – 72 (PERFORMANCE OF WORK BY THE CONTRACTOR), the Contractor shall submit, simultaneously with the cost per work activity/event of the construction schedule required by this Section, a responsibility code for all activities/events of the project for which the Contractor's forces will perform the work.

D. The Contractor shall cost load work activities/events for all BID ITEMS including ASBESTOS ABATEMENT. The sum of each BID ITEM work shall equal the value of the bid item in the Contractors' bid.

1.7 PROJECT SCHEDULE REQUIREMENTS

A. Show on the project schedule the sequence of work activities/events required for complete performance of all items of work. The Contractor Shall:

1. Show activities/events as:
   a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
   b. Contracting Officer's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.
   c. Interruption of VA Facilities utilities, delivery of Government furnished equipment, and rough-in drawings, project phasing and any other specification requirements.
   d. Test, balance and adjust various systems and pieces of equipment, maintenance and operation manuals, instructions and preventive maintenance tasks.
   e. VA inspection and acceptance activity/event with a minimum duration of five work days at the end of each phase and immediately preceding any VA move activity/event required by the contract phasing for that phase.
2. Show not only the activities/events for actual construction work for each trade category of the project, but also trade relationships to indicate the movement of trades from one area, floor, or building, to another area, floor, or building, for at least five trades who are performing major work under this contract.
3. Break up the work into activities/events of a duration no longer than 20 work days each or one reporting period, except as to non-construction activities/events (i.e., procurement of materials, delivery of equipment, concrete and asphalt curing) and any other activities/events for which the COTR may approve the showing of a longer duration. The duration for VA approval of any required submittal, shop drawing, or other submittals will not be less than 20 work days.
4. Describe work activities/events clearly, so the work is readily identifiable for assessment of completion. Activities/events labeled "start," "continue," or "completion," are not specific and will not be allowed. Lead and lag time activities will not be acceptable.

5. The schedule shall be generally numbered in such a way to reflect either discipline, phase or location of the work.

B. The Contractor shall submit the following supporting data in addition to the project schedule:

1. The appropriate project calendar including working days and holidays.
2. The planned number of shifts per day.
3. The number of hours per shift.

Failure of the Contractor to include this data shall delay the review of the submittal until the Contracting Officer is in receipt of the missing data.

C. To the extent that the Project Schedule or any revised Project Schedule shows anything not jointly agreed upon, it shall not be deemed to have been approved by the COTR. Failure to include any element of work required for the performance of this contract shall not excuse the Contractor from completing all work required within any applicable completion date of each phase regardless of the COTR’s approval of the Project Schedule.

D. Compact Disk Requirements and CPM Activity/Event Record Specifications: Submit to the VA an electronic file(s) containing one file of the data required to produce a schedule, reflecting all the activities/events of the complete project schedule being submitted.

1.8 PAYMENT TO THE CONTRACTOR:

A. Monthly, the contractor shall submit an application and certificate for payment using VA Form 10-6001a reflecting updated schedule activities and cost data in accordance with the provisions of the following Article, PAYMENT AND PROGRESS REPORTING, as the basis upon which progress payments will be made pursuant to Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.232 – Article 70 Without NAS-CPM for (PAYMENTS UNDER FIXED PRICE CONSTRUCTION). The Contractor shall be entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated project schedule. Monthly payment requests shall include: a listing of all agreed upon project schedule changes and associated data; and an electronic file (s) of the resulting monthly updated schedule.

B. Approval of the Contractor’s monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly update of the project schedule.

1.9 PAYMENT AND PROGRESS REPORTING

A. Monthly schedule update meetings will be held on dates mutually agreed to by the COTR and the Contractor. Contractor and their CPM consultant (if applicable) shall attend all monthly schedule update meetings. The Contractor shall accurately update the Project Schedule and all other data required and provide this information to the COTR three work days in advance of the schedule update meeting. Job progress will be reviewed to verify:

1. Actual start and/or finish dates for updated/completed activities/events.
2. Remaining duration for each activity/event started, or scheduled to start, but not completed.
3. Logic, time and cost data for change orders, and supplemental agreements that are to be incorporated into the Project Schedule.
4. Changes in activity/event sequence and/or duration which have been made, pursuant to the provisions of following Article, ADJUSTMENT OF CONTRACT COMPLETION.
5. Completion percentage for all completed and partially completed activities/events.
6. Logic and duration revisions required by this section of the specifications.
7. Activity/event duration and percent complete shall be updated independently.

B. After completion of the joint review, the contractor shall generate an updated computer-produced calendar-dated schedule and supply the Contracting Officer’s representative with reports in accordance with the Article, COMPUTER PRODUCED SCHEDULES, specified.

C. After completing the monthly schedule update, the contractor’s representative or scheduling consultant shall rerun all current period contract change(s) against the prior approved monthly project schedule. The analysis shall only include original workday durations and schedule logic agreed upon by the contractor and resident engineer for the contract change(s). When there is a disagreement on logic and/or durations, the Contractor shall use the schedule logic and/or durations provided and approved by the resident engineer. After each rerun

update, the resulting electronic project schedule data file shall be appropriately identified and submitted to the VA in accordance to the requirements listed in articles 1.4 and 1.7. This electronic submission is separate from the regular monthly project schedule update requirements and shall be submitted to the resident engineer within fourteen (14) calendar days of completing the regular schedule update. **Before inserting the contract changes durations, care must be taken to ensure that only the original durations will be used for the analysis, not the reported durations after progress. In addition, once the final network diagram is approved, the contractor must recreate all manual progress payment updates on this approved network diagram and associated reruns for contract changes in each of these update periods as outlined above for regular update periods. This will require detailed record keeping for each of the manual progress payment updates.**

D. Following approval of the CPM schedule, the VA, the General Contractor, its approved CPM Consultant, RE office representatives, and all subcontractors needed, as determined by the SRE, shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any necessary actions required to maintain project schedule during the reporting period. The Government representatives and the Contractor should conclude the meeting with a clear understanding of those work and administrative actions necessary to maintain project schedule status during the reporting period. This schedule coordination meeting will occur after each monthly project schedule update meeting utilizing the resulting schedule reports from that schedule update. If the project is behind schedule, discussions should include ways to prevent further slippage as well as ways to improve the project schedule status, when appropriate.

1.10 RESPONSIBILITY FOR COMPLETION

A. If it becomes apparent from the current revised monthly progress schedule that phasing or contract completion dates will not be met, the Contractor shall execute some or all of the following remedial actions:

1. Increase construction manpower in such quantities and crafts as necessary to eliminate the backlog of work.

2. Increase the number of working hours per shift, shifts per working day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the backlog of work.
3. Reschedule the work in conformance with the specification requirements.

B. Prior to proceeding with any of the above actions, the Contractor shall notify and obtain approval from the COTR for the proposed schedule changes. If such actions are approved, the representative schedule revisions shall be incorporated by the Contractor into the Project Schedule before the next update, at no additional cost to the Government.

1.11 CHANGES TO THE SCHEDULE

A. Within 30 calendar days after VA acceptance and approval of any updated project schedule, the Contractor shall submit a revised electronic file (s) and a list of any activity/event changes including predecessors and successors for any of the following reasons:
   1. Delay in completion of any activity/event or group of activities/events, which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the CPM as the direct cause for delaying the project beyond the acceptable limits.
   2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
   3. The schedule does not represent the actual prosecution and progress of the project.
   4. When there is, or has been, a substantial revision to the activity/event costs regardless of the cause for these revisions.

B. CPM revisions made under this paragraph which affect the previously approved computer-produced schedules for Government furnished equipment, vacating of areas by the VA Facility, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, shall be furnished in writing to the Contracting Officer for approval.

C. Contracting Officer's approval for the revised project schedule and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the VA representative.

D. The cost of revisions to the project schedule resulting from contract changes will be included in the proposal for changes in work as specified in FAR 52.243 – 4 (Changes,and will be based on the complexity of the revision or contract change, man hours expended in analyzing the change, and the total cost of the change.

E. The cost of revisions to the Project Schedule not resulting from contract changes is the responsibility of the Contractor.

1.12 ADJUSTMENT OF CONTRACT COMPLETION

A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, CPM data and supporting evidence as the COTR may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals. The schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved in this request. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced calendar-dated schedule for the time period in question and all other relevant information.

B. Actual delays in activities/events which, according to the computer- produced calendar-dated schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network, will not be the basis for a change to the contract completion date. The Contracting Officer will within a reasonable time after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing of the Contracting Officer's decision.

C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under FAR 52.243 – 4 (Changes). The Contractor shall include, as a part of each change order proposal, a sketch showing all CPM logic revisions, duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.

D. All delays due to non-work activities/events such as RFI’s, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

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SECTION 01 33 23

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. This specification defines the general requirements and procedures for submittals. A submittal is information submitted for VA review to establish compliance with the contract documents.

B. Detailed submittal requirements are found in the technical sections of the contract specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective technical specifications at no additional cost to the government.

C. VA approval of a submittal does not relieve the Contractor of the responsibility for any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor’s expense.

1.2 DEFINITIONS

A. Preconstruction Submittals: Submittals which are required prior to issuing contract notice to proceed or starting construction. For example, Certificates of insurance; Surety bonds; Site-specific safety plan; Construction progress schedule; Schedule of values; Submittal register; List of proposed subcontractors.

B. Shop Drawings: Drawings, diagrams, and schedules specifically prepared to illustrate some portion of the work. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be integrated and coordinated.

C. Product Data: Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions, and brochures, which describe and illustrate size, physical appearance, and other characteristics of materials, systems, or equipment for some portion of the work. Samples of warranty language when the contract requires extended product warranties.

D. Samples: Physical examples of materials, equipment, or workmanship that illustrate functional and aesthetic characteristics of a material or

product and establish standards by which the work can be judged. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project. Field samples and mock-ups constructed to establish standards by which the ensuing work can be judged.

E. Design Data: Calculations, mix designs, analyses, or other data pertaining to a part of work.

F. Test Reports: Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work. Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

G. Certificates: Document required of Contractor, or of a manufacturer, supplier, installer, or subcontractor through Contractor. The purpose is to document procedures, acceptability of methods, or personnel qualifications for a portion of the work.

H. Manufacturer's Instructions: Pre-printed material describing installation of a product, system, or material, including special notices and MSDS concerning impedances, hazards, and safety precautions.

I. Manufacturer's Field Reports: Documentation of the testing and verification actions taken by manufacturer's representative at the job site on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must indicate whether the material, product, or system has passed or failed the test.

J. Operation and Maintenance Data: Manufacturer data that is required to operate, maintain, troubleshoot, and repair equipment, including manufacturer's help, parts list, and product line documentation. This data shall be incorporated in an operations and maintenance manual.

K. Closeout Submittals: Documentation necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a phase of construction on a multi-phase contract.

1.3 SUBMITTAL REGISTER

A. The submittal register will list items of equipment and materials for which submittals are required by the specifications. This list may not be all inclusive and additional submittals may be required by the specifications. The Contractor is not relieved from supplying

submittals required by the contract documents but which have been omitted from the submittal register.

B. The submittal register will serve as a scheduling document for submittals and will be used to control submittal actions throughout the contract period.

C. The VA will provide the initial submittal register in electronic format. Thereafter, the Contractor shall track all submittals by maintaining a complete list, including completion of all data columns, including dates on which submittals are received and returned by the VA.

D. The Contractor shall update the submittal register as submittal actions occur and maintain the submittal register at the project site until final acceptance of all work by Contracting Officer.

E. The Contractor shall submit formal monthly updates to the submittal register in electronic format. Each monthly update shall document actual submission and approval dates for each submittal.

1.4 SUBMITTAL SCHEDULING

A. Submittals are to be scheduled, submitted, reviewed, and approved prior to the acquisition of the material or equipment.

B. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow time for potential resubmittal.

C. No delay costs or time extensions will be allowed for time lost in late submittals or resubmittals.

D. All submittals are required to be approved prior to the start of the specified work activity.

1.5 SUBMITTAL PREPARATION

A. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

B. Collect required data for each specific material, product, unit of work, or system into a single submittal. Prominently mark choices, options, and portions applicable to the submittal. Partial submittals will not be accepted for expedition of construction effort. Submittal will be returned without review if incomplete.

C. If available product data is incomplete, provide Contractor-prepared documentation to supplement product data and satisfy submittal requirements.

D. All irrelevant or unnecessary data shall be removed from the submittal to facilitate accuracy and timely processing. Submittals that contain the excessive amount of irrelevant or unnecessary data will be returned with review.

E. Provide a transmittal form for each submittal with the following information:
   1. Project title, location and number.
   2. Construction contract number.
   3. Date of the drawings and revisions.
   4. Name, address, and telephone number of subcontractor, supplier, manufacturer, and any other subcontractor associated with the submittal.
   5. List paragraph number of the specification section and sheet number of the contract drawings by which the submittal is required.
   6. When a resubmission, add alphabetic suffix on submittal description. For example, submittal 18 would become 18A, to indicate resubmission.
   7. Product identification and location in project.

F. The Contractor is responsible for reviewing and certifying that all submittals are in compliance with contract requirements before submitting for VA review. Proposed deviations from the contract requirements are to be clearly identified. All deviations submitted must include a side by side comparison of item being proposed against item specified. Failure to point out deviations will result in the VA requiring removal and replacement of such work at the Contractor's expense.

G. Stamp, sign, and date each submittal transmittal form indicating action taken.

H. Stamp used by the Contractor on the submittal transmittal form to certify that the submittal meets contract requirements is to be similar to the following:

CONTRACTOR (Firm Name)
_____Approved
_____Approved with corrections as noted on submittal data and/or attached sheets(s)
SIGNATURE: _____
TITLE: _____
DATE: _____

1.6 SUBMITTAL FORMAT AND TRANSMISSION

A. Provide submittals in electronic format, with the exception of material samples. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer.

B. Compile the electronic submittal file as a single, complete document. Name the electronic submittal file specifically according to its contents.

C. Electronic files must be of sufficient quality that all information is legible. Generate PDF files from original documents so that the text included in the PDF file is both searchable and can be copied. If documents are scanned, Optical Character Resolution (OCR) routines are required.

D. E-mail electronic submittal documents smaller than 5MB in size to e-mail addresses as directed by the Contracting Officer.

E. Provide electronic documents over 5MB through an electronic FTP file sharing system. Confirm that the electronic FTP file sharing system can be accessed from the VA computer network. The Contractor is responsible for setting up, providing, and maintaining the electronic FTP file sharing system for the construction contract period of performance.

F. Provide hard copies of submittals when requested by the Contracting Officer. Up to 3 additional hard copies of any submittal may be

requested at the discretion of the Contracting Officer, at no additional cost to the VA.

1.7 SAMPLES

A. Submit two sets of physical samples showing range of variation, for each required item.

B. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified.

C. When color, texture, or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

D. Before submitting samples, the Contractor is to ensure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

E. The VA reserves the right to disapprove any material or equipment which previously has proven unsatisfactory in service.

F. Physical samples supplied maybe requested back for use in the project after reviewed and approved.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.

B. In the event the Contractor fails to deliver O&M Data within the time limits specified, the Contracting Officer may withhold from progress payments 50 percent of the price of the item with which such O&M Data are applicable.

1.9 TEST REPORTS

SRE may require specific test after work has been installed or completed which could require contractor to repair test area at no additional cost to contract.

1.10 VA REVIEW OF SUBMITTALS AND RFIS

A. The VA will review all submittals for compliance with the technical requirements of the contract documents. The Architect-Engineer for this project will assist the VA in reviewing all submittals and determining contractual compliance. Review will be only for conformance with the applicable codes, standards and contract requirements.

B. Period of review for submittals begins when the VA COR receives submittal from the Contractor.

C. Period of review for each resubmittal is the same as for initial submittal.

D. VA review period is 15 working days for submittals.

E. VA review period is 10 working days for RFIs.

F. The VA will return submittals to the Contractor with the following notations:

1. "Approved": authorizes the Contractor to proceed with the work covered.
2. "Approved as noted": authorizes the Contractor to proceed with the work covered provided the Contractor incorporates the noted comments and makes the noted corrections.
3. "Disapproved, revise and resubmit": indicates noncompliance with the contract requirements or that submittal is incomplete. Resubmit with appropriate changes and corrections. No work shall proceed for this item until resubmittal is approved.
4. "Not reviewed": indicates submittal does not have evidence of being reviewed and approved by Contractor or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals after taking appropriate action.

1.11 APPROVED SUBMITTALS

A. The VA approval of submittals is not to be construed as a complete check, and indicates only that the general method of construction, materials, detailing, and other information are satisfactory.

B. VA approval of a submittal does not relieve the Contractor of the responsibility for any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor’s expense.

C. After submittals have been approved, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

D. Retain a copy of all approved submittals at project site, including approved samples.

1.12 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

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SECTION 01 35 26
SAFETY REQUIREMENTS

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SAFETY REQUIREMENTS

1.1 APPLICABLE PUBLICATIONS:

A. Latest publications listed below form part of this Article to extent referenced. Publications are referenced in text by basic designations only.

B. American Society of Safety Engineers (ASSE):

A10.1-2011.....Pre-Project & Pre-Task Safety and Health Planning

A10.34-2012.....Protection of the Public on or Adjacent to Construction Sites

A10.38-2013.....Basic Elements of an Employer’s Program to Provide a Safe and Healthful Work Environment American National Standard Construction and Demolition Operations

C. American Society for Testing and Materials (ASTM):

E84-2013.....Surface Burning Characteristics of Building Materials

D. The Facilities Guidelines Institute (FGI):

FGI Guidelines-2010Guidelines for Design and Construction of Healthcare Facilities

E. National Fire Protection Association (NFPA):

10-2013.....Standard for Portable Fire Extinguishers

30-2012.....Flammable and Combustible Liquids Code

51B-2014.....Standard for Fire Prevention During Welding, Cutting and Other Hot Work

70-2014.....National Electrical Code

70B-2013.....Recommended Practice for Electrical Equipment Maintenance

70E-2012 .....Standard for Electrical Safety in the Workplace

99-2012.....Health Care Facilities Code

241-2013.....Standard for Safeguarding Construction, Alteration, and Demolition Operations

F. The Joint Commission (TJC)

TJC Manual .....Comprehensive Accreditation and Certification Manual

G. U.S. Nuclear Regulatory Commission

10 CFR 20 .....Standards for Protection Against Radiation

H. U.S. Occupational Safety and Health Administration (OSHA):

29 CFR 1904 .....Reporting and Recording Injuries & Illnesses

29 CFR 1910 .....Safety and Health Regulations for General Industry

29 CFR 1926 .....Safety and Health Regulations for Construction Industry

CPL 2-0.124.....Multi-Employer Citation Policy

I. VHA Directive 2005-007

1.2 DEFINITIONS:

A. OSHA “Competent Person” (CP). One who is capable of identifying existing and predictable hazards in the surroundings and working conditions which are unsanitary, hazardous or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them (see 29 CFR 1926.32(f)).

B. "Qualified Person" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

C. High Visibility Accident. Any mishap which may generate publicity or high visibility.

D. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a

physician. Medical treatment does not include first aid treatment even through provided by a physician or registered personnel.

E. Recordable Injuries or Illnesses. Any work-related injury or illness that results in:

1. Death, regardless of the time between the injury and death, or the length of the illness;

2. Days away from work (any time lost after day of injury/illness onset);

3. Restricted work;

4. Transfer to another job;

5. Medical treatment beyond first aid;

6. Loss of consciousness; or

7. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (6) above.

1.3 REGULATORY REQUIREMENTS:

A. In addition to the detailed requirements included in the provisions of this contract, comply with 29 CFR 1926, comply with 29 CFR 1910 as incorporated by reference within 29 CFR 1926, comply with ASSE A10.34, and all applicable [federal, state, and local] laws, ordinances, criteria, rules and regulations. Submit matters of interpretation of standards for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern except with specific approval and acceptance by the COR.

1.4 ACCIDENT PREVENTION PLAN (APP):

A. The APP (aka Construction Safety & Health Plan) shall interface with the Contractor's overall safety and health program. Include any portions of the Contractor's overall safety and health program referenced in the APP in the applicable APP element and ensure it is site-specific. The Government considers the Prime Contractor to be the "controlling authority" for all worksite safety and health of each

subcontractor(s). Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out.

B. The APP shall be prepared as follows:

1. Written in English by a qualified person who is employed by the Prime Contractor articulating the specific work and hazards pertaining to the contract (model language can be found in ASSE A10.33). Specifically articulating the safety requirements found within these VA contract safety specifications.

2. Address both the Prime Contractors and the subcontractors work operations.

3. State measures to be taken to control hazards associated with materials, services, or equipment provided by suppliers.

4. Address all the elements/sub-elements and in order as follows:

   a. **SIGNATURE SHEET.** Title, signature, and phone number of the following:

      1) Plan preparer (Qualified Person such as corporate safety staff person or contracted Certified Safety Professional with construction safety experience);

      2) Plan approver (company/corporate officers authorized to obligate the company);

      3) Plan concurrence (e.g., Chief of Operations, Corporate Chief of Safety, Corporate Industrial Hygienist, project manager or superintendent, project safety professional). Provide concurrence of other applicable corporate and project personnel (Contractor).

   b. **BACKGROUND INFORMATION**. List the following:

      1) Contractor

      2) Contract number

3) Project name

4) Brief project description, description of work to be performed, and location; phases of work anticipated (these will require an AHA).

c. STATEMENT OF SAFETY AND HEALTH POLICY. Provide a copy of current corporate/company Safety and Health Policy Statement, detailing commitment to providing a safe and healthful workplace for all employees. The Contractor's written safety program goals, objectives, and accident experience goals for this contract should be provided.

d. **RESPONSIBILITIES AND LINES OF AUTHORITIES**. Provide the following:

1) A statement of the employer's ultimate responsibility for the implementation of his SOH program

2) Identification and accountability of personnel responsible for safety at both corporate and project level. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes.

3) The names of Competent and/or Qualified Person(s) and proof of competency/qualification to meet specific OSHA Competent/Qualified Person(s) requirements must be attached.

4) Requirements that no work shall be performed unless a designated competent person is present on the job site

5) Requirements for pre-task Activity Hazard Analysis (AHAs)

6) Lines of authority

7) Policies and procedures regarding noncompliance with safety requirements (to include disciplinary actions for violation of safety requirements) should be identified

e. SUBCONTRACTORS AND SUPPLIERS. If applicable, provide procedures for coordinating SOH activities with other employers on the job site:

1) Identification of subcontractors and suppliers (if known)

2) Safety responsibilities of subcontractors and suppliers.

f. **TRAINING.**

1) Site-specific SOH orientation training at the time of initial hire or assignment to the project for every employee before working on the project site is required.

2) Mandatory training and certifications that are applicable to this project (e.g., explosive actuated tools, crane operator, rigger, crane signal person, fall protection, electrical lockout/NFPA 70E, machine/equipment lockout, confined space, etc…) and any requirements for periodic retraining/recertification are required.

3) Procedures for ongoing safety and health training for supervisors and employees shall be established to address changes in site hazards/conditions.

4) OSHA 10-hour training is required for all workers on site and the OSHA 30-hour training is required for Trade Competent Persons (CPs)

g. SAFETY AND HEALTH INSPECTIONS.

1) Specific assignment of responsibilities for a minimum daily job site safety and health inspection during periods of work activity: Who will conduct (e.g., “Site Safety and Health CP”), proof of inspector’s training/qualifications, when inspections will be conducted, procedures for documentation, deficiency tracking system, and follow-up procedures.

2) Any external inspections/certifications that may be required (e.g., contracted CSP or CSHT)

h. ACCIDENT INVESTIGATION & REPORTING. The Contractor shall conduct mishap investigations of all OSHA Recordable Incidents. The APP shall include accident/incident investigation procedure & identify person(s) responsible to provide the following to the COR:

1) Exposure data (man-hours worked)

2) Accident investigations, reports, and logs.

i. **PLANS (PROGRAMS, PROCEDURES) REQUIRED.** Based on a risk assessment of contracted activities and on mandatory OSHA compliance programs, the Contractor shall address all applicable occupational risks in site-specific compliance and accident prevention plans. These Plans shall include but are not to be limited to procedures for addressing the risks associates with the following:

1) Emergency response

2) Contingency for severe weather

3) Fire Prevention

4) Medical Support

5) Posting of emergency telephone numbers

6) Prevention of alcohol and drug abuse

7) Site sanitation (housekeeping, drinking water, toilets)

8) Night operations and lighting

9) Hazard communication program

10) Welding/Cutting “Hot” work

11) Electrical Safe Work Practices (Electrical LOTO/NFPA 70E)

12) General Electrical Safety

13) Hazardous energy control (Machine LOTO)

14) Site-Specific Fall Protection & Prevention

15) Excavation/trenching

16) Asbestos abatement

17) Lead abatement

18) Crane Critical lift

19) Respiratory protection

20) Health hazard control program

21) Radiation Safety Program

22) Abrasive blasting

23) Heat/Cold Stress Monitoring

24) Crystalline Silica Monitoring (Assessment)

25) Demolition plan (to include engineering survey

26) Formwork and shoring erection and removal

27) PreCast Concrete

C. Submit the APP to the COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.

D. Once accepted by the COR, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified.

E. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the COR. Should any severe hazard exposure, i.e. imminent danger, become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ASSE/SAFE A10.34) and the environment.

1.5 ACTIVITY HAZARD ANALYSES (AHAS):

A. AHAs are also known as Job Hazard Analyses, Job Safety Analyses, and Activity Safety Analyses. Before beginning each work activity involving a type of work presenting hazards not experienced in previous project operations or where a new work crew or sub-contractor is to perform the work, the Contractor(s) performing that work activity shall prepare an AHA (Example electronic AHA forms can be found on the US Army Corps of Engineers web site)

B. AHAs shall define the activities being performed and identify the work sequences, the specific anticipated hazards, site conditions, equipment, materials, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk.

C. Work shall not begin until the AHA for the work activity has been accepted by the COR and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.

1. The names of the Competent/Qualified Person(s) required for a particular activity (for example, excavations, scaffolding, fall protection, other activities as specified by OSHA and/or other State and Local agencies) shall be identified and included in the AHA. Certification of their competency/qualification shall be submitted to the Government Designated Authority (GDA) for acceptance prior to the start of that work activity.

2. The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person(s).

   a. If more than one Competent/Qualified Person is used on the AHA activity, a list of names shall be submitted as an attachment to the AHA. Those listed must be Competent/Qualified for the type of work involved in the AHA and familiar with current site safety issues.

   b. If a new Competent/Qualified Person (not on the original list) is added, the list shall be updated (an administrative action not requiring an updated AHA). The new person shall acknowledge in writing that he or she has reviewed the AHA and is familiar with current site safety issues.

3. Submit AHAs to the COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES for review at least 15 calendar days prior to the start of each phase. Subsequent AHAs as shall be formatted as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.

4. The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.

5. Develop the activity hazard analyses using the project schedule as the basis for the activities performed. All activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier, or subcontractor and provided to the prime contractor for review and approval and then submitted to the COR.

1.6 PRECONSTRUCTION CONFERENCE:

A. Contractor representatives who have a responsibility or significant role in implementation of the accident prevention program, as required by 29 CFR 1926.20(b)(1), on the project shall attend the preconstruction conference to gain a mutual understanding of its implementation. This includes the project superintendent, subcontractor superintendents, and any other assigned safety and health professionals.

B. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, review, and acceptance of AHAs to preclude project delays.

C. Deficiencies in the submitted APP will be brought to the attention of the Contractor within 14 days of submittal, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Do not begin work until there is an accepted APP.

1.7 “SITE SAFETY AND HEALTH OFFICER” (SSHO) AND “COMPETENT PERSON” (CP):

A. The Prime Contractor shall designate a minimum of one SSHO at each project site that will be identified as the SSHO to administer the Contractor's safety program and government-accepted Accident Prevention Plan. Each subcontractor shall designate a minimum of one CP in compliance with 29 CFR 1926.20 (b)(2) that will be identified as a CP to administer their individual safety programs.

B. Further, all specialized Competent Persons for the work crews will be supplied by the respective contractor as required by 29 CFR 1926 (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations).

C. These Competent Persons can have collateral duties as the subcontractor's superintendent and/or work crew lead persons as well as fill more than one specialized CP role (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations).

D. The SSHO or an equally-qualified Designated Representative/alternate will maintain a presence on the site during construction operations in accordance with FAR Clause 52.236-6: *Superintendence by the Contractor*. CPs will maintain presence during their construction activities in accordance with above mentioned clause. A listing of the designated SSHO and all known CPs shall be submitted prior to the start of work as part of the APP with the training documentation and/or AHA as listed in Section 1.8 below.

E. The repeated presence of uncontrolled hazards during a contractor's work operations will result in the designated CP as being deemed incompetent and result in the required removal of the employee in accordance with FAR Clause 52.236-5: Material and Workmanship, Paragraph (c).

1.8 TRAINING:

A. The designated Prime Contractor SSHO must meet the requirements of all applicable OSHA standards and be capable (through training, experience, and qualifications) of ensuring that the requirements of 29 CFR 1926.16 and other appropriate Federal, State and local requirements are met for the project. As a minimum the SSHO must have completed the OSHA 30-hour Construction Safety class and have five (5) years of construction industry safety experience or three (3) years if he/she possesses a Certified Safety Professional (CSP) or certified Construction Safety and Health Technician (CSHT) certification or have a safety and health degree from an accredited university or college.

B. All designated CPs shall have completed the OSHA 30-hour Construction Safety course within the past 5 years.

C. In addition to the OSHA 30 Hour Construction Safety Course, all CPs with high hazard work operations such as operations involving asbestos, electrical, cranes, demolition, work at heights/fall protection, fire safety/life safety, ladder, rigging, scaffolds, and trenches/excavations shall have a specialized formal course in the hazard recognition & control associated with those high hazard work operations. Documented “repeat” deficiencies in the execution of safety requirements will require retaking the requisite formal course.

D. All other construction workers shall have the OSHA 10-hour Construction Safety Outreach course and any necessary safety training to be able to identify hazards within their work environment.

E. Submit training records associated with the above training requirements to the COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance.

F. Prior to any worker for the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the SSHO or his/her designated representative. As a minimum, this briefing shall include information on the site-specific hazards, construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, emergency procedures, accident reporting etc... Documentation shall be provided to the Resident Engineer that individuals have undergone contractor’s safety briefing.

G. Ongoing safety training will be accomplished in the form of weekly documented safety meeting.

1.9 INSPECTIONS:

A. The SSHO shall conduct frequent and regular safety inspections (daily) of the site and each of the subcontractors CPs shall conduct frequent and regular safety inspections (daily) of the their work operations as required by 29 CFR 1926.20(b)(2). Each week, the SSHO shall conduct a formal documented inspection of the entire construction areas with the subcontractors’ “Trade Safety and Health CPs” present in their work areas. Coordinate with, and report findings and corrective actions weekly to COR.

B. A Certified Safety Professional (CSP) with specialized knowledge in construction safety or a certified Construction Safety and Health Technician (CSHT) shall randomly conduct a monthly site safety inspection. The CSP or CSHT can be a corporate safety professional or independently contracted. The CSP or CSHT will provide their certificate number on the required report for verification as necessary.

1. Results of the inspection will be documented with tracking of the identified hazards to abatement.

2. The COR will be notified immediately prior to start of the inspection and invited to accompany the inspection.

3. Identified hazard and controls will be discussed to come to a mutual understanding to ensure abatement and prevent future reoccurrence.

4. A report of the inspection findings with status of abatement will be provided to the COR within one week of the onsite inspection.

1.10 ACCIDENTS, OSHA 300 LOGS, AND MAN-HOURS:

A. Notify the COR as soon as practical, but no more than four hours after any accident meeting the definition of OSHA Recordable Injuries or Illnesses or High Visibility Accidents, property damage equal to or greater than $5,000, or any weight handling equipment accident. Within notification include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the COR determine whether a government investigation will be conducted.

B. Conduct an accident investigation for recordable injuries and illnesses, for Medical Treatment defined in paragraph DEFINITIONS, and property damage accidents resulting in at least $20,000 in damages, to establish the root cause(s) of the accident. Complete the VA Form 2162, and provide the report to the COR will provide copies of any required or special forms.

C. A summation of all man-hours worked by the contractor and associated sub-contractors for each month will be reported to the COR monthly.

D. A summation of all OSHA recordable accidents experienced on site by the contractor and associated sub-contractors for each month will be provided to the COR monthly. The contractor and associated sub-contractors' OSHA 300 logs will be made available to the COR as requested.

1.11 PERSONAL PROTECTIVE EQUIPMENT (PPE):

A. PPE is governed in all areas by the nature of the work the employee is performing. For example, specific PPE required for performing work on electrical equipment is identified in NFPA 70E, Standard for Electrical Safety in the Workplace.

B. Mandatory PPE includes:

1. Hard Hats – unless written authorization is given by the COR in circumstances of work operations that have limited potential for falling object hazards such as during finishing work or minor remodeling. With authorization to relax the requirement of hard hats, if a worker becomes exposed to an overhead falling object hazard, then hard hats would be required in accordance with the OSHA regulations.

2. Safety glasses - unless written authorization is given by the COR appropriate safety glasses meeting the ANSI Z.87.1 standard must be worn by each person on site.

3. Appropriate Safety Shoes – based on the hazards present, safety shoes meeting the requirements of ASTM F2413-11 shall be worn by each person on site unless written authorization is given by the COR.

4. Hearing protection - Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks.

5. Face Masks – minimum 3-ply cloth or N-95 face masks must be worn by all contractor employees at all times while inside the hospital.

6. Covid-19 Vaccine - All contractor employees working inside the hospital shall have proof of Covid 19 vaccinations.

1.12 INFECTION CONTROL

A. Infection Control is critical in all medical center facilities. Interior construction activities causing disturbance of existing dust, or creating new dust, must be conducted within ventilation-controlled areas that minimize the flow of airborne particles into patient areas. Exterior construction activities causing disturbance of soil or creates dust in some other manner must be controlled.

B. An AHA associated with infection control will be performed by VA personnel in accordance with FGI Guidelines (i.e. Infection Control Risk Assessment (ICRA)). The ICRA procedure found on the American Society for Healthcare Engineering (ASHE) website will be utilized. Risk classifications of Class II or lower will require approval by the COR or Government Designated Authority before beginning any construction work. Risk classifications of Class III or higher will require a permit before beginning any construction work. Infection Control permits will be issued by the COR. The Infection Control Permits will be posted outside the appropriate construction area. More than one permit may be issued for a construction project if the work is located in separate areas requiring separate classes. The primary project scope area for this project is: **Class [____}**, however, work outside the primary project scope area may vary. The required infection control precautions with each class are as follows:

1. Class I requirements:

   a. During Construction Work:

      1) Notify the COR

      2) Execute work by methods to minimize raising dust from construction operations.

      3) Ceiling tiles: Immediately replace a ceiling tile displaced for visual inspection.

   b. Upon Completion:

      1) Clean work area upon completion of task

      2) Notify the COR

2. Class II requirements:

a. During Construction Work:

1) Notify the COR

2) Provide active means to prevent airborne dust from dispersing into atmosphere such as wet methods or tool mounted dust collectors where possible.

3) Water mist work surfaces to control dust while cutting.

4) Seal unused doors with duct tape.

5) Block off and seal air vents.

6) Remove or isolate HVAC system in areas where work is being performed.

b. Upon Completion:

1) Wipe work surfaces with cleaner/disinfectant.

2) Contain construction waste before transport in tightly covered containers.

3) Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.

4) Upon completion, restore HVAC system where work was performed

5) Notify the COR

3. Class III requirements:

a. During Construction Work:

1) Obtain permit from the COR

2) Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system.

3) Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.

4) Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.

5) Contain construction waste before transport in tightly covered containers.

6) Cover transport receptacles or carts. Tape covering unless solid lid.

b. Upon Completion:

1) Do not remove barriers from work area until completed project is inspected by the COR and thoroughly cleaned by the VA Environmental Services Department.

2) Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.

3) Vacuum work area with HEPA filtered vacuums.

4) Wet mop area with cleaner/disinfectant.

5) Upon completion, restore HVAC system where work was performed.

6) Return permit to the COR

4. Class IV requirements:

a. During Construction Work:

1) Obtain permit from the COR

2) Isolate HVAC system in area where work is being done to prevent contamination of duct system.

3) Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit)

before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.

4) Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.

5) Seal holes, pipes, conduits, and punctures.

6) Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave work site.

7) All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.

b. Upon Completion:

1) Do not remove barriers from work area until completed project is inspected by the COR with thorough cleaning by the VA Environmental Services Dept.

2) Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.

3) Contain construction waste before transport in tightly covered containers.

4) Cover transport receptacles or carts. Tape covering unless solid lid.

5) Vacuum work area with HEPA filtered vacuums.

6) Wet mop area with cleaner/disinfectant.

7) Upon completion, restore HVAC system where work was performed.

8) Return permit to the COR

C. Barriers shall be erected as required based upon classification (Class III & IV requires barriers) and shall be constructed as follows:

1. Class III and IV - closed door with masking tape applied over the frame and door is acceptable for projects that can be contained in a single room.

2. Construction, demolition or reconstruction not capable of containment within a single room must have the following barriers erected and made presentable on hospital occupied side:

   a. Class III & IV (where dust control is the only hazard, and an agreement is reached with the Resident Engineer and Medical Center) - Airtight plastic barrier that extends from the floor to ceiling. Seams must be sealed with duct tape to prevent dust and debris from escaping

   b. Class III & IV - Drywall barrier erected with joints covered or sealed to prevent dust and debris from escaping.

   c. Class III & IV - Seal all penetrations in existing barrier airtight

   d. Class III & IV - Barriers at penetration of ceiling envelopes, chases and ceiling spaces to stop movement air and debris

   e. Class IV only - Anteroom or double entrance openings that allow workers to remove protective clothing or vacuum off existing clothing

   f. Class III & IV - At elevators shafts or stairways within the field of construction, overlapping flap minimum of two feet wide of polyethylene enclosures for personnel access.

D. Products and Materials:

1. Sheet Plastic: Fire retardant polystyrene, 6-mil thickness meeting local fire codes

2. Barrier Doors: Self Closing solid core wood in steel frame, painted

3. Dust proof drywall

4. High Efficiency Particulate Air-Equipped filtration machine rated at 95% capture of 0.3 microns including pollen, mold spores and dust particles. HEPA filters should have ASHRAE 85 or other prefilter to extend the useful life of the HEPA. Provide both primary and

secondary filtrations units. Maintenance of equipment and replacement of the HEPA filters and other filters will be in accordance with manufacturer’s instructions.

5. Exhaust Hoses: Heavy duty, flexible steel reinforced; Ventilation Blower Hose

6. Adhesive Walk-off Mats: Provide minimum size mats of 24 inches x 36 inches

7. Disinfectant: Hospital-approved disinfectant or equivalent product

8. Portable Ceiling Access Module

E. Before any construction on site begins, all contractor personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.

F. A dust control program will be established and maintained as part of the contractor’s infection preventive measures in accordance with the FGI Guidelines for Design and Construction of Healthcare Facilities. Prior to start of work, prepare a plan detailing project-specific dust protection measures with associated product data, including periodic status reports, and submit to COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

G. Medical center Infection Control personnel will monitor for airborne disease (e.g. aspergillosis) during construction. A baseline of conditions will be established by the medical center prior to the start of work and periodically during the construction stage to determine impact of construction activities on indoor air quality with safe thresholds established.

H. In general, the following preventive measures shall be adopted during construction to keep down dust and prevent mold.

1. Contractor shall verify that construction exhaust to exterior is not reintroduced to the medical center through intake vents or building openings. HEPA filtration is required where the exhaust dust may reenter the medical center.

2. Exhaust hoses shall be exhausted so that dust is not reintroduced to the medical center.

3. Adhesive Walk-off/Carpet Walk-off Mats shall be used at all interior transitions from the construction area to occupied medical center area. These mats shall be changed as often as required to maintain clean work areas directly outside construction area at all times.

4. Vacuum and wet mop all transition areas from construction to the occupied medical center at the end of each workday. Vacuum shall utilize HEPA filtration. Maintain surrounding area frequently. Remove debris as it is created. Transport these outside the construction area in containers with tightly fitting lids.

5. The contractor shall not haul debris through patient-care areas without prior approval of the Resident Engineer and the Medical Center. When, approved, debris shall be hauled in enclosed dust proof containers or wrapped in plastic and sealed with duct tape. No sharp objects should be allowed to cut through the plastic. Wipe down the exterior of the containers with a damp rag to remove dust. All equipment, tools, material, etc. transported through occupied areas shall be made free from dust and moisture by vacuuming and wipe down.

6. There shall be no standing water during construction. This includes water in equipment drip pans and open containers within the construction areas. All accidental spills must be cleaned up and dried within 12 hours. Remove and dispose of porous materials that remain damp for more than 72 hours.

7. At completion, remove construction barriers and ceiling protection carefully, outside of normal work hours. Vacuum and clean all surfaces free of dust after the removal.

I. Final Cleanup:

1. Upon completion of project, or as work progresses, remove all construction debris from above ceiling, vertical shafts and utility chases that have been part of the construction.

2. Perform HEPA vacuum cleaning of all surfaces in the construction area. This includes walls, ceilings, cabinets, furniture (built-in or free standing), partitions, flooring, etc.

3. All new air ducts shall be cleaned prior to final inspection.

J. Exterior Construction

1. Contractor shall verify that dust will not be introduced into the medical center through intake vents, or building openings. HEPA filtration on intake vents is required where dust may be introduced.

2. Dust created from disturbance of soil such as from vehicle movement will be wetted with use of a water truck as necessary

3. All cutting, drilling, grinding, sanding, or disturbance of materials shall be accomplished with tools equipped with either local exhaust ventilation (i.e. vacuum systems) or wet suppression controls.

1.13 TUBERCULOSIS SCREENING

A. Contractor shall provide written certification that all contract employees assigned to the work site have had a pre-placement tuberculin screening within 90 days prior to assignment to the worksite and been found have negative TB screening reactions. Contractors shall be required to show documentation of negative TB screening reactions for any additional workers who are added after the 90-day requirement before they will be allowed to work on the work site. NOTE: This can be the Center for Disease Control (CDC) and Prevention and two-step skin testing or a Food and Drug Administration (FDA)-approved blood test.

1. Contract employees manifesting positive screening reactions to the tuberculin shall be examined according to current CDC guidelines prior to working on VHA property.

2. Subsequently, if the employee is found without evidence of active (infectious) pulmonary TB, a statement documenting examination by a physician shall be on file with the employer (construction contractor), noting that the employee with a positive tuberculin screening test is without evidence of active (infectious) pulmonary TB.

3. If the employee is found with evidence of active (infectious) pulmonary TB, the employee shall require treatment with a subsequent statement to the fact on file with the employer before being allowed to return to work on VHA property.

1.14 FIRE SAFETY

A. Fire Safety Plan: Establish and maintain a site-specific fire protection program in accordance with 29 CFR 1926. Prior to start of work, prepare a plan detailing project-specific fire safety measures, including periodic status reports, and submit to COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. This plan may be an element of the Accident Prevention Plan.

B. Site and Building Access: Maintain free and unobstructed access to facility emergency services and for fire, police and other emergency response forces in accordance with NFPA 241.

C. Separate temporary facilities, such as trailers, storage sheds, and dumpsters, from existing buildings and new construction by distances in accordance with NFPA 241. For small facilities with less than 6 m (20 feet) exposing overall length, separate by 3m (10 feet).

D. Temporary Construction Partitions:

1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood (flame spread rating of 25 or less in accordance with ASTM E84) on both sides of fire retardant treated wood or metal steel studs. Extend the partitions through suspended ceilings to floor slab deck or roof. Seal joints and penetrations. At door openings, install Class C, ¾ hour fire/smoke rated doors with self-closing devices.

2. Install temporary construction partitions as shown on drawings to maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures.

3. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-

penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.

E. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.

F. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with // Resident Engineer COR.

G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to COR.

H. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.

I. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.

L. Existing Fire Protection: Do not impair automatic sprinklers, smoke and heat detection, and fire alarm systems, except for portions immediately under construction, and temporarily for connections. Provide fire watch for impairments more than 4 hours in a 24-hour period. Request interruptions in accordance with Article, OPERATIONS AND STORAGE AREAS, and coordinate with COR. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the medical center. Parameters for the testing and results of any tests performed shall be recorded by the medical center and copies provided to the Resident Engineer.

M. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with COR.

N. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with COR at least 4 hours in advance.

O. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to COR.

P. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.

Q. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.

R. If required, submit documentation to the COR that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

1.15 ELECTRICAL

A. All electrical work shall comply with NFPA 70 (NEC), NFPA 70B, NFPA 70E, 29 CFR Part 1910 Subpart J – General Environmental Controls, 29 CFR Part 1910 Subpart S – Electrical, and 29 CFR 1926 Subpart K in addition to other references required by contract.

B. All qualified persons performing electrical work under this contract shall be licensed journeyman or master electricians. All apprentice electricians performing under this contract shall be deemed unqualified persons unless they are working under the immediate supervision of a licensed electrician or master electrician.

C. All electrical work will be accomplished de-energized and in the Electrically Safe Work Condition (refer to NFPA 70E for Work Involving Electrical Hazards, including Exemptions to Work Permit). Any Contractor, subcontractor or temporary worker who fails to fully comply with this requirement is subject to immediate termination in accordance with FAR clause 52.236-5(c). Only in rare circumstance where achieving an electrically safe work condition prior to beginning work would increase or cause additional hazards, or is infeasible due to equipment design or operational limitations is energized work permitted. The COR with approval of the Medical Center Director will make the determination if the circumstances would meet the exception outlined above. An AHA specific to energized work activities will be developed, reviewed, and accepted prior to the start of that work.

1. Development of a Hazardous Electrical Energy Control Procedure is required prior to de-energization. A single Simple Lockout/Tagout Procedure for multiple work operations can only be used for work

involving qualified person(s) de-energizing one set of conductors or circuit part source. Task specific Complex Lockout/Tagout Procedures are required at all other times.

2. Verification of the absence of voltage after de-energization and lockout/tagout is considered “energized electrical work” (live work) under NFPA 70E, and shall only be performed by qualified persons wearing appropriate shock protective (voltage rated) gloves and arc rate personal protective clothing and equipment, using Underwriters Laboratories (UL) tested and appropriately rated contact electrical testing instruments or equipment appropriate for the environment in which they will be used.

3. Personal Protective Equipment (PPE) and electrical testing instruments will be readily available for inspection by the The COR.

D. Before beginning any electrical work, an Activity Hazard Analysis (AHA) will be conducted to include Shock Hazard and Arc Flash Hazard analyses (NFPA Tables can be used only as a last alterative and it is strongly suggested a full Arc Flash Hazard Analyses be conducted). Work shall not begin until the AHA for the work activity has been accepted by the COR and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.

E. Ground-fault circuit interrupters. All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites shall have approved ground-fault circuit interrupters for personnel protection. “Assured Equipment Grounding Conductor Program” only is not allowed.

1.16 FALL PROTECTION

A. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) for ALL WORK, unless specified differently or the OSHA 29 CFR 1926 requirements are more stringent, to include steel erection activities, systems-engineered activities (prefabricated) metal buildings, residential (wood) construction and scaffolding work.

1. The use of a Safety Monitoring System (SMS) as a fall protection method is prohibited.

2. The use of Controlled Access Zone (CAZ) as a fall protection method is prohibited.

3. A Warning Line System (WLS) may ONLY be used on floors or flat or low-sloped roofs (between 0 - 18.4 degrees or 4:12 slope) and shall be erected around all sides of the work area (See 29 CFR 1926.502(f) for construction of WLS requirements). Working within the WLS does not require FP. No worker shall be allowed in the area between the roof or floor edge and the WLS without FP. FP is required when working outside the WLS.

4. Fall protection while using a ladder will be governed by the OSHA requirements.

1.17 SCAFFOLDS AND OTHER WORK PLATFORMS

A. All scaffolds and other work platforms construction activities shall comply with 29 CFR 1926 Subpart L.

B. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) as stated in Section 1.16.

C. The following hierarchy and prohibitions shall be followed in selecting appropriate work platforms.

1. Scaffolds, platforms, or temporary floors shall be provided for all work except that can be performed safely from the ground or similar footing.

2. Ladders less than 20 feet may be used as work platforms only when use of small hand tools or handling of light material is involved.

3. Ladder jacks, lean-to, and prop-scaffolds are prohibited.

4. Emergency descent devices shall not be used as working platforms.

D. Contractors shall use a scaffold tagging system in which all scaffolds are tagged by the Competent Person. Tags shall be color-coded: green indicates the scaffold has been inspected and is safe to use; red indicates the scaffold is unsafe to use. Tags shall be readily visible, made of materials that will withstand the environment in which they are used, be legible and shall include:

1. The Competent Person’s name and signature;

2. Dates of initial and last inspections.

E. Mast Climbing work platforms: When access ladders, including masts designed as ladders, exceed 20 ft (6 m) in height, positive fall protection shall be used.

1.18 EXCAVATION AND TRENCHES

A. All excavation and trenching work shall comply with 29 CFR 1926 Subpart P.

B. All excavations and trenches 5 feet in depth or greater shall require a written trenching and excavation permit (NOTE – some States and other local jurisdictions require separate state/jurisdiction-issued excavation permits). The permit shall be completed and provided to the COR prior to commencing work for the day. At the end of the day, the permit shall be closed out and provided to the COR. The permit shall be maintained onsite and include the following:

1. Determination of soil classification

2. Indication that utilities have been located and identified. If utilities could not be located after all reasonable attempt, then excavating operations will proceed cautiously.

3. Indication of selected excavation protective system.

4. Indication that the spoil pile will be stored at least 2 feet from the edge of the excavation and safe access provided within 25 feet of the workers.

5. Indication of assessment for a potential toxic, explosive, or oxygen deficient atmosphere.

C. If not using an engineered protective system such as a trench box, shielding, shoring, or other Professional Engineer designed system and using a sloping or benching system, soil classification cannot be Solid Rock or Type A. All soil will be classified as Type B or Type C and sloped or benched in accordance with Appendix B of 29 CFR 1926.

1.22 WELDING AND CUTTING

As specified in section 1.14, Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with COR. Obtain permits from COR at least 4 hours in advance.

1.23 LADDERS

A. All Ladder use shall comply with 29 CFR 1926 Subpart X.

B. All portable ladders shall be of sufficient length and shall be placed so that workers will not stretch or assume a hazardous position.

C. Manufacturer safety labels shall be in place on ladders

D. Step Ladders shall not be used in the closed position

E. Top steps or cap of step ladders shall not be used as a step

F. Portable ladders, used as temporary access, shall extend at least 3 ft (0.9 m) above the upper landing surface.

1. When a 3 ft (0.9-m) extension is not possible, a grasping device (such as a grab rail) shall be provided to assist workers in mounting and dismounting the ladder.

2. In no case shall the length of the ladder be such that ladder deflection under a load would, by itself, cause the ladder to slip from its support.

G. Ladders shall be inspected for visible defects on a daily basis and after any occurrence that could affect their safe use. Broken or damaged ladders shall be immediately tagged "DO NOT USE," or with similar wording, and withdrawn from service until restored to a condition meeting their original design.

1.24 FLOOR & WALL OPENINGS

A. All floor and wall openings shall comply with 29 CFR 1926 Subpart M.

B. Floor and roof holes/openings are any that measure over 2 in (51 mm) in any direction of a walking/working surface which persons may trip or fall into or where objects may fall to the level below. See 21.F for covering and labeling requirements. Skylights located in floors or roofs are considered floor or roof hole/openings.

C. All floor, roof openings or hole into which a person can accidentally walk or fall through shall be guarded either by a railing system with toeboards along all exposed sides or a load-bearing cover. When the cover is not in place, the opening or hole shall be protected by a removable guardrail system or shall be attended when the guarding system has been removed, or other fall protection system.

1. Covers shall be capable of supporting, without failure, at least twice the weight of the worker, equipment and material combined.

2. Covers shall be secured when installed, clearly marked with the word “HOLE”, “COVER” or “Danger, Roof Opening-Do Not Remove” or color-coded or equivalent methods (e.g., red or orange “X”). Workers must be made aware of the meaning for color coding and equivalent methods.

3. Roofing material, such as roofing membrane, insulation or felts, covering or partly covering openings or holes, shall be immediately cut out. No hole or opening shall be left unattended unless covered.

4. Non-load-bearing skylights shall be guarded by a load-bearing skylight screen, cover, or railing system along all exposed sides.

5. Workers are prohibited from standing/walking on skylights.

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SECTION 01 42 19
REFERENCE STANDARDS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the availability and source of references and standards specified in the project manual under paragraphs APPLICABLE PUBLICATIONS and/or shown on the drawings.

1.2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS FPMR PART 101-29 (FAR 52.211-1) (AUG 1998)

A. The GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, FPMR Part 101-29 and copies of specifications, standards, and commercial item descriptions cited in the solicitation may be obtained for a fee by submitting a request to – GSA Federal Supply Service, Specifications Section, Suite 8100, 470 East L'Enfant Plaza, SW, Washington, DC 20407, Telephone (202) 619-8925, Facsimile (202) 619-8978.

B. If the General Services Administration, Department of Agriculture, or Department of Veterans Affairs issued this solicitation, a single copy of specifications, standards, and commercial item descriptions cited in this solicitation may be obtained free of charge by submitting a request to the addressee in paragraph (a) of this provision. Additional copies will be issued for a fee.

1.3 AVAILABILITY FOR EXAMINATION OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-4) (JUN 1988)

The specifications and standards cited in this solicitation can be examined at the following location:

DEPARMENT OF VETERANS AFFAIRS
Office of Construction & Facilities Management
Facilities Quality Service (00CFM1A)
425 Eye Street N.W, (sixth floor)
Washington, DC 20001
Telephone Numbers: (202) 632-5249 or (202) 632-5178
Between 9:00 AM - 3:00 PM

1.4 AVAILABILITY OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-3) (JUN 1988)

The specifications cited in this solicitation may be obtained from the associations or organizations listed below.

AA Aluminum Association Inc.
http://www.aluminum.org

AABC Associated Air Balance Council
https://www.aabc.com

AAMA American Architectural Manufacturer's Association
http://www.aamanet.org

AASHTO American Association of State Highway and Transportation Officials
http://www.aashto.org

AATCC American Association of Textile Chemists and Colorists
http://www.aatcc.org

ACGIH American Conference of Governmental Industrial Hygienists
http://www.acgih.org

ACI American Concrete Institute
http://www.aci-int.net

ACPA American Concrete Pipe Association
http://www.concrete-pipe.org

ACPPA American Concrete Pressure Pipe Association
http://www.acppa.org

ADC Air Diffusion Council
http://flexibleduct.org

AGA American Gas Association
http://www.aga.org

AGC Associated General Contractors of America
http://www.agc.org

AGMA American Gear Manufacturers Association, Inc.
http://www.agma.org

AH American Hort

https://www.americanhort.org

AHAM Association of Home Appliance Manufacturers
http://www.aham.org

AIA American Institute of Architects

http://www.aia.org

AISC American Institute of Steel Construction
http://www.aisc.org

AISI American Iron and Steel Institute
http://www.steel.org

AITC American Institute of Timber Construction
https://aitc-glulam.org

AMCA Air Movement and Control Association, Inc.
http://www.amca.org

ANSI American National Standards Institute, Inc.
http://www.ansi.org

APA The Engineered Wood Association
http://www.apawood.org

ARI Air-Conditioning and Refrigeration Institute
http://www.ari.org

ARPM Association for Rubber Product Manufacturers

https://arpm.com

ASABE American Society of Agricultural and Biological Engineers
https://www.asabe.org

ASCE American Society of Civil Engineers
http://www.asce.org

ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers
http://www.ashrae.org

ASME American Society of Mechanical Engineers
http://www.asme.org

ASSE American Society of Sanitary Engineering International
http://www.asse-plumbing.org

ASTM American Society for Testing and Materials International
http://www.astm.org

AWI Architectural Woodwork Institute
https://www.awinet.org

AWS American Welding Society
https://www.aws.org

AWWA American Water Works Association
https://www.awwa.org

BHMA Builders Hardware Manufacturers Association
https://www.buildershardware.com

BIA The Brick Industry Association
http://www.gobrick.com

CAGI Compressed Air and Gas Institute
https://www.cagi.org

CGA Compressed Gas Association, Inc.
https://www.cganet.com

CI The Chlorine Institute, Inc.
https://www.chlorineinstitute.org

CISCA Ceilings and Interior Systems Construction Association
https://www.cisca.org

CISPI Cast Iron Soil Pipe Institute
https://www.cispi.org

CLFMI Chain Link Fence Manufacturers Institute
https://www.chainlinkinfo.org

CPA Composite Panel Association

https://www.compositepanel.org

CPMB Concrete Plant Manufacturers Bureau
https://www.cpmb.org

CRA California Redwood Association
http://www.calredwood.org

CRSI Concrete Reinforcing Steel Institute
https://www.crsi.org

CTI Cooling Technology Institute
https://www.cti.org

DHA Decorative Hardwoods Association

https://www.decorativehardwoods.org

DHI Door and Hardware Institute
https://www.dhi.org

EGSA Electrical Generating Systems Association
http://www.egsa.org

EEI Edison Electric Institute
https://www.eei.org

EPA United States Environmental Protection Agency
https://www.epa.gov

ETL ETL Testing Services
http://www.intertek.com

FAA Federal Aviation Administration
https://www.faa.gov

FCC Federal Communications Commission
https://www.fcc.gov

FPS Forest Products Society
http://www.forestprod.org

GANA Glass Association of North America
http://www.glasswebsite.com

FM Factory Mutual Global Insurance
https://www.fmglobal.com

GA Gypsum Association
https://gypsum.org

GSA General Services Administration
https://www.gsa.gov

HI Hydraulic Institute
http://www.pumps.org

ICC International Code Council
https://shop.iccsafe.org

ICEA Insulated Cable Engineers Association
https://www.icea.net

ICAC Institute of Clean Air Companies
http://www.icac.com

IEEE Institute of Electrical and Electronics Engineers
https://www.ieee.org\

IGMA Insulating Glass Manufacturers Alliance

https://www.igmaonline.org

IMSA International Municipal Signal Association
http://www.imsasafety.org

MBMA Metal Building Manufacturers Association
https://www.mbma.com

MSS Manufacturers Standardization Society of the Valve and Fittings Industry
http://msshq.org

NAAMM National Association of Architectural Metal Manufacturers
https://www.naamm.org

PHCC Plumbing-Heating-Cooling Contractors Association
https://www.phccweb.org

NBS National Bureau of Standards
See - NIST

NBBI The National Board of Boiler and Pressure Vessel Inspectors
https://www.nationalboard.org

NEC National Electric Code
See - NFPA National Fire Protection Association

NEMA National Electrical Manufacturers Association
https://www.nema.org

NFPA National Fire Protection Association
https://www.nfpa.org

NHLA National Hardwood Lumber Association
https://www.nhla.com

NIH National Institute of Health
https://www.nih.gov

NIST National Institute of Standards and Technology
https://www.nist.gov

NELMA Northeastern Lumber Manufacturers Association, Inc.
http://www.nelma.org

NPA National Particleboard Association
(See CPA, Composite Panel Association)

NSF National Sanitation Foundation
http://www.nsf.org

OSHA Occupational Safety and Health Administration
Department of Labor
https://www.osha.gov

PCA Portland Cement Association
https://www.cement.org

PCI Precast Prestressed Concrete Institute
https://www.pci.org

PPI Plastics Pipe Institute
https://www.plasticpipe.org

PEI Porcelain Enamel Institute
http://www.porcelainenamel.com

PTI Post-Tensioning Institute
http://www.post-tensioning.org

RFCI Resilient Floor Covering Institute
https://www.rfci.com

RIS Redwood Inspection Service
(See Western Wood Products Association)

https://www.wwpa.org

SCMA Southern Cypress Manufacturers Association
http://www.cypressinfo.org

SDI Steel Door Institute
http://www.steeldoor.org

SJI Steel Joist Institute
https://www.steeljoist.org

SMACNA Sheet Metal & Air-Conditioning Contractors' National Association
https://www.smacna.org

SSPC The Society for Protective Coatings
https://www.sspc.org

STI Steel Tank Institute
https://www.steeltank.com

SWI Steel Window Institute
https://www.steelwindows.com

TCNA Tile Council of North America

https://www.tcnatile.com

TEMA Tubular Exchanger Manufacturers Association
http://www.tema.org

TPI Truss Plate Institute
https://www.tpinst.org

UBC The Uniform Building Code
(See ICC)

UL Underwriters' Laboratories Incorporated
https://www.ul.com

ULC Underwriters' Laboratories of Canada
https://www.ulc.ca

WCLB West Coast Lumber Inspection Bureau
http://www.wclib.org

WDMA Window and Door Manufacturers Association

https://www.wdma.com

WRCLA Western Red Cedar Lumber Association
https://www.realcedar.com

WWPA Western Wood Products Association
http://www.wwpa.org

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SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies requirements for Contractor Quality Control (CQC) for Design-Bid-Build (DBB) or Design-Build (DB) construction projects. This section can be used for both project types.

1.2 APPLICABLE PUBLICATIONS

A. The publication listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

B. ASTM International (ASTM)

1. D3740 - (2012a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
2. E329 - (2014a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.3 SUBMITTALS

Government approval is required for all submittals. CQC inspection reports shall be submitted under this Specification section and follow the [Applicable CQC Control Phase (Preparatory, Initial, or Follow-Up)]: [Applicable Specification section] naming convention.

1. Preconstruction Submittals
   a. CQC Plan
2. Test Reports
   a. Verification Statement

PART 2 PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

Establish and maintain an effective quality control (QC) system. that complies with the FAR Clause 52.246.12 titled “Inspection of Construction”. QC consists of plans, procedures, and organization necessary to produce an end product which complies with the Contract requirements. The QC system covers all design and construction

operations, both onsite and offsite, and be keyed to the proposed design and construction sequence. The project superintendent will be held responsible for the quality of work and is subject to removal by the Contracting Office or Authorized designee for non-compliance with the quality requirements specified in the Contract. In this context the highest level manager responsible for the overall construction activities at the site, including quality and production is the project superintendent. The project superintendent maintains a physical presence at the site at all times and is responsible for all construction and related activities at the site, except as otherwise acceptable to the Contracting Officer.

3.2 CQC PLAN:

A. Submit the CQC Plan no later than /30days after receipt of Notice to Proceed (NTP) proposed to implement the requirements of the FAR Clause 52.246.12 titled “Inspection of Construction”. The Government will consider an Interim CQC Plan for the first 5business days of NTP. Design and/or construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an Interim plan applicable to the particular feature of work to be started. Work outside of the accepted Interim CQC Plan will not be permitted to begin until acceptance of a CQC Plan or another Interim CQC Plan containing the additional work scope is accepted.

B. Content of the CQC Plan: Include, as a minimum, the following to cover all design and construction operations, both onsite and offsite, including work by subcontractors, designers of record consultants, architects/engineers (A/E), fabricators, suppliers, and purchasing agents:

1. A description of the QC organization, including a chart showing lines of authority and acknowledgement that the CQC staff will implement the three phase control system for all aspects of the work specified. Include a CQC System Manager that reports to the project superintendent.
2. The name, qualifications (in resume format) duties, responsibilities, and authorities of each person assigned a CQC function.
3. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the

functions of the CQC System Manager, including authority to stop work which is not in compliance with the Contract. Letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities will be issued by the CQC System Manager. Furnish copies of these letters to the Contracting Officer or Authorized designee.

4. Procedures for scheduling, reviewing, certifying, and managing submittals including those of subcontractors, designers of record, consultants, A/E’s offsite fabricators, suppliers and purchasing agents. These procedures must be in accordance with Section 01 33 23 Shop Drawings, Product Data, and Samples.
5. Control, verification, and acceptance of testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities approved by the Contracting Officer or Authorized designee are required to be used)
6. Procedures for tracking Preparatory, Initial, and Follow-Up control phases and control, verification, and acceptance tests including documentation.
7. Procedures for tracking design and construction deficiencies from identification through acceptable corrective action. Establish verification procedures that identified deficiencies have been corrected.
8. Reporting procedures, including proposed reporting formats.
9. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks has separate control requirements, and is identified by different trades or disciplines, or it is work by the same trade in a different environment. Although each section of specifications can generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the Coordination meeting.
10. Coordinate schedule work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections and Schedule of Special Inspections. Where the applicable Code issue by the International Code Council (ICC) calls for inspections by the Building Official, the Contractor must

include the inspections in the CQC Plan and must perform the inspections required by the applicable ICC. The Contractor must perform these inspections using independent qualified inspectors. Include the Special Inspection Plan requirements in the CQC Plan.

C. Additional Requirements for Design Quality Control (DQC) Plan: The following additional requirements apply to the DQC Plan for DB projects only and not DBB projects:

1. Submit and maintain a DQC Plan as an effective QC program which assures that all services required by this contract are performed and provided in a manner that meets professional architectural and engineering quality standards. As a minimum, all documents must be technically reviewed by competent, independent reviewers identified in the DQC Plan. The same element that produced the product may not perform the independent technical review (ITR). Correct errors and deficiencies in the design documents prior to submitting them to the Government.
2. Include the design schedule in the master project schedule, showing the sequence of events involved in carrying out the project design tasks within the specific Contract period. This should be at a detailed level of scheduling sufficient to identify all major design tasks, including those that control the flow of work. Include review and correction periods associated with each item. This should be a forward planning as well as a project monitoring tool. The schedule reflects calendar days and not dates for each activity. If the schedule is changed, submit a revised schedule reflecting the change within 7 calendar days. Include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. Submit at each design phase as part of the project documentation these completed discipline-specific checklists.
3. Implement the DQC Plan by a DQC Manager who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated. This individual must be a person who has verifiable engineering or architectural design experience and is a Professional Engineer or Registered Architect within the state of Construction location. Notify the Contracting Officer or Authorized designee, in writing, of the name of the individual, and the name of an alternate person assigned to the position.

D. Acceptance of Plan: Acceptance of the Contractor's plan is required prior to the start of design and construction. Acceptance is conditional and will be predicated on satisfactory performance during the design and construction. The Government reserves the right to require the Contractor to make changes in the CQC Plan and operations including removal of personnel as necessary, to obtain the quality specified.

E. Notification of Changes: After acceptance of the CQC Plan, notify the Contracting Officer or Authorized designee in writing of any proposed change. Proposed changes are subject to acceptance by the Government prior to implementation by the Contractor.

3.3 COORDINATION MEETING:

After the Preconstruction Conference Post-award Conference before start of design or construction, and prior to acceptance by the Government of the CQC Plan, meet with the Contracting Officer or Authorized designee to discuss the Contractor's quality control system. Submit the CQC Plan a minimum of 5 business days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details must be developed, including the forms for recording the CC operations, design activities (if applicable), control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting will be prepared by the Government, signed by both the Contractor and Contracting Officer or Authorized designee and will become a part of the contract file. There can be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings or address deficiencies in the CQC system or procedures which can require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION:

A. Personnel Requirements: The requirements for the CQC organization are a Safety and Health Manager, CQC System Manager, a Design Quality Manager (if applicable), and sufficient number of additional qualified personnel to ensure safety and Contract compliance. The Safety and Health Manager shall satisfy the requirements of Specification 01 35 26 Safety Requirements and reports directly to a senior project (or corporate) official independent from the CQC System Manager. The Safety

and Health Manager will also serve as a member of the CQC Staff. Personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly will also be included as part of the CQC organization. The Contractor’s CQC staff maintains a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure Contract compliance. The CQC staff will be subject to acceptance by the Contracting Officer or Authorized designee. Provide adequate office space, filing systems, and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly complete and furnish all letters, material submittals, shop drawings submittals, schedules and all other project documentation to the CQC organization. The CQC organization is responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the Government.

B. CQC System Manager: Identify as CQC System Manager an individual within the onsite work organization that is responsible for overall management of CQC and has the authority to act in all CQC matters for the Contractor. The CQC system Manager qualifications will be reviewed and PM or SRE to determine qualifications based on project complexity at construction review This CQC System manager is on the site at all times during construction and is employed by the General Contractor. Identify in the plan an alternate to serve in the event of the CDQC System Manager’s absence. The requirements for the alternate are the same as the CQC System Manager.

C. CQC Personnel: In addition to CQC personnel specified elsewhere in the contract, provide as part of the CQC organization specialized personnel to assist in the CQC System Manager for the following areas, as applicable: electrical, mechanical, civil, structural, environmental, architectural, materials technician submittals clerk, Commissioning Agent/LEED specialist, and low voltage systems. These individuals or specified technical companies are directly employed by the General Contractor and cannot be employed by a supplier or subcontractor on this project; be responsible to the CQC System Manager; be physically present at the construction site during work on the specialized personnel’s areas of responsibility; have the necessary education or experience in accordance with the Experience Matrix listed herein.

These individuals can perform other duties but need to be allowed sufficient time to perform the specialized personnel's assigned quality controls duties as described in the CQC Plan.

EXPERIENCE MATRIX

Area	Qualifications
Mechanical	Graduate Mechanical Engineer with 2 years experience or construction professional with 5 years of experience supervising mechanical features of work in the field with a construction company.
Electrical	Graduate Electrical Engineer with 2 years related experience or construction professional with 5 years of experience supervising electrical features of work in the field with a construction company.
Structural	Graduate Civil Engineer (with Structural Track or Focus), Structural Engineer, or Construction Manager with 2 years experience or construction professional with 5 years experience supervising structural features of work in the field with a construction company.
Architectural	Graduate Architect with 2 years experience or construction professional with 5 years of related experience.
Environmental	Graduate Environmental Engineer with 3 years experience.
Submittals	Submittal Clerk with 1 year experience.
Testing, Adjusting, and Balancing (TAB)	Specialist must be a member of AABC or an experienced technician of the firm certified by the NEBB.
Design Quality Control Manager	Registered Architect or Professional Engineer

D. Additional Requirements: In addition to the above experience and education requirements, the CQC System Manager and Alternate CQC System Manager are required to have completed the Construction Quality Management (CQM) for Construction course. If the CQC System Manager does not have a current specification, obtain the CQM for Contractors course identification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Command and the Army Corps of Engineers. Contact the Contracting Officer or Authorized designee for information on the next scheduled class.

E. Organizational Changes: Maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer or Authorized designee for acceptance.

3.5 **SUBMITTALS AND DELIVERABLES:** Submittals have to comply with the requirements in Section 01 33 23 Shop Drawings, Product Data, and Samples. The CQC organization is responsible for certifying that all submittals and deliverables are in compliance with the contract requirements. When Section 01 91 00 General Commissioning Requirements is included in the contract, the submittals required by the section have to be coordinated with the Section 01 33 23 Shop Drawings, Product Data, and Samples to ensure adequate time is allowed for each type of submittal required.

3.6 CONTROL:

A. CQC is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control are required to be conducted by the CQC System Manager for each definable feature of the construction work as follows:

1. Preparatory Phase: This phase is performed prior to beginning work on each definable feature of work after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase includes:
   a. A review of each paragraph of applicable specifications, references codes, and standards. Make available during the preparatory inspection a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Government personnel until final acceptance of the work.
   b. Review of the Contract drawings.
   c. Check to assure that all materials and equipment have been tested, submitted, and approved.
   d. Review of provisions that have been made to provide required control inspection and testing.

e. Review Special Inspections required by Section 01 45 35 Special Inspections, that Statement of Special Inspections and the Schedule of Specials Inspections.
f. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the Contract.
g. Examination of required materials, equipment, and sample work to assure that they are on hand conform to approved shop drawings or submitted data, and are properly stored.
h. Review of the appropriate Activity Hazard Analysis (AHA) to assure safety requirements are met.
i. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards – contract defined or industry standard if not contract defined - for that feature of work.
j. Check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.
k. Discussion of the initial control phase.
l. The Government needs to be notified at least 48 hours or 2 business days in advance of beginning the Preparatory control phase. Include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. Document the results of the Preparatory phase actions by separate minutes prepared by the CQC System Manager and attach to the daily CQC report. Instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

B. Initial Phase: This phase is accomplished at the beginning of a definable feature of work. Accomplish the following:
1. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the Preparatory meeting.
2. Verify adequacy of controls to ensure full contract compliance. Verify the required control inspection and testing is in compliance with the contract.

3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
4. Resolve all differences.
5. Check safety to include compliance with an upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
6. The Government needs to be notified at least 48 hours or 2 business days in advance of beginning the initial phase for definable features of work. Prepare separate minutes of this phase by the CQC System Manager and attach to the daily CQC report. Indicate the exact location of initial phase for definable feature of work for future reference and comparison with Follow-Up phases.
7. The initial phase for each definable feature of work is repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
8. Coordinate scheduled work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections, and the Schedule of Special Inspections.

C. Follow-Up Phase: Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements until the completion of the particular feature of work. Record the checks in the CQC documentation. Conduct final Follow-Up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work. Do not build upon nor conceal non-conforming work. Coordinate scheduled work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections, and the Schedule of Special Inspections

D. Additional Preparatory and Initial Phases on the same definable features of work if: the quality ongoing work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

A. Testing Procedure: Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, furnish to the Government

duplicate samples of test specimens for possible testing by the Government. Testing includes operation and acceptance test when specified. Procure the services of a Department of Veteran Affairs approved testing laboratory or establish an approved testing laboratory at the project site. Perform the following activities and record and provide the following data:

1. Verify that testing procedures comply with contract requirements.
2. Verify that facilities and testing equipment are available and comply with testing standards.
3. Check test instrument calibration data against certified standards.
4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
5. Record results of all tests taken, both passing and failing on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the unique sequential control number identifying the test. If approved by the Contracting Officer or Authorized designee, actual test reports are submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer or Authorized designee. Failure to submit timely test reports as stated results in nonpayment for related work performed and disapproval of the test facility for this Contract.

B. Testing Laboratories: All testing laboratories must be validated through the procedures contained in Specification section 01 45 29 Testing Laboratory Services.

1. Capability Check: The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician’s testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt and steel is required to meet criteria detailed in ASTM D3740 and ASTM E329.
2. Capability Recheck: If the selected laboratory fails the capability check, the Contractor will be assessed a charge equal to value of recheck to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected

laboratory. Such costs will be deducted from the Contract amount due the Contractor.

C. Onsite Laboratory: The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.8 COMPLETION INSPECTION

A. Punch-Out Inspection: Conduct an inspection of the work by the CQC system Manager near the end of the work, or any increment of the work established by the specifications. Prepare and include in the CQC documentation a punch list of items which do not conform to the approved drawings and specifications. Include within the list of deficiencies the estimated date by which the deficiencies will be corrected. Make a second inspection the CQC System Manager or staff to ascertain that all deficiencies have been corrected. Once this is accomplished, notify the Government that the facility is ready for the Government Pre-Final Inspection.

B. Pre-Final Inspection: The Government will perform the Pre-Final Inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. Ensure that all items on this list have been corrected before notifying the Government, so that a Final Acceptance Inspection with the customer can be scheduled. Correct any items noted on the Pre-Final Inspection in a timely manner. These inspections and any deficiency corrections required by this paragraph need to be accomplished within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate construction completion dates.

C. Final Acceptance Inspection: The Contractor's QC Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Authorized designee is required to be in attendance at the Final Acceptance Inspection. Additional Government personnel can also be in attendance. The Final Acceptance Inspection will be formally scheduled by the Contracting Officer's or Authorized designee based upon results of the Pre-Final Inspection. Notify the Contracting Officer through the Resident Engineer office at least 14 days prior to the Final Acceptance Inspection and include the Contractor's assurance that all specific items previously identified to

the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date schedule for the Final Acceptance Inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with FAR Clause 52.246-12 titled "Inspection of Construction".

3.9 DOCUMENTATION

A. Quality Control Activities: Maintain current records providing factual evidence that required QC activities and tests have been performed. Include in these records the work of subcontractors and suppliers on an acceptable form that includes, as a minimum, the following information:

1. The name and area of responsibility of the Contractor/Subcontractor
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
4. Test and control activities performed with results and references to specification/drawing requirements. Identify the Control Phase (Preparatory, Initial, and/or Follow-Up). List deficiencies noted, along with corrective action.
5. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specification/drawing requirements.
6. Submittals and deliverables reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. Instructions given/received and conflicts in plans and specifications.
10. Provide documentation of design quality control activities. For independent design reviews, provide, as a minimum, identification of the Independent Technical Reviewer (ITR) team, the ITR review comments, responses, and the record of resolution of the comments.

B. Verification Statement: Indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. Cover both conforming and deficient features and include a statement that equipment and materials incorporated in the work and workmanship comply with the Contract. Furnish the original and one copy of these records in report form to the Government daily with 1 week after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, prepare and submit on report for every 7 days of no work and on the last day of a no work period. All calendar days need to be accounted for throughout the life of the contract. The first report following a day of no work will be for that day only. Reports need to be signed and dated by the CQC System Manager. Include copies of test reports and copies of reports prepared by all subordinate QC personnel within the CQC System Manager Report.

3.10 SAMPLE FORMS

Templates of various quality control reports can be found on the Whole Building Design Guide website at https://www.wbdg.org/FFC/NAVGRAPH/01%2045%2000.00%2020_quality_control_reports.pdf

3.11 **NOTIFICATION OF NONCOMPLIANCE:** The Contracting Officer or Authorized designee will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor should take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site will be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer can issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

--- End of Section ---

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies the requirements for the management of non-hazardous building construction and demolition waste.

B. Waste disposal in landfills shall be minimized to the greatest extent possible. Of the inevitable waste that is generated, as much of the waste material as economically feasible shall be salvaged, recycled or reused.

C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle not limited to the following:

1. Waste Management Plan development and implementation.
2. Techniques to minimize waste generation.
3. Sorting and separating of waste materials.
4. Salvage of existing materials and items for reuse or resale.
5. Recycling of materials that cannot be reused or sold.

D. At a minimum the following waste categories shall be diverted from landfills:

1. Soil.
2. Inerts (eg, concrete, masonry and asphalt).
3. Clean dimensional wood and palette wood.
4. Green waste (biodegradable landscaping materials).
5. Engineered wood products (plywood, particle board and I-joists, etc).
6. Metal products (eg, steel, wire, beverage containers, copper, etc).
7. Cardboard, paper and packaging.
8. Bitumen roofing materials.
9. Plastics (eg, ABS, PVC).
10. Carpet and/or pad.
11. Gypsum board.
12. Insulation.
13. Paint.
14. Fluorescent lamps.

1.2 RELATED WORK

A. Section 02 41 00, DEMOLITION.

B. Section 01 00 00, GENERAL REQUIREMENTS.

C. Lead Paint: Section 02 83 33.13, LEAD BASED PAINT REMOVAL AND DISPOSAL.

1.3 QUALITY ASSURANCE

A. Contractor shall practice efficient waste management when sizing, cutting and installing building products. Processes shall be employed to ensure the generation of as little waste as possible. Construction /Demolition waste includes products of the following:
   1. Excess or unusable construction materials.
   2. Packaging used for construction products.
   3. Poor planning and/or layout.
   4. Construction error.
   5. Over ordering.
   6. Weather damage.
   7. Contamination.
   8. Mishandling.
   9. Breakage.

B. Establish and maintain the management of non-hazardous building construction and demolition waste set forth herein. Conduct a site assessment to estimate the types of materials that will be generated by demolition and construction.

C. Contractor shall develop and implement procedures to reuse and recycle new materials to a minimum of 50 percent.

D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.

E. Contractor shall provide all demolition, removal and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations. The Whole Building Design Guide website http://www.wbdg.org provides a Construction Waste Management Database that contains information on companies that haul, collect, and process recyclable debris from construction projects.

F. Contractor shall assign a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Such areas are to be kept neat and clean and clearly marked to avoid contamination or mixing of materials.

G. Contractor shall provide on-site instructions and supervision of separation, handling, salvaging, recycling, reuse and return methods to be used by all parties during waste generating stages.

H. Record on daily reports any problems in complying with laws, regulations and ordinances with corrective action taken.

1.4 TERMINOLOGY

A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial and industrial waste resulting from construction, remodeling, repair and demolition operations.

B. Clean: Untreated and unpainted; uncontaminated with adhesives, oils, solvents, mastics and like products.

C. Construction and Demolition Waste: Includes all non-hazardous resources resulting from construction, remodeling, alterations, repair and demolition operations.

D. Dismantle: The process of parting out a building in such a way as to preserve the usefulness of its materials and components.

E. Disposal: Acceptance of solid wastes at a legally operating facility for the purpose of land filling (includes Class III landfills and inert fills).

F. Inert Backfill Site: A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of filling an excavation, shoring or other soil engineering operation.

G. Inert Fill: A facility that can legally accept inert waste, such as asphalt and concrete exclusively for the purpose of disposal.

H. Inert Solids/Inert Waste: Non-liquid solid resources including, but not limited to, soil and concrete that does not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives established by a regional water board, and does not contain significant quantities of decomposable solid resources.

I. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.

J. Mixed Debris Recycling Facility: A solid resource processing facility that accepts loads of mixed construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing non-recyclable materials.

K. Permitted Waste Hauler: A company that holds a valid permit to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal.

L. Recycling: The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.
   1. On-site Recycling – Materials that are sorted and processed on site for use in an altered state in the work, i.e. concrete crushed for use as a sub-base in paving.
   2. Off-site Recycling – Materials hauled to a location and used in an altered form in the manufacture of new products.

M. Recycling Facility: An operation that can legally accept materials for the purpose of processing the materials into an altered form for the manufacture of new products. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not be required to have a solid waste facilities permit or be regulated by the local enforcement agency.

N. Reuse: Materials that are recovered for use in the same form, on-site or off-site.

O. Return: To give back reusable items or unused products to vendors for credit.

P. Salvage: To remove waste materials from the site for resale or re-use by a third party.

Q. Source-Separated Materials: Materials that are sorted by type at the site for the purpose of reuse and recycling.

R. Solid Waste: Materials that have been designated as non-recyclable and are discarded for the purposes of disposal.

S. Transfer Station: A facility that can legally accept solid waste for the purpose of temporarily storing the materials for re-loading onto other trucks and transporting them to a landfill for disposal, or recovering some materials for re-use or recycling.

1.5 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:

B. Prepare and submit to the Resident Engineer a written demolition debris management plan. The plan shall include, but not be limited to, the following information:
   1. Procedures to be used for debris management.
   2. Techniques to be used to minimize waste generation.
   3. Analysis of the estimated job site waste to be generated:

a. List of each material and quantity to be salvaged, reused, recycled.
b. List of each material and quantity proposed to be taken to a landfill.

4. Detailed description of the Means/Methods to be used for material handling.
   a. On site: Material separation, storage, protection where applicable.
   b. Off site: Transportation means and destination. Include list of materials.
      1) Description of materials to be site-separated and self-hauled to designated facilities.
      2) Description of mixed materials to be collected by designated waste haulers and removed from the site.
   c. The names and locations of mixed debris reuse and recycling facilities or sites.
   d. The names and locations of trash disposal landfill facilities or sites.
   e. Documentation that the facilities or sites are approved to receive the materials.

C. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.

D. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

1.6 APPLICABLE PUBLICATIONS

A Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

B. U.S. Green Building Council (USGBC):
LEED Green Building Rating System for New Construction

1.7 RECORDS

Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template.

PART 2 - PRODUCTS

2.1 MATERIALS

A. List of each material and quantity to be salvaged, recycled, reused.

B. List of each material and quantity proposed to be taken to a landfill.

C. Material tracking data: Receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices, net total costs or savings.

PART 3 - EXECUTION

3.1 COLLECTION

A. Provide all necessary containers, bins and storage areas to facilitate effective waste management.

B. Clearly identify containers, bins and storage areas so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.

C. Hazardous wastes shall be separated, stored, disposed of according to local, state, federal regulations.

3.2 DISPOSAL

A. Contractor shall be responsible for transporting and disposing of materials that cannot be delivered to a source-separated or mixed materials recycling facility to a transfer station or disposal facility that can accept the materials in accordance with state and federal regulations.

B. Construction or demolition materials with no practical reuse or that cannot be salvaged or recycled shall be disposed of at a landfill or incinerator.

3.3 REPORT

A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.

B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.

C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices.Include the net total costs for ea. disposal.

- - - E N D - - -

SECTION 01 81 13
SUSTAINABLE CONSTRUCTION REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes general requirements and procedures to comply with federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable construction.

B. The Design Professional has selected materials and utilized integrated design processes that achieve the Government’s objectives. Contractor is responsible to maintain and support these objectives in developing means and methods for performing work and in proposing product substitutions or changes to specified processes. Obtain approval from Contracting Officer for all changes and substitutions to materials or processes. Proposed changes must meet, or exceed, materials or processes specified.

1.2 RELATED WORK

A. Section 01 74 19 CONSTRUCTION WASTE MANANGEMENT.

1.3 DEFINITIONS

A. Recycled Content: Recycled content of materials is defined according to Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260). Recycled content value of a material assembly is determined by weight. Recycled fraction of assembly is multiplied by cost of assembly to determine recycled content value.

1. “Post-Consumer” material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. “Pre-Consumer” material is defined as material diverted from waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

B. Biobased Products: Biobased products are derived from plants and other renewable agricultural, marine, and forestry materials and provide an alternative to conventional petroleum derived products. Biobased products include diverse categories such as lubricants, cleaning products, inks, fertilizers, and bioplastics.

C. Low Pollutant-Emitting Materials: Materials and products which are minimally odorous, irritating, or harmful to comfort and well-being of installers and occupants.

D. Volatile Organic Compounds (VOC): Chemicals that are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects.

1.4 REFERENCE STANDARDS

A. Carpet and Rug Institute Green Label Plus program.

B. U.S. Department of Agriculture BioPreferred program (USDA BioPreferred).

C. U.S. Environmental Protection Agency Comprehensive Procurement Guidelines (CPG).

D. U.S. Environmental Protection Agency WaterSense Program (WaterSense).

E. U.S. Environmental Protection Agency ENERGY STAR Program (ENERGY STAR).

F. U. S. Department of Energy Federal Energy Management Program (FEMP).

G. Green Electronic Council EPEAT Program (EPEAT).

1.5 SUBMITTALS

A. All submittals to be provided by contractor to COR.

B. Sustainability Action Plan:

1. Submit documentation as required by this section; provide additional copies of typical submittals required under technical sections when sustainable construction requires copies of record submittals.
2. Within 30 days after Preconstruction Meeting provide a narrative plan for complying with requirements stipulated within this section.
3. Sustainability Action Plan must:
   a. Make reference to sustainable construction submittals defined by this section.
   b. Address all items listed under PERFORMANCE CRITERIA.
   c. Indicate individual(s) responsible for implementing the plan.

C. Low Pollutant-Emitting Materials Tracking Spreadsheet: Within 30 days after Preconstruction Meeting provide a preliminary Low Pollutant-Emitting Materials Tracking Spreadsheet. The Low Pollutant-Emitting Materials Tracking Spreadsheet must be an electronic file and include all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13.

D. Construction Indoor Air Quality (IAQ) Management Plan:

1. Not more than 30 days after Preconstruction Meeting provide a Construction IAQ Management Plan as an electronic file including descriptions of the following:
   a. Instruction procedures for meeting or exceeding minimum requirements of ANSI/SMACNA 008-2008, Chapter 3, including procedures for HVAC Protection, Source Control, Pathway Interruption, Housekeeping, and Scheduling.
   b. Instruction procedures for protecting absorptive materials stored on-site or installed from moisture damage.
   c. Schedule of submission of photographs of on-site construction IAQ management measures such as protection of ducts and on-site stored oil installed absorptive materials.
   d. Instruction procedures if air handlers must be used during construction, including a description of filtration media to be used at each return air grille.
   e. Instruction procedure for replacing all air-filtration media immediately prior to occupancy after completion of construction, including a description of filtration media to be used at each air handling or air supply unit.
   f. Instruction procedures and schedule for implementing building flush-out.

E. Product Submittals:
   1. Recycled Content: Submit product data from manufacturer indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content (excluding MEP systems equipment and components).
   2. Biobased Content: Submit product data for products to be installed or used which are included in any of the USDA BioPreferred program’s product categories. Data to include percentage of biobased content and source of biobased material.
   3. Low Pollutant-Emitting Materials: Submit product data confirming compliance with relevant requirements for all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13.
   4. For applicable products and equipment, submit product documentation confirming ENERGY STAR label, FEMP certification, WaterSense, and/or EPEAT certification.

F. Sustainable Construction Progress Reports: Concurrent with each Application for Payment, submit a Sustainable Construction Progress Report to confirm adherence with Sustainability Action Plan.
   1. Include narratives of revised strategies for bringing work progress into compliance with plan and product submittal data.
   2. Include updated and current Low Pollutant-Emitting Materials Tracking Spreadsheet.
   3. Include construction waste tracking, in tons or cubic yards, including waste description, whether diverted or landfilled, hauler, and percent diverted for comingled quantities; and excluding land-clearing debris and soil. Provide haul receipts and documentation of diverted percentages for comingled wastes.

G. Closeout Submittals: Within 14 days after Substantial Completion provide the following:
   1. Final version of Low Pollutant-Emitting Materials Tracking Spreadsheet.
   2. Manufacturer’s cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed air handling units are used during construction.
   3. Manufacturer’s cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for final filtration media in air handling units.
   4. Minimum 18 construction photographs including six photographs taken on three different occasions during construction of ANSI/SMACNA 008-2008, Chapter 3 approaches employed, along with a brief description of each approach, documenting implementation of IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
   5. Flush-out Documentation:
      a. Product data for filtration media used during flush-out.
      b. Product data for filtration media installed immediately prior to occupancy.
      c. Signed statement describing building air flush-out procedures including dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.

1.6 QUALITY ASSURANCE

A. Preconstruction Meeting: After award of Contract and prior to commencement of Work, schedule and conduct meeting with COR/Resident Engineer and Architect to discuss the Project Sustainable Action Plan content as it applies to submittals, project delivery, required Construction Indoor Air Quality (IAQ) Management Plan, and other Sustainable Construction Requirements. The purpose of this meeting is to develop a mutual understanding of the Sustainable Construction Requirements and coordination of contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.

B. Construction Job Conferences: Status of compliance with Sustainable Construction Requirements of these specifications will be an agenda item at regular job meetings conducted during the course of work at the site.

1.7 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

B. Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

C. Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

D. Green Seal Standard GC-36, Commercial Adhesives, October 19, 2000.

E. South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

F. South Coast Air Quality Management District (SCAQMD) Rule 1168, July 1, 2005 and rule amendment date of January 7, 2005.

G. Sheet Metal and Air Conditioning National Contractors' Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition (ANSI/SMACNA 008-2008), Chapter 3.

H. California Department of Public Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1, Emission Testing method for California Specification 01350 (CDPH Standard Method V1.1-2010).

I. Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260).

J. ASHRAE Standard 52.2-2015.

PART 2 – PRODUCTS

2.1 PERFORMANCE CRITERIA

A. Construction waste diversion from landfill disposal must comprise at least 50 percent of total construction waste, excluding land clearing debris and soil. Alternative daily cover (ADC) does not qualify as material diverted from disposal.

B. Low Pollutant-Emitting Materials:

1. Adhesives, sealants and sealant primers applied on site within the weatherproofing membrane must comply with VOC limits of SCAQMD Rule 1168:

a. Flooring Adhesives and Sealants:

1) Indoor carpet adhesives: 50 g/L.
2) Rubber Floor Adhesives: 60 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Porous Material (Except Wood) Substrate: 50 g/L.
5) Architectural Non-Porous Sealant Primer: 250 g/L.
6) Architectural Porous Sealant Primer: 775 g/L.
7) Other Sealant Primer: 750 g/L.
8) Sheet-Applied Rubber Lining Operations: 850 g/L.
9) Top and Trim Adhesive: 250 g/L.
10) Architectural Sealant: 250 g/L.
11) Other Sealant: 420 g/L.

b. Non-Flooring Adhesives and Sealants:

1) Drywall and Panel Adhesives: 50 g/L.
2) Multipurpose Construction Adhesives: 70 g/L.
3) Structural Glazing Adhesives: 100 g/L.
4) Metal-to-Metal Substrate Adhesives: 30 g/L.
5) Plastic Foam Substrate Adhesive: 50 g/L.
6) Porous Material (Except Wood) Substrate Adhesive: 50 g/L.
7) Fiberglass Substrate Adhesive: 80 g/L.
8) Architectural Non-Porous Sealant Primer: 250 g/L.
9) Architectural Porous Sealant Primer: 775 g/L.
10) Other Sealant Primer: 750 g/L.
11) PVC Welding Adhesives: 510 g/L.
12) CPVC Welding Adhesives: 490 g/L.
13) ABS Welding Adhesives: 325 g/L.
14) Plastic Cement Welding Adhesives: 250 g/L.
15) Adhesive Primer for Plastic: 550 g/L.

16) Contact Adhesive: 80 g/L.
17) Special Purpose Contact Adhesive: 250 g/L.
18) Structural Wood Member Adhesive: 140 g/L.
19) Sheet Applied Rubber Lining Operations: 850 g/L.
20) Top and Trim Adhesive: 250 g/L.
21) Architectural Sealants: 250 g/L.
22) Other Sealants: 420 g/L.

2. Aerosol adhesives applied on site within the weatherproofing membrane must comply with the following Green Seal GS-36.
   a. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent VOCs by weight.
   b. Aerosol Adhesive, General-Purpose Web Spray: 55 percent VOCs by weight.
   c. Special-Purpose Aerosol Adhesive (All Types): 70 percent VOCs by weight.
3. Paints and coatings applied on site within the weatherproofing membrane must comply with the following criteria:
   a. VOC content limits for paints and coatings established in Green Seal Standard GS-11.
   b. VOC content limit for anti-corrosive and anti-rust paints applied to interior ferrous metal substrates of 250 g/L established in Green Seal GC-03.
   c. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed VOC content limits established in SCAQMD Rule 1113.
   d. Comply with the following VOC content limits:
      1) Anti-Corrosive/Antirust Paints: 250 g/L.
      2) Clear Wood Finish, Lacquer: 550 g/L.
      3) Clear Wood Finish, Sanding Sealer: 350 g/L.
      4) Clear Wood Finish, Varnish: 350 g/L.
      5) Floor Coating: 100 g/L.
      6) Interior Flat Paint, Coating or Primer: 50 g/L.
      7) Interior Non-Flat Paint, Coating or Primer: 150 g/L.
      8) Sealers and Undercoats: 200 g/L.
      9) Shellac, Clear: 730 g/L.
      10) Shellac, Pigmented: 550 g/L.
      11) Stain: 250 g/L.
      12) Clear Brushing Lacquer: 680 g/L.

13) Concrete Curing Compounds: 350 g/L.
14) Japans/Faux Finishing Coatings: 350 g/L.
15) Magnesite Cement Coatings: 450 g/L.
16) Pigmented Lacquer: 550 g/L.
17) Waterproofing Sealers: 250 g/L.
18) Wood Preservatives: 350 g/L.
19) Low-Solids Coatings: 120 g/L.

4. Carpet installed in building interior must comply with one of the following:
   a. Meet testing and product requirements of the Carpet and Rug Institute Green Label Plus program.
   b. Maximum VOC concentrations specified in CDPH Standard Method V1.1-2010, using office scenario at the 14 day time point.
5. Each non-carpet flooring element installed in building interior which is not inherently non-emitting (stone, ceramic, powder-coated metals, plated or anodized metal, glass, concrete, clay brick, and unfinished or untreated solid wood flooring) must comply with one of the following:
   a. Meet requirements of the FloorScore standard as shown with testing by an independent third-party.
   b. Maximum VOC concentrations specified in CDPH Standard Method V1.1-2010, using office scenario at 14 day time point.
6. Composite wood and agrifiber products used within the weatherproofing membrane must contain no added urea-formaldehyde resins.
7. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde.

C. Recycled Content:
1. Any products being installed or used that are listed on EPA Comprehensive Procurement Guidelines designated product list must meet or exceed the EPA’s recycled content recommendations. The EPA Comprehensive Procurement Guidelines categories include:
   a. Building insulation.
   b. Cement and concrete.
   c. Consolidated and reprocessed latex paint.
   d. Floor tiles.
   e. Flowable fill.

f. Laminated paperboard.
g. Modular threshold ramps.
h. Nonpressure pipe.
i. Patio blocks.
j. Railroad grade crossing surfaces.
k. Roofing materials.
l. Shower and restroom dividers/partitions.
m. Structural fiberboard.
n. Nylon carpet and nylon carpet backing.
o. Compost and fertilizer made from recovered organic materials.
p. Hydraulic mulch.
q. Lawn and garden edging.
r. Plastic lumber landscaping timbers and posts.
s. Park benches and picnic tables.
t. Plastic fencing.
u. Playground equipment.
v. Playground surfaces.
w. Bike racks.

D. Biobased Content:

1. Materials and equipment being installed or used that are listed on the USDA BioPreferred program product category list must meet or exceed USDA’s minimum biobased content threshold. Refer to individual specification sections for detailed requirements applicable to that section.
   a. USDA BioPreferred program categories include:
      1) Adhesive and Mastic Removers.
      2) Carpets.
      3) Cleaners.
      4) Composite Panels.
      5) Corrosion Preventatives.
      6) Floor Cleaners and Protectors.
      7) Floor Coverings (Non-Carpet).
      8) Glass Cleaners.
      9) Interior Paints and Coatings.
      10) Multipurpose Cleaners.
      11) Packaging Films.
      12) Paint Removers.
      13) Plastic Insulating Foam.

14) Concrete Sealers.
15) Concrete Stains.

E. Materials, products, and equipment being installed which fall into a category covered by the WaterSense program must be WaterSense-labeled or meet or exceed WaterSense program performance requirements, unless disallowed for infection control reasons.
   1. WaterSense categories include:
      a. Faucets

F. Materials, products, and equipment being installed which fall into any of the following product categories must be Energy Star-labeled.
   1. Applicable Energy Star product categories as of 09/14/2017 include:
      a. Electronics and Information Technology:
         1) Audio/Video Equipment.
         2) Computers.
         3) Data Center Storage.
         4) Imaging Equipment.
         5) Monitors.
         6) Professional Displays.
         7) Telephones.
         8) Televisions.
         9) Uninterruptible Power Supplies.
         10) Voice over Internet Protocol (VoIP) Phones.
         11)
      b. Heating and Cooling Equipment:
         1) Water Heaters.
         2) Light Commercial Heating and Cooling Equipment.
      c. Other:
         1) Light Bulbs.
         2) Light Fixtures.

G. Materials, products, and equipment being installed which fall into any of the following categories must be FEMP-designated. FEMP-designated product categories as of 09/14/2017 include:
   1. Light Emitting Diode (LED) Luminaires.

H. Electronic products and equipment being installed which fall into any of the following categories shall be EPEAT registered. Electronic products and equipment covered by EPEAT program as of 09/14/2017 include:
   1. Computers.

2. Displays.
3. Imaging Equipment.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Construction Indoor Air Quality Management:
1. During construction, meet or exceed recommended control measures of ANSI/SMACNA 008-2008, Chapter 3.
2. Protect stored on-site and installed absorptive materials from moisture damage.
3. If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda). Replace all filtration media immediately prior to occupancy.
4. Perform building flush-out as follows:
a. After construction ends, prior to occupancy and with interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 degrees Fahrenheit and a relative humidity no higher than 60 percent. OR
b. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it must be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or design minimum outside air rate determined until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space. During each day of flush-out period, ventilation must begin a minimum of three hours prior to occupancy and continue during occupancy.

-----END----

SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies demolition and removal of buildings, portions of buildings, utilities, other structures and debris from trash dumps shown.

1.2 RELATED WORK:

A. Safety Requirements: Section 01 35 26 Safety Requirements Article, ACCIDENT PREVENTION PLAN (APP).

B. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.

C. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.

D. Construction Waste Management: Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.

E. Infectious Control: Section 01 35 26, SAFETY REQUIREMENTS.

1.3 PROTECTION:

A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.

B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.

C. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.

E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it

results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.

F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
   1. No wall or part of wall shall be permitted to fall outwardly from structures.
   3. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
   4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.

G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Medical Center; any damaged items shall be repaired or replaced as approved by the Resident Engineer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have Resident Engineer’s approval.

H. The work shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

I. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS and Section 01 35 26, SAFETY REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 DEMOLITION:

A. Completely demolish and remove buildings and structures, including all appurtenances related or connected thereto, as noted below:
   1. As required for installation of new utility service lines.
   2. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside building lines of new structures.

B. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Medical Center to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.

D. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.

E. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Resident Engineer. When Utility lines are encountered that are not indicated on the drawings, the Resident Engineer shall be notified prior to further work in that area.

3.2 CLEAN-UP:

On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Resident Engineer.

Clean-up shall include off the Medical Center / disposal of all items and materials not required to remain property of the Government as well as all debris and rubbish resulting from demolition operations.

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies wood blocking, sheathing, and rough hardware.

1.2 RELATED WORK:

A. Gypsum sheathing: Section 09 29 00, GYPSUM BOARD.

B. Cement board sheathing: Section 06 16 63, CEMENTITIOUS SHEATHING.

1.3 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop Drawings showing framing connection details, fasteners, connections and dimensions.

C. Manufacturer’s Literature and Data:

1. Submit data for lumber, panels, hardware and adhesives.
2. Submit data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plants that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
3. Submit data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
4. For products receiving a waterborne treatment, submit statement that moisture content of treated materials was reduced to levels specified before shipment to project site.

D. Manufacturer’s certificate for unmarked lumber.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Protect lumber and other products from dampness both during and after delivery at site.

B. Pile lumber in stacks in such manner as to provide air circulation around surfaces of each piece.

C. Stack plywood, sheathing, and other board products so as to prevent warping.

D. Locate stacks on well drained areas, supported at least 152 mm (6 inches) above grade and cover with well-ventilated sheds having

firmly constructed over hanging roof with sufficient end wall to protect lumber from driving rain.

1.5 QUALITY ASSURANCE:

A. Installer: A firm with a minimum of three (3) years' experience in the type of work required by this section.

1.6 GRADING AND MARKINGS:

A. Any unmarked lumber or plywood panel for its grade and species will not be allowed on VA Construction sites for lumber and material not normally grade marked, provide manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material meet the specified the specified requirements.

1.7 APPLICABLE PUBLICATIONS:

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.

B. American Forest and Paper Association (AFPA):

NDS-15.....National Design Specification for Wood Construction

WCD1-01.....Details for Conventional Wood Frame Construction

C. American Institute of Timber Construction (AITC):

A190.1-07.....Structural Glued Laminated Timber

D. American Society of Mechanical Engineers (ASME):

B18.2.1-12(R2013).....Square and Hex Bolts and Screws

B18.2.2-10.....Square and Hex Nuts

B18.6.1-81(R2008).....Wood Screws

E. American Plywood Association (APA):

E30-11.....Engineered Wood Construction Guide

F. ASTM International (ASTM):

A653/A653M-13.....Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process

C954-11.....Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.033 inch (2.24 mm) to 0.112-inch (2.84 mm) in thickness

C1002-14.....Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Metal Studs

D198-14.....Test Methods of Static Tests of Lumber in Structural Sizes

D2344/D2344M-13.....Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates

D2559-12a.....Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions

D3498-03(R2011).....Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems

D6108-13.....Test Method for Compressive Properties of Plastic Lumber and Shapes

D6109-13.....Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products

D6111-13a.....Test Method for Bulk Density and Specific Gravity of Plastic Lumber and Shapes by Displacement

D6112-13.....Test Methods for Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes

F844-07a(R2013).....Washers, Steel, Plan (Flat) Unhardened for General Use

F1667-13.....Nails, Spikes, and Staples

G. American Wood Protection Association (AWPA):

AWPA Book of Standards

H. Commercial Item Description (CID):

A-A-55615.....Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)

I. Forest Stewardship Council (FSC):

FSC-STD-01-001(Ver. 4-0)FSC Principles and Criteria for Forest Stewardship

J. Military Specification (Mil. Spec.):

MIL-L-19140E.....Lumber and Plywood, Fire-Retardant Treated

K. Environmental Protection Agency (EPA):

40 CFR 59(2014).....National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

L. Truss Plate Institute (TPI):
TPI-85.....Metal Plate Connected Wood Trusses

M. U.S. Department of Commerce Product Standard (PS)
PS 1-95.....Construction and Industrial Plywood
PS 20-10.....American Softwood Lumber Standard

N. ICC Evaluation Service (ICC ES):
AC09.....Quality Control of Wood Shakes and Shingles
AC174.....Deck Board Span Ratings and Guardrail Systems (Guards and Handrails)

PART 2 - PRODUCTS

2.1 LUMBER:

A. Unless otherwise specified, each piece of lumber must bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
   1. Identifying marks are to be in accordance with rule or standard under which material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification.
   2. Inspection agency for lumber approved by the Board of Review, American Lumber Standards Committee, to grade species used.

B. Sizes:
   1. Conforming to PS 20.
   2. Size references are nominal sizes, unless otherwise specified, actual sizes within manufacturing tolerances allowed by standard under which produced.

2.2 ROUGH HARDWARE AND ADHESIVES:

A. Anchor Bolts:
   1. ASME B18.2.1 and ASME B18.2.2 galvanized, 13 mm (1/2 inch) unless shown otherwise.
   2. Extend at least 203 mm (8 inches) into masonry or concrete with ends bent 50 mm (2 inches).

B. Miscellaneous Bolts: Expansion Bolts: C1D A-A-55615; lag bolt, long enough to extend at least 65 mm (2-1/2 inches) into masonry or concrete. Provide 13 mm (1/2 inch) bolt unless shown otherwise.

C. Washers
   1. ASTM F844.

2. Provide zinc or cadmium coated steel or cast iron for washers exposed to weather.

PART 3 - EXECUTION

3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS:

A. Fasteners:

1. Bolts:
   a. Fit bolt heads and nuts bearing on wood with washers.
   b. Countersink bolt heads flush with the surface of nailers.
   c. Embed in concrete and solid masonry or provide expansion bolts. Special bolts or screws designed for anchor to solid masonry or concrete in drilled holes may be used.
   d. Provide toggle bolts to hollow masonry or sheet metal.
   e. Provide bolts to steel over 2.84 mm (0.112 inch, 11 gage) in thickness. Secure wood nailers to vertical structural steel members with bolts, placed one at ends of nailer and 610 mm (24 inch) intervals between end bolts. Provide clips to beam flanges.
2. Drill Screws to steel less than 2.84 mm (0.112 inch) thick.
   a. ASTM C1002 for steel less than 0.84 mm (0.033 inch) thick.
   b. ASTM C954 for steel over 0.84 mm (0.033 inch) thick.
4. Power actuated drive pins may be provided where practical to anchor to solid masonry, concrete, or steel.

B. Sheathing:

1. Provide plywood or structural-use panels for sheathing.
2. Lay panels with joints staggered, with edge and ends 3 mm (1/8 inch) apart and nailed over bearings as specified.
3. Set nails not less than 9 mm (3/8 inch) from edges.
4. Install 50 mm by 101 mm (2 inch by 4 inch) blocking spiked between joists, rafters and studs to support edge or end joints of panels.
5. Match and align sheathing which is an extension of work in place to existing.

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SECTION 06 16 63
CEMENTITIOUS SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cement board sheathing at exterior framed wall construction.

1.2 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this Section.

B. American National Standards Institute (ANSI):

1. A118.9-10 - Cementitious Backer Units.

C. ASTM International (ASTM):

1. C954-18 - Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
2. C1002-18 - Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
3. C1325-14 - Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units.

1.3 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Description of each product.
2. Installation instructions.
3. Warranty.

C. Samples:

1. Cement Board: 200 mm by 200 mm (8 inches by 8 inches), minimum size.
2. Fasteners: One of each type used.

D. Provide Sustainable Construction Requirements-Provide in accordance with other Division 1 sections.

1.4 DELIVERY AND STORAGE

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.5 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

1.6 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant sheathing against material and manufacturing defects.

1. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

A. Provide products from one manufacturer.

2.2 SHEATHING

A. Cement Boards: Meeting ANSI A118.9 and ASTM C1325.

1. Thickness: 13 mm (1/2 inch), 16 mm (5/8 inch) or Match Existing.
2. Width: 1219 mm (48 inches), minimum.

2.3 ACCESSORIES

A. Steel Drill Screws: Corrosion-resistant, self-drilling.

1. ASTM C1002, Type S for fastening to framing less than 0.8 mm (33 mils) thick.
2. ASTM C954 for fastening to framing 0.8 mm (33 mils) thick and greater.

B. Joint Reinforcement: Alkali resistant tape as recommended by sheathing manufacturer.

C. Bonding Material: As recommended by sheathing manufacturer.

D. Air Barrier: As specified in Section 07 27 26, FLUID-APPLIED MEMBRANE AIR BARRIER, VAPOR PERMEABLE

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Verify framing is plumb and level and in plane.

D. Correct substrate deficiencies.

3.2 SHEATHING INSTALLATION

A. Install products according to manufacturer's instructions.

1. Secure units to framing members with screws spaced maximum 200 mm (8 inches) o.c. and not closer than 13 mm (1/2 inch) from edge of unit.
2. Install screw heads without penetrating cement board surface.
3. Install sheathing with 6 mm (1/4 inch) gap where sheathing abuts masonry or similar materials to prevent wicking of moisture.
4. Install sheathing with 10 mm (3/8 inch) gap where non-load-bearing construction abuts structural elements or building expansion joints.
5. Horizontal Installation: Abut ends of boards over centers of studs. Stagger end joints minimum one stud spacing for adjacent boards. Fasten boards at perimeter and within field of board to each stud.
6. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Fasten boards at perimeter and with fin field of board to each stud.
7. Apply bonding material to imbed tape and completely fill board joints, and gaps between each panel.

3.3 PROTECTION

A. Remove loose or spalling joint finish. Patch areas missing joint finish.

B. Replace broken or damaged boards.

C. Protect boards from moisture using temporary coverings until finishes are applied.

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SECTION 07 21 13
THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermal insulation.

a. Batt or blanket insulation at exterior framed and furred walls.

b. Board or block insulation at wall assemblies.

c. Spray-in-place rigid foam insulation, and intumescent ignition barrier.

1.2 RELATED WORK

A. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Adhesives VOC Limits.

B. Section 07 27 26, FLUID APPLIED AIR VAPOR MEMBRANES

C. Section 07 60 00, FLASHING AND SHEET METAL

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

C553-13(2019).....Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

C578-19.....Rigid, Cellular Polystyrene Thermal Insulation.

C612-14(2019).....Mineral Fiber Block and Board Thermal Insulation.

C954-18.....Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Base to Steel Studs From 0.033 (0.84 mm) inch to 0.112 inch (2.84 mm) in thickness.

C1002-18.....Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

D312/D312M-16a.....Asphalt Used in Roofing.

E84-20.....Surface Burning Characteristics of Building Materials.

F1667-18a.....Driven Fasteners: Nails, Spikes, and Staples.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show insulation type, thickness, and R-value for each location.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Adhesive indicating manufacturer recommendation for each application.

D. Sustainable Construction Submittals:

1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
2. Low Pollutant-Emitting Materials: Show volatile organic compound types and quantities.

1.5 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.6 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

C. Protect foam plastic insulation from UV exposure.

1.7 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 INSULATION - GENERAL

A. Insulation Types:

1. Semi-Rigid Mineral Wool: Basis of Design Product: Thermafiber® RainBarrier® 45, non-combustible, semi-rigid mineral wool insulation board that is water-repellent and resists temperatures above 2,000 degrees F, meets ASTM C612, IVB.
   a. Size: 3”
   b. R-value: 4.3 per inch.
   c. Facing: Unfaced.

d. Density: 4.5 pcf.
e. Moisture-Resistance: Absorption of less than 0.03% by volume when tested in accordance with ASTM C1104.

2. Composite Cement Board Insulation: Basis of Design Product: National Gypsum PermaBASE CI Insulated Cement Board
   a. Size: 3″ x 48″ x 8′
   b. R-value: 16
   c. Facing: Manufacture’s standard cement board.
   d. Density: 2.6 psf.
   e. Moisture-Resistance: Absorption of less than 5% by volume when tested in accordance with ASTM C209
3. Spray-in-place rigid polyurethane foam insulation: Basis of Design Product: Demilec Heatlok Soy 200+, two component, closed cell, spray applied, rigid polyurethane foam system
   a. Air Permeance: 0.02 L/sm2 per inch
   b. R-value: Initial 7.4 per inch
   c. Density: 2.1 pcf.
   d. Water Permeance: <1 perm when tested in accordance with ASTM E 96
   e. Compliant with CA 01350 VOC Emissions standard
   f. Intumescent paint must be used on spray foam where foam insulation is not covered with an ignition barrier.
      1) Basis of design: RDR Technologies, LLC: DC315
      2) Comply with AC377 and AC456
      3) ASTM E 84: Flame Spread 0 Smoke Development 10
      4) CAN/ULC S102 - (tested as a system over SPF: FSR 23 SDC 145
      5) Low emitting material per CAL 1350
      6) Apply in accordance with manufacturer’s instructions
   g. Use low expansion type foam in locations where the perimeter barrier could be deformed or damaged with high pressure.

2.2 THERMAL INSULATION

A. Exterior Framing or Furring Insulation:
   1. Mineral Fiber Board: ASTM C612, Type IB.
B. Exterior Porcelain Tile Finish:
   1. Cement Board Faced High-density polyisocyanurate insulation: ASTM C591 I
   2. Mineral Fiber Board: ASTM C612, Type IB.

2.3 SPRAY-IN-PLACE RIGID POLYURETHANE FOAM INSULATION: CLOSED CELL CONTENT (ASTM D2856): >90% ACCESSORIES

A. Composite framing support (CFS) system: Basis of design product **Advanced Architectural Products (A2P)**: SMARTci GreenGirt Clips Composite Framing Support (CFS) System

1. System consisting of polyester resin matrix with recycled materials, fire retardant additives and reinforced with integral continuous metal inserts the length of profile at all fastening locations. Reinforce CFS systems with glass strand rovings used internally for longitudinal (lengthwise) strength and continuous strand glass mats or stitched reinforcements used internally for transverse (crosswise) strength.
2. Depth of Girt: 3 inch deep.
3. On Center Spacing: 16 inch or as shown on drawings.
4. Orientation: As indicated on drawings.
5. Provide continuous non-corrosive steel insert for engagement of fasteners, at least 16 gauge thick with G90 galvanized coating designation in compliance with ASTM A653/A653M.
   a. Fully engage and secure steel insert with adjacent CMH at ends, allowing for thermal expansion.
   b. Anchor sub-girts and other wall cladding support accessories to steel insert set into and part of CFS.
6. Provide integral compression seal in CFS sections to ensure insulation panel will not dislodge.
7. Provide integral anti-siphon grooves on exterior and interior flanges of CFS.
8. Provide force distribution zones integrally designed into profile of CFS.
9. Thermal Transmission: CFS system design should limit rate of heat flow crosswise through the profile section to less than 1.190 watts per 8’ length in profile and temperature delta of 100 degrees Fahrenheit. Rate of heat flow to be determined in accordance with ASTM C1045-01, validated by a third party.
10. Surface Burning Characteristics:
    a. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84.
    b. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.

11. Self-Extinguishing: Comply with ASTM D635.
12. Profile Visual Requirements: Per ASTM D4385.
13. Mechanical Strength Requirements: Provide CMH system in compliance with the performance loading criteria and specified safety factors to meet the below requirements:

Longitudinal:

Evaluation	**Method**	**Minimum Longitudinal**
Modulus of Elasticity	ASTM D638	29,000,000 psi
Tensile Strength	ASTM D638	50,000 psi
Compressive Strength	ASTM D6641	50,000 psi
Flexural Stress	ASTM D790	50,000 psi

Crosswise:

Evaluation	**Method**	**Minimum Crosswise**
Modulus of Elasticity	ASTM D638	3,300,000 psi
Tensile Strength	ASTM D638	40,000 psi
Compressive Strength	ASTM 6641	30,000 psi
Flexural Stress	ASTM D790	40,000 psi

14. Barcol Hardness: 45, in accordance with ASTM D2583.
15. Water Absorption: Less than 0.46 percent by weight, within 24 hours, tested in accordance with ASTM D570.
16. Density: Within range of 0.062 to 0.070 lbs/cubic inch, in accordance with ASTM D792.
17. Lengthwise Coefficient of Thermal Expansion: 7.0×10^{-6} inch/inch/degrees F, in accordance with ASTM D696.
18. Notched Izod Impact, Lengthwise: 160 ft lbs/inch, in accordance with ASTM D256 within temperature range indicated.
19. Notched Izod Impact, Crosswise: 100 ft lbs/inch, in accordance with ASTM D256 within temperature range indicated.

B. Fasteners:

1. Corrosion-resistant, self-tapping and self-drilling screws, bolts, nuts, and other fasteners as recommended by CFS system manufacturer for CMH material and project application.
2. Screws: ASTM C954 or ASTM C1002, size and length to suit application with washer minimum 50 mm (2 inches) diameter.

3. Impaling Pins: Steel pins with head minimum 50 mm (2 inches) diameter.
   a. Length: As required to extend beyond insulation and retain cap washer when washer is placed on pin.
   b. Adhesive: Type recommended by manufacturer to suit application.

C. Insulation Adhesive: One-component polyurethane sealant, or type recommended by insulation manufacturer to suit application.

D. Tape: Pressure sensitive adhesive on one face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Install board insulation with joints close and flush, in regular courses, and with end joints staggered.

C. Install batt and blanket insulation with joints tight. Fill framing voids completely. Seal penetrations, terminations, facing joints, facing cuts, tears, and unlapped joints with tape.

D. Fit insulation tight against adjoining construction and penetrations, unless indicated otherwise.

E. Install system to fill-in exterior spaces without gaps or voids, and do not compress insulation panels.

F. Trim insulation neatly to fit spaces, and insulate miscellaneous gaps and voids.

G. Install CFS system in compliance with system orientation, sizes, and locations as indicated on drawings.

3.3 THERMAL INSULATION

A. Exterior Framing or Furring Insulation:
   1. General:
      a. Open voids are not acceptable.

b. Pack insulation around door frames and windows, in building expansion joints, door soffits, and other voids.
c. Pack behind outlets, around pipes, ducts, and services encased in walls.

B. Exterior Porcelain Tile Finish:
1. Apply composite insulation with ends and edges closely butted, but not forced, together.
2. Stagger end joints in successive courses.
3. Drive fasteners into field of cement board first, working toward ends and edges.
4. Space fasteners maximum 8" o.c. with perimeter fasteners at least 3/8" and less than 5/8" from ends and edges.
5. Ensure Insulated Cement Board is tight to framing. Do not overdrive screws to the point they penetrate the fiberglass mesh in composite insulation.
6. For exterior finishes applied directly to Insulated Cement Board, reinforcing mesh must be embedded in basecoat (consult exterior finish manufacturer for additional installation requirements).

C. Inside face of existing Vapor Retarder:
1. Do not begin installation until substrates have been properly prepared.
2. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
3. Commencement of work outlined in this section shall be deemed as acceptance of existing work and conditions.
4. Clean surfaces thoroughly prior to installation.
5. Apply only when surfaces and environmental conditions are within limits prescribed by the material manufacturer.
6. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
7. Install in accordance with manufacturer's instructions. Apply as recommended by manufacturer to thickness as indicated on drawings.

3.4 CLEANING

A. Remove excess adhesive before adhesive sets.

3.5 PROTECTION

A. Protect insulation from construction operations.
B. Repair damage.

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SECTION 07 27 26
FLUID-APPLIED MEMBRANE AIR BARRIERS, VAPOR PERMEABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fluid-applied vapor-permeable air barrier at exterior above grade wall assemblies.
2. Connection to adjacent air barrier components providing a durable, continuous, full building air barrier.

1.2 RELATED WORK

A. Section 01 45 29 TESTING LABORATORY SERVICES: General Quality Assurance and Quality Control Requirements.

B. Section 07 40 00 ROOFING AND SIDING PANELS: Flashing Components of Factory Finished Roofing and Wall Systems Requiring Air Barrier Transitions.

C. Section 07 60 00 FLASHING AND SHEET METAL: Metal Flashing Requiring Air Barrier Transitions.

D. Section 07 92 00, JOINT SEALANTS: Joint Sealants.

E. Division 08 sections for aluminum-framed entrances and storefronts aluminum windows glazed aluminum curtain walls louvers and vents: Exterior Wall Openings Requiring Air Barrier Transitions.

F. Section 07 54 23 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING: Wall Sheathings, Roofing membrane.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. Air Barrier Association of America (ABAA):
Quality Assurance Program.

C. ASTM International (ASTM):
C920-18.....Elastomeric Joint Sealants.
C1193-16.....Use of Joint Sealants.
D412-16.....Vulcanized Rubber and Thermoplastic Elastomers-Tension.
E96/E96M-16.....Water Vapor Transmission of Materials.
E162-16.....Surface Flammability of Materials Using a Radiant Heat Energy Source.
E783-02(2018).....Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

E1186-17.....Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
E2178-13.....Air Permanence of Building Materials.
E2357-18.....Determining Air Leakage of Air Barrier Assemblies.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
   1. Show size, configuration, and fabrication and installation details.
B. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Installation instructions.
C. Sustainable Construction Submittals:
   1. Low Pollutant-Emitting Materials:
      a. Identify volatile organic compound types and quantities.
D. Test reports:
   1. Submit field inspection and test reports.
E. Certificates: Certify each product complies with specifications.
   1. Compatibility: Certify products are compatible with adjacent materials.
F. Qualifications: Substantiate qualifications comply with specifications.
   1. Manufacturer with project experience list
   2. Installer with project experience list
      a. Include personnel qualifications.
      b. Field supervisor qualifications.
      c. Certify installer approval by air barrier manufacturer.
G. Installation Audit:
   1. Submit audit report.

1.5 QUALITY ASSURANCE

A. Coordinate work with adjacent and related work to provide continuous, unbroken, durable air barrier system.
B. Manufacturer Qualifications:
   1. Regularly and presently manufactures specified products.
   2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.
   3. Accreditation by ABAA.
C. Installer Qualifications:
   1. Regularly and presently installs specified products.

2. Approved by manufacturer.
3. Accredited by ABAA.
4. Applicators certified according to ABAA Quality Assurance Program.
5. Applicators trained and certified by manufacturer of air barrier system.
6. Full time on-site field supervisor has completed three projects of similar scope within last year.
7. Field supervisor accredited by ABAA as Level 3 Accredited Installer.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.
B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.
C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight, conditioned facility.
B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Environment:
1. Work Area Ambient Temperature Range: 4 to 32 degrees C (40 to 90 degrees F) continuously, beginning 48 hours before installation.
2. Surface Requirements: visibly dry, and complying with manufacturer's instructions.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Air-Barrier Assembly Air Leakage: Maximum 0.2 L/s/square meter (0.04 cfm/square feet) of surface area at 75 Pa (1.57 psf) differential pressure when tested according to ASTM E2357.
B. Provide full system of compatible materials under conditions of service and application required. Compatibility based on testing by material manufacturer.
C. Perform as continuous vapor permeable air barrier and moisture drainage plane.

D. Transition to adjacent flashings and discharge water to building exterior.

E. Accommodate substrate movement and seal expansion and control joints, construction material transitions, opening transitions, penetrations, and perimeter conditions without moisture deterioration and air leakage exceeding performance requirements.

2.2 PRODUCTS - GENERAL

A. Provide air barrier system components from one manufacturer.

B. Sustainable Construction Requirements:

1. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:

a. Non-Flooring Adhesives and Sealants.

2.3 AIR BARRIER

A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier:

1. Elastomeric, modified bituminous or synthetic polymer membrane.

2. Air Permeance: ASTM E2178: 0.02 L/s/square meter (0.004 cfm/square feet) of surface area at 75 Pa (1.57 psf) differential pressure.

3. Vapor Permeance: ASTM E96/E96M: Minimum 580 ng/Pa/s/square meter (10 perms).

4. Elongation: Ultimate, ASTM D412, Die C: 200 percent, minimum.

5. Thickness: Minimum 1.0 mm (40 mils) dry film thickness, applied in single continuous coat.

6. Surface Burning Characteristics: When tested according to ASTM E84.

a. Flame Spread Rating: 25 maximum.

b. Smoke Developed Rating: 450 maximum.

2.4 ACCESSORIES

A. Primer: Waterborne primer complying with VOC requirements, recommended air barrier manufacturer to suit application.

B. Counterflashing Sheet: Modified bituminous, minimum 1.0 mm (40 mils) thick, self-adhering composite sheet consisting of minimum 0.8 mm (33 mils) of rubberized asphalt laminated to polyethylene film.

C. Substrate Patching Material: Manufacturer's standard trowel-grade filler material.

D. Sprayed Polyurethane Foam Sealant: Foamed-in-place, 24 to 32 kg/cu. m (1.5 to 2.0 pcf) density, with maximum flame-spread index of 25 when tested according to ASTM E84.

E. Flexible Opening Transition: Cured low-modulus silicone extrusion with reinforcing ribs, sized to fit opening widths, designed for adhesion to or insertion into aluminum framing extrusions, and compatible with air barrier system materials and accessories.

F. Joint Sealant: ASTM C920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, approved by membrane air barrier manufacturer for adhesion and compatibility with membrane air barrier and accessories.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Correct substrate deficiencies:

1. Remove projections and excess materials and fill voids with substrate patching material.
2. Remove contaminants capable of affecting subsequently installed product's performance.

D. Prepare and treat substrate joints and cracks according to ASTM C1193 and membrane air barrier manufacturer's instructions.

3.2 INSTALLATION - AIR BARRIER

A. Install products according to manufacturer's instructions and approved submittal drawings.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Install air barrier components according to requirements of ABAA Quality Assurance Program.

C. Apply primer.

D. Install transition strips and accessory materials.

E. Seal air barrier to adjacent components of building air barrier system.

F. Install flexible opening transition at each opening perimeter. Extend transition onto each substrate minimum 75 mm (3 inches).

1. Fill gaps at perimeter of openings with foam sealant.

G. At penetrations, seal transition strips around penetrating objects with termination mastic.

1. Fill gaps at perimeter of penetrations with sprayed polyurethane foam sealant.

H. At top of through-wall flashings, seal with continuous transition strip of manufacturer's recommended material to suit application.

I. Apply air barrier in full contact with substrate to produce continuous seal with transitions.

J. Apply fluid membrane in thickness recommended by manufacturer, and minimum specified thickness.

K. Leave air barrier exposed until tested and inspected and approved by Contracting Officer’s Representative.

3.3 FIELD QUALITY CONTROL

A. Field Inspections and Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

1. Perform inspections and tests before concealing air barrier with subsequent work.

B. Inspections:

1. Compatibility of materials within air barrier system and adjacent materials.
2. Suitability of substrate and support for air barrier.
3. Suitability of conditions under which air barrier is applied.
4. Adequacy of substrate priming.
5. Application and treatment of joints and edges of transition strips, flexible opening transitions, and accessory materials.
6. Continuity and gap-free installation of air barrier, transition strips, and accessory materials.

C. Inspection and Test Frequency: Determined by installed air barrier surface area.

1. Up to 900 square meter (10,000 square feet): One inspection.
2. 901 - 3,300 square meter (10,001 - 35,000 square feet): Two inspections.
3. 3,300 - 7,000 square meter (35,001 - 75,000 square feet): Three inspections.
4. 7,001 - 11,600 square meter (75,001 - 125,000 square feet): Four inspections.
5. 11,601 - 19,000 square meter (125,001 - 200,000 square feet): Five inspections.
6. Over 19,000 square meter (200,000 square feet): Six inspections.

D. Submit inspection and test reports to Contracting Officer’s Representative within seven calendar days of completing inspection and test.

E. Audit:
   1. Provide installer and site inspections audit by ABAA.
   2. Coordinate scheduling of work and associated audit inspections.
   3. Cooperate with ABAA’s testing agency. Allow access to work and staging areas.
   4. Notify ABAA in writing of schedule for Work of this Section to allow sufficient time for testing and inspection.

F. Defective Work:
   1. Correct deficiencies, make necessary repairs, and retest as required to demonstrate compliance with specified requirements.

3.4 CLEANING

A. Remove masking materials.

B. Clean spills and overspray using cleaning agents recommended by manufacturers of affected construction.

3.5 PROTECTION

A. Protect air barrier from construction operations.

B. Protect air barrier from exposure to UV light exposure exceeding manufacturer's recommendation.

C. Replace overexposed materials and retest.

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SECTION 07 54 23
THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic Polyolefin (TPO) sheet roofing adhered to roof deck.

1.2 RELATED WORK

A. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Non-Flooring Adhesives and Sealants VOC Limits.

B. Section 07 60 00 FLASHING AND SHEET METAL: Parapet coping

C. Section 07 21 13, THERMAL INSULATION: Insulation at top of parapet

D. Section 07 27 26 FLUID-APPLIED MEMBRANE AIR BARRIERS, VAPOR PERMEABLE

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):

FX-1-16.....Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.

C. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):

7-16.....Minimum Design Loads for Buildings and Other Structures.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):

90.1-13.....Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. ASTM International (ASTM):

C67-20.....Sampling and Testing Brick and Structural Clay Tile.

C140/C140M-20a.....Sampling and Testing Concrete Masonry Units and Related Units.

C1371-15.....Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.

C1549-16.....Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.

D1876-08(2015)e1.....Peel Resistance of Adhesives (T-Peel Test).

D4263-83(2018).....Indicating Moisture in Concrete by the Plastic Sheet Method.

D4434/D4434M-15.....Poly(Vinyl Chloride) Sheet Roofing.

D6878/D6878M-13.....Thermoplastic Polyolefin Based Sheet Roofing.

E408-13.....Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

E1918-16.....Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.

E1980-11(2019).....Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

F. Cool Roof Rating Council (CRRC):

1-20.....Product Rating Program.

G. National Roofing Contractors Association (NRCA):

Manual-19.....The NRCA Roofing Manual: Membrane Roofing Systems.

H. U.S. Department of Agriculture (USDA):

BioPreferred® Program Catalog.

I. UL LLC (UL):

580-06.....Tests for Uplift Resistance of Roof Assemblies.

1897-20.....Uplift Tests for Roof Covering Systems.

J. U.S. Department of Commerce National Institute of Standards and Technology (NIST):

DOC PS 1-19.....Structural Plywood.

DOC PS 2-18.....Performance Standard for Wood-Based Structural-Use Panels.

K. U.S. Environmental Protection Agency (EPA):

Energy Star.....ENERGY STAR Program Requirements for Roof Products Version 3.0.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Base flashing and termination details.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Minimum fastener pullout resistance.
3. Installation instructions.
4. Warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Approved by roofing system manufacturer as installer for roofing system with specified warranty.
   2. Regularly installs specified products.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.
B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, and manufacture date.
C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Comply with NRCA Manual storage and handling requirements.
B. Store products indoors in dry, weathertight facility.
C. Store adhesives according to manufacturer's instructions.
D. Protect products from damage during handling and construction operations.
E. Products stored on the roof deck must not cause permanent deck deflection.

1.8 FIELD CONDITIONS

A. Environment:
   1. Product Temperature: Minimum 4 degrees C (40 degrees F) for minimum 48 hours before installation.
   2. Weather Limitations: Install roofing only during dry current and forecasted weather conditions.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."
B. Manufacturer's Warranty: Warrant roofing system against material and manufacturing defects and agree to repair any leak caused by a defect in the roofing system materials or workmanship of the installer.
   1. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Roofing System: Thermoplastic Polyolefin (TPO) sheet roofing adhered to roof deck.

2.2 SYSTEM PERFORMANCE

A. Design roofing system complying with specified performance:

1. Wind:
   a. Basic wind speed V3s = 49 meters per second (110 MPH) per MOA “3 second gust wind speed map”.
   b. Wind Exposure = B
   c. Wind Importance Factor Iw = 1.15.
2. SEISMIC:
   a. Seismic use group – III
   b. Seismic Factor Ie = 1.50
   c. Sps = 1.006
   d. Sp1 = 0.559
   e. Ss = 1.509
   f. S1 = 0.559
   g. Seismic design category = D
3. SNOW:
   a. Ground Snpw Load pf = 40 pounds per square foot
   b. Snow Exposure Factor Ce = 1.0
   c. Thermal Factor = Ct = 1.0
   d. Snow Load Importance Factor Is = 1.2

2.3 PRODUCTS - GENERAL

A. Provide roof system components from one manufacturer.

2.4 TPO ROOFING MEMBRANE

1. TPO Sheet: ASTM D6878/D6878M, internally fabric or scrim reinforced, 1.5 mm (60 mils) thick, with fabric backing
   a. Exposed sheet color shall be white.
   b. Provide adhesively bonded membrane over EPS insulation coping.

2.5 MEMBRANE ACCESSORY MATERIALS

A. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as TPO sheet membrane.

B. Factory Formed Flashings: Inside and outside corners, pipe boots, and other special flashing shapes to minimize field fabrication.

C. Bonding Adhesive: Manufacturer's standard, water based.

D. Metal Termination Bars: Manufacturer's standard, stainless-steel or aluminum, 25 mm wide by 3 mm thick (1-inch wide by 1/8 inch thick) factory drilled for fasteners.

E. Battens: Manufacturer's standard, galvannealed or galvanized steel sheet, 25 mm wide by 1.3 mm thick (1-inch wide by 0.05 inch thick), factory punched for fasteners.

F. Fasteners: Manufacturer's standard coated steel with metal or plastic plates, to suit application.

G. Primers, Sealers, T-Joint Covers, Lap Sealants, and Termination Reglets: As specified by roof membrane manufacturer.

H. Adhesive and sealant materials recommended by roofing system manufacturer for intended use, identical to materials utilized in approved listed roofing system, and compatible with roofing membrane.

2.6 ACCESSORIES

A. Flashing and Sheet Metal: specified in Section 07 60 00.

B. GLASS MAT GYPSUM SUBSTRATE:

1. Glass mat gypsum substrate Type X (special fire-resistant) ASTM C117/ C1177M.
2. provide maximum substrate widths and lengths available.
3. Provide thickness required to match existing where occurs or minimum (0.5 inch) thick.
4. Mechanically fasten to structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine and verify substrate suitability with roofing Installer and roofing inspector present.

1. Verify roof penetrations are complete, secured against movement,.
2. Verify substrate is clean, dry, and in-plane ready to receive roofing system.

B. Correct unsatisfactory conditions before beginning roofing work.

3.2 PREPARATION

A. Complete roof parapet construction before beginning roofing work:

1. Curbs, blocking, edge strips, nailers, cants, and other components to which insulation, roofing, and base flashing is attached in place ready to receive insulation and roofing.
2. Coordinate roofing membrane installation with flashing work and roof insulation work so insulation and flashing are installed concurrently to permit continuous roofing operations.
3. Complete installation of flashing, insulation, and roofing in same day except for the area where temporary protection is required when work is stopped for inclement weather or end of work day.

B. Dry out surfaces that become wet from any cause during progress of the work before roofing work is resumed. Apply materials to dry substrates, only.

C. Remove projections capable of damaging roofing materials.

3.3 TEMPORARY PROTECTION

A. Install temporary protection consisting of a temporary seal and water cut-offs at the end of each day's work and when work is halted for an indefinite period or work is stopped when precipitation is imminent.

B. Install temporary cap flashing over top of base flashings where permanent flashings are not in place to protect against water intrusion into roofing system. Securely anchor in place to prevent blow off and damage by construction activities.

C. Temporarily seal exposed insulation surfaces within roofing membrane.

1. Apply temporary seal and water cut off by extending roofing membrane beyond insulation and securely embedding edge of the roofing membrane in 6 mm (1/4 inch) thick by 50 mm (2 inches) wide strip of temporary closure sealant. Weight roofing membrane edge with sandbags, to prevent displacement; space sandbags maximum 2400 mm (8 feet) on center.

2. Direct water away from work. Provide drainage, preventing water accumulation.

3. Check daily to ensure temporary seal remains watertight. Reseal open areas and weight down.

D. Before the work resumes, cut off and discard portions of roof membrane in contact with temporary seal.

1. Cut minimum 150 mm (6 inches) back from sealed edges and surfaces.

3.4 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Comply with NRCA Manual installation requirements.

C. Do not allow membrane and flashing to contact surfaces contaminated with asphalt, coal tar, oil, grease, or other substances incompatible with TPO.

3.5 ROOFING INSTALLATION

A. Roll membrane out; inspect for defects as membrane is unrolled. Remove defective areas:

1. Lap edges and ends of sheets 50 mm (2 inches) or more as recommended by the manufacturer.

2. Heat weld laps. Apply pressure as required. Seam strength of laps as required by ASTM D4434/D4434M.
3. Check seams to ensure continuous adhesion and correct defects.
4. Finish seam edges with beveled bead of lap sealant.
5. Finish seams same day as membrane is installed.
6. Anchor membrane perimeter to parapet wall as indicated on drawings.

B. Membrane Perimeter Anchorage:
1. Install batten at perimeter of each roof area, curb flashing, expansion joints and similar penetrations on top of roof membrane as indicated on drawings.

C. Adhered System:
1. Apply bonding adhesive in quantities required by roof membrane manufacturer.
2. Fold sheet back on itself, clean and coat the bottom side of the membrane and the top of substrate with adhesive. Do not coat the lap joint area.
3. After adhesive has set according to adhesive manufacturer's instruction, roll roofing membrane into adhesive minimizing voids and wrinkles.
4. Repeat for other half of sheet.

3.6 FLASHING INSTALLATION

A. Install flashings same day as roofing membrane is installed. When flashing cannot be completely installed in one day, complete installation until flashing is watertight and provide temporary covers or seals.

B. Installing Building Expansion Joints:
1. Install base flashing on curbs as specified.
2. Coordinate installation with roof expansion joint system.
3. Install flexible tubing 1-1/2 times the width of joint centered over joint. Cover tubing with flashing sheet adhered to base flashing and lapping base flashing roofing manufacturer's standard dimension. Finish edges of laps with sealant.

C. Repairs to Membrane and Flashings:
1. Remove sections of roofing membrane or flashing that are creased, wrinkled, or fishmouthed.
2. Cover removed areas, cuts and damaged areas with a patch extending 100 mm (4 inches) beyond damaged, cut, or removed area. Heat weld to

roofing membrane or flashing sheet. Finish edge of lap with lap sealant.

3.7 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

B. Manufacturer Services:

1. Inspect initial installation, installation in progress, and completed work.
2. Issue supplemental installation instructions necessitated by field conditions.
3. Prepare and submit inspection reports.
4. Certify completed installation complies with manufacturer's instructions and warranty requirements.

3.8 CLEANING

A. Remove excess adhesive before adhesive sets.

B. Clean exposed roofing surfaces. Remove contaminants and stains.

3.9 PROTECTION

A. Protect roofing system from traffic and construction operations.

1. Protect roofing system when used for subsequent work platform, materials storage, or staging.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

- - - E N D - - -

SECTION 07 60 00
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Formed sheet metal work for wall and roof flashing, copings, roof edge metal, fasciae, drainage specialties, and formed expansion joint covers are specified in this section.

1.2 RELATED WORK

A. Section 07 54 23 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING: Membrane base flashings and stripping.

B. Division 07 ROOFING AND WALL SYSTEM: Flashing components of factory finished roofing and wall systems.

C. Section 07 92 00, JOINT SEALANTS: Joint Sealants.

D. Section 09 91 00, PAINTING: Paint materials and application.

1.3 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.

B. Aluminum Association (AA):

AA-C22A41.....Aluminum Chemically etched medium matte, with clear anodic coating, Class I Architectural, 0.7-mil thick

AA-C22A42.....Chemically etched medium matte, with integrally colored anodic coating, Class I Architectural, 0.7 mils thick

AA-C22A44.....Chemically etched medium matte with electrolytically deposited metallic compound, integrally colored coating Class I Architectural, 0.7-mil thick finish

C. American National Standards Institute/Single-Ply Roofing Institute/Factory Mutual (ANSI/SPRI/FM):

4435/ES-1-11.....Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems

D. American Architectural Manufacturers Association (AAMA):

AAMA 620-02.....Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum

AAMA 621-02.....Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates

E. ASTM International (ASTM):

A240/A240M-20.....Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.

A653/A653M-20.....Steel Sheet Zinc-Coated (Galvanized) or Zinc Alloy Coated (Galvanized) by the Hot- Dip Process

B32-08(2014).....Solder Metal

B209-14.....Aluminum and Aluminum-Alloy Sheet and Plate

B370-12(2019).....Copper Sheet and Strip for Building Construction

D173/D173M-03(2018).....Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing

D412-16.....Vulcanized Rubber and Thermoplastic Elastomers-Tension

D1187/D1187M-97(2018)...Asphalt Base Emulsions for Use as Protective Coatings for Metal

D1784-20.....Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

D3656/D3656M-13.....Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns

D4586/D4586M-07(2018)...Asphalt Roof Cement, Asbestos Free

F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Architectural Sheet Metal Manual.

G. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06.....Metal Finishes Manual

H. Federal Specification (Fed. Spec):

A-A-1925A.....Shield, Expansion; (Nail Anchors)

UU-B-790A.....Building Paper, Vegetable Fiber

I. International Code Commission (ICC): International Building Code, Current Edition

1.4 PERFORMANCE REQUIREMENTS

A. Wind Design Standard: Fabricate and install copings,roof-edge flashings tested per ANSI/SPRI/FM ES-1 to resist design pressure indicated in Section 07 54 23 TPO Roofing.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop Drawings: For all specified items, including:
   1. Flashings
   2. Copings
   3. Gutter and Conductors
   4. Expansion joints

C. Manufacturer's Literature and Data: For all specified items, including:
   1. Two-piece counterflashing
   2. Thru wall flashing
   3. Expansion joint cover, each type
   4. Nonreinforced, elastomeric sheeting

D. Certificates: Indicating compliance with specified finishing requirements, from applicator and contractor.

PART 2 - PRODUCTS

2.1 FLASHING AND SHEET METAL MATERIALS

A. Stainless Steel: ASTM A240, Type 302B, dead soft temper.

B. Aluminum Sheet: ASTM B 221, alloy 6063 with alloy temper as recommended for specific installation.

C. Galvanized Sheet: ASTM, A653.

D. Nonreinforced, Elastomeric Sheeting: Elastomeric substances reduced to thermoplastic state and extruded into continuous homogenous sheet (0.056 inch) thick. Sheeting shall have not less than 7 MPa (1,000 psi) tensile strength and not more than seven percent tension-set at 50 percent elongation when tested in accordance with ASTM D412. Sheeting shall show no cracking or flaking when bent through 180 degrees over a 1 mm (1/32 inch) diameter mandrel and then bent at same point over same size mandrel in opposite direction through 360 degrees at temperature of -30°C (-20 °F).

2.2 FLASHING ACCESSORIES

A. Solder: ASTM B32; flux type and alloy composition as required for use with metals to be soldered.

B. Rosin Paper: Fed-Spec. UU-B-790, Type I, Grade D, Style 1b, Rosin-sized sheathing paper, weighing approximately 3 Kg/10 m^2(6 pounds/100 square feet).

C. Bituminous Paint: ASTM D1187, Type I.

D. Fasteners:

1. Use stainless steel for stainless steel and aluminum alloy. Use galvanized steel or stainless steel for galvanized steel.
2. Nails:
   a. Minimum diameter for aluminum nails 3 mm (0.105 inch).
   b. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.
   c. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.
3. Rivets: Not less than 3 mm (1/8 inch) diameter.
4. Expansion Shields: Fed Spec A-A-1925A.

E. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.

F. Insect Screening: ASTM D3656, 18 by 18 regular mesh.

G. Roof Cement: ASTM D4586.

2.3 SHEET METAL THICKNESS

A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:

B. Concealed Locations (Built into Construction):

1. Stainless steel: 0.25 mm (0.010 inch) thick.
2. Galvanized steel: 0.5 mm (0.021 inch) thick.

C. Exposed Locations:

1. Stainless steel: 0.4 mm (0.015 inch).

D. Thickness of aluminum or galvanized steel is specified with each item.

2.4 FABRICATION, GENERAL

A. Jointing:

1. In general, stainless steel joints, except expansion and contraction joints, shall be locked and soldered.
2. Jointing of stainless steel over 0.45 mm (0.018 inch) thick shall be done by lapping, riveting and soldering.
3. Joints shall conform to following requirements:

a. Flat-lock joints shall finish not less than 19 mm (3/4 inch) wide.
b. Lap joints subject to stress shall finish not less than 25 mm (one inch) wide and shall be soldered and riveted.
c. Unsoldered lap joints shall finish not less than 100 mm (4 inches) wide or as shown on the drawings, whichever is greater.

4. Flat and lap joints shall be made in direction of flow.
5. Edges of nonreinforced elastomeric sheeting shall be jointed by lapping not less than 100 mm (4 inches) or as shown on the drawings, whichever is greater, in the direction of flow and cementing with asphalt roof cement or sealant as required by the manufacturer's printed instructions.
6. Soldering:
   a. Pre tin both mating surfaces with solder for a width not less than 38 mm (1 1/2 inches) of stainless steel,.
   b. Wire brush to produce a bright surface before soldering lead coated copper.
   c. Treat in accordance with metal producers recommendations other sheet metal required to be soldered.
   d. Completely remove acid and flux after soldering is completed.

B. Expansion and Contraction Joints:
1. Fabricate in accordance with the Architectural Sheet Metal Manual recommendations for expansion and contraction of sheet metal work in continuous runs.
2. Space joints as shown or as specified.
3. Space expansion and contraction joints for stainless steel at intervals not exceeding 7200 mm (24 feet).
4. Space expansion and contraction joints for aluminum at intervals not exceeding 5400 mm (18 feet), except do not exceed 3000 mm (10 feet) for gravel stops and fascia-cant systems.
5. Fabricate slip-type or loose locked joints and fill with sealant unless otherwise specified.
6. Fabricate joint covers of same thickness material as sheet metal served.

C. Cleats:
1. Fabricate cleats to secure flashings and sheet metal work over 300 mm (12 inches) wide and where specified.

2. Provide cleats for maximum spacing of 300 mm (12 inch) centers unless specified otherwise.
3. Form cleats of same metal and weights or thickness as the sheet metal being installed unless specified otherwise.
4. Fabricate cleats from 50 mm (2 inch) wide strip. Form end with not less than 19 mm (3/4 inch) wide loose lock to item for anchorage. Form other end of length to receive nails free of item to be anchored and end edge to be folded over and cover nail heads.

D. Edge Strips or Continuous Cleats:
1. Fabricate continuous edge strips where shown and specified to secure loose edges of the sheet metal work.
2. Except as otherwise specified, fabricate edge strips minimum 0.6 mm (0.024 inch) thick stainless steel and/or 1.25 mm (0.050 inch) thick aluminum.
3. Use material compatible with sheet metal to be secured by the edge strip.
4. Fabricate in 3000 mm (10 feet) maximum lengths with not less than 19 mm (3/4 inch) loose lock into metal secured by edge strip.
5. Fabricate Strips for fascia anchorage to extend below the supporting wood construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm (3/4-inch).
6. Fabricate anchor edge maximum width of 75 mm (3 inches) or of sufficient width to provide adequate bearing area to insure a rigid installation using 0.8 mm (0.031 inch) thick stainless steel and/or 1.6 mm (0.0625 inch) thick aluminum.

E. Drips:
1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascia’s, gravel stops, wall copings, by folding edge back 13 mm (1/2 inch) and bending out 45 degrees from vertical to carry water away from the wall.
2. Form drip to provide hook to engage cleat or edge strip for fastening for not less than 19 mm (3/4 inch) loose lock where shown.

F. Edges:
1. Edges of flashings concealed in masonry joints opposite drain side shall be turned up 6 mm (1/4 inch) to form dam, unless otherwise specified or shown otherwise.
2. Finish exposed edges of flashing with a 6 mm (1/4 inch) hem formed by folding edge of flashing back on itself when not hooked to edge

strip or cleat. Use 6 mm (1/4 inch) minimum penetration beyond wall face with drip for through-wall flashing exposed edge.

3. All metal roof edges shall meet requirements of IBC, current edition.

G. Metal Options:

1. Where options are permitted for different metals use only one metal throughout.
2. Stainless steel may be used in concealed locations for fasteners of other metals exposed to view.

2.5 FINISHES

A. Use same finish on adjacent metal or components and exposed metal surfaces unless specified or shown otherwise.

B. In accordance with NAAMM Metal Finishes Manual AMP 500, unless otherwise specified.

C. Finish exposed metal surfaces as follows, unless specified otherwise:

1. Stainless Steel: Finish No. 2B or 2D.
2. Aluminum:
   a. Clear Finish: AA-C22A41 medium matte, clear anodic coating, Class 1 Architectural, 18 mm (0.7 mils) thick.
   b. Colored Finish: AA-C22A42 (anodized) or AA-C22A44 (electrolytically deposited metallic compound) medium matte, integrally colored coating, Class 1 Architectural, 18 mm (0.7 mils) thick. Dyes will not be accepted.
   c. Fluorocarbon Finish: AAMA 620, high performance organic coating.
3. Steel and Galvanized Steel:
   a. Finish painted under Section 09 91 00, PAINTING unless specified as prefinished item.
   b. Manufacturer's finish:
      1) Baked on prime coat over a phosphate coating.
      2) Baked-on prime and finish coat over a phosphate coating.
      3) Fluorocarbon Finish: AAMA 621, high performance organic coating.

2.6 BASE FLASHING

A. Use metal base flashing at vertical surfaces intersecting built-up roofing without cant strips or where shown.

1. Use stainless steel, thickness specified unless specified otherwise.

2. When flashing is over 250 mm (10 inches) in vertical height or horizontal width use 0.5 mm (0.018 inch) stainless steel.
3. Use stainless steel at aluminum roof curbs where flashing contacts the aluminum.

B. Fabricate metal base flashing up vertical surfaces not less than 200 mm (8 inch) nor more than 400 mm (16 inch) or as shown on the drawings, whichever is greater.

C. Fabricate roof flange not less than 100 mm (4 inches) wide unless shown otherwise. When base flashing length exceeds 2400 mm (8 feet) form flange edge with 13 mm (1/2 inch) hem to receive cleats.

D. Form base flashing bent from strip except pipe flashing. Fabricate ends for riveted soldered lap seam joints. Fabricate expansion joint ends as specified.

2.7 COUNTERFLASHING (CAP FLASHING OR HOODS)

A. Stainless steel, unless specified otherwise.

B. Fabricate to lap base flashing a minimum of 100 mm (4 inches) with drip:

1. Form lock seams for outside corners. Allow for lap joints at ends and inside corners.
2. In general, form flashing in lengths not less than 2400 mm (8 feet) and not more than 3000 mm (10 feet).
3. Two-piece, lock in type flashing may be used in-lieu-of one piece counter-flashing.
4. Manufactured assemblies may be used.
5. Where counterflashing is installed at new work use an integral flange at the top designed to be extended into the masonry joint or reglet in concrete.
6. Where counterflashing is installed at existing work use surface applied type, formed to provide a space for the application of sealant at the top edge.

C. Surface Mounted Counterflashing; one or two piece:

1. Use at existing or new surfaces where flashing cannot be inserted in vertical surface.
2. One piece fabricate upper edge folded double for 65 mm (2 1/2 inches) with top 19 mm (3/4 inch) bent out to form "V" joint sealant pocket with vertical surface. Perforate flat double area against vertical surface with horizontally slotted fastener holes at 400 mm (16 inch) centers between end holes. Option: One piece surface

mounted counter-flashing (cap flashing) may be used. Fabricate as detailed on Plate 51 of SMACNA Architectural Sheet Metal Manual.

3. Two pieces: Fabricate upper edge to lock into surface mounted receiver. Fabricate receiver joint sealant pocket on upper edge and lower edge to receive counterflashing, with slotted fastener holes at 400 mm (16 inch) centers between upper and lower edge.

2.8 CONDUCTORS (DOWNSPOUTS)

A. Fabricate conductors of same metal and thickness as gutters in sections approximately 3000 mm (10 feet) long [with 19 mm (3/4 inch) wide flat locked seams].

1. Fabricate open face channel shape with hemmed longitudinal edges.

B. Fabricate elbows by mitering, riveting, and soldering except seal aluminum in lieu of solder. Lap upper section to the inside of the lower piece.

C. Fabricate conductor brackets or hangers of same material as conductor, 2 mm (1/16 inch) thick by 25 mm (one inch) minimum width. Form to support conductors 25 mm (one inch) from wall surface in accordance with Architectural Sheet Metal Manual for rectangular and round shapes.

D. Conductor Heads:

1. Fabricate of same material as conductor.
2. Fabricate conductor heads to not less than 250 mm (10 inch) wide by 200 mm (8 inch) deep by 200 mm (8 inches) from front to back.
3. Form front and side edges channel shape not less than 13 mm (1/2 inch) wide flanges with edge hemmed.
4. Slope bottom to sleeve to conductor or downspout at not less than 60 degree angle.
5. Extend wall edge not less than 25 mm (one inch) above front edge.
6. Solder joints for water tight assembly.
7. Fabricate outlet tube or sleeve at bottom not less than 50 mm (2 inches) long to insert into conductor.

2.9 INSULATED EXPANSION JOINT COVERS

A. Either type optional, use only one type throughout.

B. Types:

1. Construct of two preformed, stainless steel strips, not less than 0.4 mm (0.015 inch) thick, mechanically and adhesively bonded to both sides of a 2 mm (1/16 inch) thick neoprene or butyl sheet, or to a 0.4 mm (32 mil) thick reinforced chlorinated polyethylene sheet. Adhesively attach a 10 mm (3/8 inch) thick sheet of closed

cell, neoprene foam insulation, to the underside of the neoprene, butyl, or chlorinated polyethylene sheet.

2. Constructed of a 2 mm (1/16 inch) thick vinyl sheet, flanged at both sides with stainless steel strips not less than 0.4 mm (0.015 inch) thick. Vinyl sheet locked and encased by the stainless steel strip and prepunched for nailing. A 10 mm (3/8 inch) thick closed cell polyvinyl chloride foam insulating strip shall be heat laminated to the underside of the vinyl sheet between the stainless steel strips.

C. Expansion joint covers shall have factory fabricated mitered corners, crossing tees, and other necessary accessories. Furnish in the longest available lengths.

D. Metal flange of sufficient width to extend over the top of the curb and down curb sides 50 mm (2 inches) with hemmed edge for lock to edge strip.

2.10 SCUPPERS

A. Fabricate scuppers with minimum of 100 mm (4 inch) wide flange.

B. Provide flange at top on through wall scupper to extend to top of base flashing.

C. Fabricate exterior wall side to project not less than 13 mm (1/2 inch) beyond face of wall with drip at bottom outlet edge.

D. Fabricate not less than 100 mm (4 inch) wide flange to lap behind gravel stop fascia.

E. Fabricate exterior wall flange for through wall scupper not less than 25 mm (one inch) wide on top and sides with edges hemmed.

F. Fabricate gravel stop bar of 25 mm x 25 mm (one by one inch) angle strip soldered to bottom of scupper.

G. Fabricate scupper not less than 200 mm (8 inch) wide and not less than 125 mm (5 inch) high for through wall scupper.

H. Solder joints watertight.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install flashing and sheet metal items as shown in Sheet Metal and Air Conditioning Contractors National Association, Inc., publication, ARCHITECTURAL SHEET METAL MANUAL, except as otherwise shown or specified.

2. Apply Sealant as specified in Section 07 92 00, JOINT SEALANTS.

3. Apply sheet metal and other flashing material to surfaces which are smooth, sound, clean, dry and free from defects that might affect the application.
4. Remove projections which would puncture the materials and fill holes and depressions with material compatible with the substrate. Cover holes or cracks in wood wider than 6 mm (1/4 inch) with sheet metal compatible with the roofing and flashing material used.
5. Coordinate with masonry work for the application of a skim coat of mortar to surfaces of unit masonry to receive flashing material before the application of flashing.
6. Apply a layer of 7 Kg (15 pound) saturated felt followed by a layer of rosin paper to wood surfaces to be covered with copper. Lap each ply 50 mm (2 inch) with the slope and nail with large headed copper nails.
7. Confine direct nailing of sheet metal to strips 300 mm (12 inch) or less wide. Nail flashing along one edge only. Space nail not over 100 mm (4 inches) on center unless specified otherwise.
8. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inch) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
9. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
10. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
11. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
12. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.
13. Where required to prevent galvanic action between dissimilar metal isolate the contact areas of dissimilar metal with sheet lead, waterproof building paper, or a coat of bituminous paint.
14. Isolate aluminum in contact with dissimilar metals others than stainless steel, white bronze or other metal compatible with aluminum by:

a. Paint dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
b. Paint dissimilar metal with a coat of bituminous paint.
c. Apply an approved caulking material between aluminum and dissimilar metal.

15. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
16. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.
17. Bitumen Stops:
    a. Install bitumen stops for built-up roof opening penetrations through deck and at formed sheet metal gravel stops.
    b. Nail leg of bitumen stop at 300 mm (12 inch) intervals to nailing strip at roof edge before roofing material is installed.

3.2 THROUGH-WALL FLASHING

A. General:

1. Install continuous through-wall flashing between top of concrete foundation walls and bottom of masonry building walls; at top of concrete floors; under masonry, concrete, or stone copings and elsewhere as shown.
2. Where exposed portions are used as a counterflashings, lap base flashings at least 100 mm (4 inches) and use thickness of metal as specified for exposed locations.
3. Exposed edge of flashing may be formed as a receiver for two piece counter flashing as specified.
4. Terminate exterior edge beyond face of wall approximately 6 mm (1/4 inch) with drip edge where not part of counter flashing.
5. Turn back edge up 6 mm (1/4 inch) unless noted otherwise where flashing terminates in mortar joint or hollow masonry unit joint.
6. Under copings terminate both edges beyond face of wall approximately 6 mm (1/4 inch) with drip edge.
7. Lap end joints at least two corrugations, but not less than 100 mm (4 inches). Seal laps with sealant.
8. Where dowels, reinforcing bars and fastening devices penetrate flashing, seal penetration with sealing compound. Sealing compound is specified in Section 07 92 00, JOINT SEALANTS.

9. Coordinate with other work to set in a bed of mortar above and below flashing so that total thickness of the two layers of mortar and flashing are same as regular mortar joint.
10. Where ends of flashing terminate turn ends up 25 mm (1 inch) and fold corners to form dam extending to wall face in vertical mortar or veneer joint.
11. Continue flashing around columns:
    a. Where flashing cannot be inserted in column reglet hold flashing vertical leg against column.
    b. Counterflash top edge with 75 mm (3 inch) wide strip of saturated cotton unless shown otherwise. Secure cotton strip with roof cement to column. Lap base flashing with cotton strip 38 mm (1 1/2 inch).

B. Flashing at Cavity Wall Construction: Where flashing occurs in cavity walls turn vertical portion up against backup under waterproofing. Turn up over insulation.

C. Flashing at Veneer Walls:
1. Install near line of finish floors over shelf angles or where shown.
2. Turn up against sheathing.
3. At stud framing, hem top edge 19 mm (3/4 inch) and secure to each stud with stainless steel fasteners through sheathing.
4. Coordinate with installation of waterproofing or air vapor membrane for lap over top of flashing.

D. Lintel Flashing when not part of shelf angle flashing:
1. Install flashing full length of lintel to nearest vertical joint in masonry over veneer.
2. Turn ends up 25 mm (one inch) and fold corners to form dam and extend end to face of wall.
3. Turn back edge up to top of lintel; terminate back edge as specified for back-up wall.

E. Window Sill Flashing:
1. Install flashing to extend not less than 100 mm (4 inch) beyond ends of sill into vertical joint of masonry or veneer.
2. Turn back edge up to terminate under window frame.
3. Turn ends up 25 mm (one inch) and fold corners to form dam and extend to face of wall.

F. Door Sill Flashing:

1. Install flashing under bottom of plate sills of doors over curbs opening onto roofs. Extend flashing out to form counter flashing or receiver for counter flashing over base flashing. Set in sealant.
2. Extend sill flashing 200 mm (8 inch) beyond jamb opening. Turn ends up one inch in vertical masonry joint, extend end to face of wall. Join to counter flashing for water tight joint.
3. Where doors thresholds cover over waterproof membranes install sill flashing over water proof membrane under thresholds. Extend beyond opening to cover exposed portion of waterproof membrane and not less than 150 mm (6 inch) beyond door jamb opening at ends. Turn up approximately 6 mm (1/4 inch) under threshold.

G. Flashing at Masonry, Stone, or Precast Concrete Copings:
1. Install flashing with drips on both wall faces unless shown otherwise.
2. Form penetration openings to fit tight against dowel or other item with edge turned up. Seal penetrations with sealant.

3.3 BASE FLASHING

A. Install where roof membrane type base flashing is not used and where shown.
1. Install flashing at intersections of roofs with vertical surfaces or at penetrations through roofs, to provide watertight construction.
2. Install metal flashings and accessories having flanges extending out on top of the built-up roofing before final bituminous coat and roof aggregate is applied.
3. Set flanges in heavy trowel coat of roof cement and nail through flanges into wood nailers over bituminous roofing.
4. Secure flange by nailing through roofing into wood blocking with nails spaced 75 mm (3 inch) on centers or, when flange over 100 mm (4 inch) wide terminate in a 13 mm (1/2 inch) folded edge anchored with cleats spaced 200 mm (8 inch) on center. Secure one end of cleat over nail heads. Lock other end into the seam.

B. For long runs of base flashings install in lengths of not less than 2400 mm (8 feet) nor more than 3000 mm (ten feet). Install a 75 mm (3 inch) wide slip type, loose lock expansion joint filled with sealant in joints of base flashing sections over 2400 mm (8 feet) in length. Lock and solder corner joints at corners.

C. Extend base flashing up under counter flashing of roof specialties and accessories or equipment not less than 75 mm (3 inch).

3.4 COUNTERFLASHING (CAP FLASHING OR HOODS)

A. General:

1. Install counterflashing over and in conjunction with installation of base flashings, except as otherwise specified or shown.
2. Install counterflashing to lap base flashings not less than 100 mm (4 inch).
3. Install upper edge or top of counterflashing not less than 225 mm (9 inch) above top of the roofing.
4. Lap joints not less than 100 mm (4 inch). Stagger joints with relation to metal base flashing joints.
5. Use surface applied counterflashing on existing surfaces and new work where not possible to integrate into item.
6. When fastening to concrete or masonry, use screws driven in expansion shields set in concrete or masonry. Use screws to wood and sheet metal. Set fasteners in mortar joints of masonry work.

B. One Piece Counterflashing:

1. Where flashing is surface mounted on flat surfaces.
   a. When top edge is double folded anchor flat portion below sealant "V" joint with fasteners spaced not over 400 mm (16 inch) on center:
      1) Locate fasteners in masonry mortar joints.
      2) Use screws to sheet metal or wood.
   b. Fill joint at top with sealant.

C. Two-Piece Counterflashing:

1. Surface applied type receiver:
   a. Secure to face construction in accordance, with manufacturers’ instructions.
   b. Completely fill space at the top edge of receiver with sealant.
2. Insert counter flashing in receiver in accordance with fabricator or manufacturer's instructions and to fit tight against base flashing.

D. When counter flashing is a component of other flashing install as shown.

3.5 COPINGS

A. General:

1. On walls topped with a wood plank or sloped insulation, install coping to the wall studs or top plate and shown on the drawings.

2. Where shown turn down exposed side of coping and extend down over base flashing as specified for counter-flashing. Secure counter-flashing to lock strip in coping at continuous cleat.
3. Install ends adjoining existing construction to form space for installation of sealants and overlap. Sealant is specified in Section 07 92 00, JOINT SEALANTS.

B. Aluminum Coping:
1. Install with 6 mm (1/4 inch) joint between ends of coping sections.
2. Install joint covers, centered at each joint, and securely lock in place. Set in two beads of sealant as shown on drawings.

3.6 EXPANSION JOINT COVERS, INSULATED

A. Install insulated expansion joint covers at locations shown on curbs not less than 200 mm (8 inch) high above roof surface.

B. Install continuous edge strips of same metal as expansion joint flange, nailed at not less than 75 mm (3 inch) centers.

C. Install insulated expansion joint covers in accordance with manufacturer's directions locking edges to edge strips.

3.7 CONDUCTORS (DOWNSPOUTS)

A. Where scuppers discharge into downspouts install conductor head to receive discharge with back edge up behind drip edge of scupper. Fasten and seal joint. Sleeve conductors to gutter outlet tubes and fasten joint and joints between sections.

B. Set conductors plumb and clear of wall, and anchor to wall with two anchor straps, located near top and bottom of each section of conductor. Strap at top shall be fixed to downspout, intermediate straps and strap at bottom shall be slotted to allow not less than 13 mm (1/2 inch) movement for each 3000 mm (10 feet) of downspout.

C. Install elbows, offsets and shoes where shown and required. Slope not less than 45 degrees.

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section covers interior and exterior sealant and their application, wherever required for complete installation of building materials or systems.

1.2 RELATED WORK (INCLUDING BUT NOT LIMITED TO THE FOLLOWING):

A. Sustainable Design Requirements: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

. Glazing: Section 08 80 00, GLAZING.

F. Glazed Aluminum Curtain Wall: Section 08 44 13, GLAZED ALUMINUM CURTAIN WALLS.

1.3 QUALITY ASSURANCE:

A. Installer Qualifications: An experienced installer with a minimum of three (3) years’ experience and who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance. Submit qualification.

B. Source Limitations: Obtain each type of joint sealant through one (1) source from a single manufacturer.

C. Lab Tests: Submit samples of materials that will be in contact or affect joint sealants to joint sealant manufacturers for tests as follows:

1. Adhesion Testing: Before installing elastomeric sealants, test their adhesion to protect joint substrates according to the method in ASTM C794 to determine if primer or other specific joint preparation techniques are required.
2. Compatibility Testing: Before installing elastomeric sealants, determine compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Perform testing per ASTM C1248 on interior and exterior sealants to determine if sealants or primers will stain adjacent surfaces. No sealant work is to start until results of these tests have been submitted to the Contracting Officer Representative (COR) and the COR has given written approval to proceed with the work.

D. Mockups: Before installing joint sealants, apply elastomeric sealants as follows to verify selections and to demonstrate aesthetic effects and qualities of materials and execution:
   1. Joints in mockups of assemblies that are indicated to receive elastomeric joint sealants.

1.4 CERTIFICATION:

A. Contractor is to submit to the COR written certification that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vapor tight seals (as applicable), and that materials supplied meet specified performance requirements.

1.5 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Sustainable Design Submittals, as described below:
   1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.
C. Installer qualifications.
D. Contractor certification.
E. Manufacturer's installation instructions for each product used.
F. Cured samples of exposed sealants for each color.
G. Manufacturer's Literature and Data:
   1. Primers
   2. Sealing compound, each type, including compatibility when different sealants are in contact with each other.
H. Manufacturer warranty.

1.6 PROJECT CONDITIONS:

A. Environmental Limitations:
   1. Do not proceed with installation of joint sealants under following conditions:
      a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C (40 degrees F).
      b. When joint substrates are wet.
B. Joint-Width Conditions:

1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions:

1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 DELIVERY, HANDLING, AND STORAGE:

A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.

B. Carefully handle and store to prevent inclusion of foreign materials.

C. Do not subject to sustained temperatures exceeding 32 degrees C (90 degrees F) or less than 5 degrees C (40 degrees F).

1.8 DEFINITIONS:

A. Definitions of terms in accordance with ASTM C717 and as specified.

B. Backing Rod: A type of sealant backing.

C. Bond Breakers: A type of sealant backing.

D. Filler: A sealant backing used behind a back-up rod.

1.9 WARRANTY:

A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".

B. Manufacturer Warranty: Manufacturer shall warranty their sealant for a minimum of five (5) years from the date of installation and final acceptance by the Government. Submit manufacturer warranty.

1.10 APPLICABLE PUBLICATIONS:

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. ASTM International (ASTM):

C509-06.....Elastomeric Cellular Preformed Gasket and Sealing Material

C612-14.....Mineral Fiber Block and Board Thermal Insulation

C717-14a.....Standard Terminology of Building Seals and Sealants

C734-06(R2012).....Test Method for Low-Temperature Flexibility of Latex Sealants after Artificial Weathering

C794-10.....Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
C919-12.....Use of Sealants in Acoustical Applications.
C920-14a.....Elastomeric Joint Sealants.
C1021-08(R2014).....Laboratories Engaged in Testing of Building Sealants
C1193-13.....Standard Guide for Use of Joint Sealants.
C1248-08(R2012).....Test Method for Staining of Porous Substrate by Joint Sealants
C1330-02(R2013).....Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
C1521-13.....Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
D217-10.....Test Methods for Cone Penetration of Lubricating Grease
D1056-14.....Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
E84-09.....Surface Burning Characteristics of Building Materials

C. Sealant, Waterproofing and Restoration Institute (SWRI).
The Professionals' Guide

D. Environmental Protection Agency (EPA):
40 CFR 59(2014).....National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 SEALANTS:

A. Exterior Sealants:
1. Vertical surfaces, provide non-staining ASTM C920, Type S or M, Grade NS, Class 25, Use NT.
2. Horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T.
3. Provide location(s) of exterior sealant as follows:
a. Joints formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Provide sealant at exterior surfaces of exterior wall penetrations.
b. Metal to metal.
i. Voids where items penetrate exterior walls.

C. Interior Sealants:

1. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system are to comply with the following limits for VOC content when calculated according to 40 CFR 59, (EPA Method 24):
   a. Architectural Sealants: 250 g/L.
   b. Sealant Primers for Nonporous Substrates: 250 g/L.
   c. Sealant Primers for Porous Substrates: 775 g/L.//
2. Vertical and Horizontal Surfaces: ASTM C920, Type S or M, Grade NS, Class 25, Use NT.
3. Provide location(s) of interior sealant as follows:
   a. Typical narrow joint 6 mm, (1/4 inch) or less at walls and adjacent components.
   b. Perimeter of doors, windows, access panels which adjoin concrete or masonry surfaces.
   c. Interior surfaces of exterior wall penetrations.
   f. Exposed isolation joints at top of full height walls.
   h. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.

2.2 COLOR:

A. Color of sealants to be light gray or aluminum, unless otherwise indicated in construction documents.

2.3 JOINT SEALANT BACKING:

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
   1. Type C: Closed-cell material with a surface skin.

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056 or synthetic rubber (ASTM C509), nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32 degrees C (minus 26 degrees F). Provide products with low compression set and of size and shape to provide a

secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 FILLER:

A. Mineral fiberboard: ASTM C612, Class 1.

B. Thickness same as joint width.

C. Depth to fill void completely behind back-up rod.

2.6 PRIMER:

A. As recommended by manufacturer of caulking or sealant material.

B. Stain free type.

2.7 CLEANERS-NON POROUS SURFACES:

A. Chemical cleaners compatible with sealant and acceptable to manufacturer of sealants and sealant backing material. Cleaners to be free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.

B. Coordinate for repair and resolution of unsound substrate materials.

C. Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

3.2 PREPARATIONS:

A. Prepare joints in accordance with manufacturer's instructions and SWRI (The Professionals’ Guide).

B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.

1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.

2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include but are not limited to the following:
   a. Concrete.
   b. Masonry.
   c. Unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous surfaces include but are not limited to the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

C. Do not cut or damage joint edges.

D. Apply non-staining masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions or as indicated by pre-construction joint sealant substrate test.
   1. Apply primer prior to installation of back-up rod or bond breaker tape.
   2. Use brush or other approved means that will reach all parts of joints. Avoid application to or spillage onto adjacent substrate surfaces.

3.3 BACKING INSTALLATION:

A. Install backing material, to form joints enclosed on three sides as required for specified depth of sealant.

B. Where deep joints occur, install filler to fill space behind the backing rod and position the rod at proper depth.

C. Cut fillers installed by others to proper depth for installation of backing rod and sealants.

D. Install backing rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.

E. Where space for backing rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.

3.4 SEALANT DEPTHS AND GEOMETRY:

A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.

B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.5 INSTALLATION:

A. General:

1. Apply sealants and caulking only when ambient temperature is between 5 degrees C and 38 degrees C (40 degrees and 100 degrees F).
2. Do not install polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
3. Do not install sealant type listed by manufacture as not suitable for use in locations specified.
4. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
5. Avoid dropping or smearing compound on adjacent surfaces.
6. Fill joints solidly with compound and finish compound smooth.
7. Tool exposed joints to form smooth and uniform beds, with slightly concave surface conforming to joint configuration per Figure 5A in ASTM C1193 unless shown or specified otherwise in construction documents. Remove masking tape immediately after tooling of sealant and before sealant face starts to “skin” over. Remove any excess sealant from adjacent surfaces of joint, leaving the working in a clean finished condition.
8. Finish paving or floor joints flush unless joint is otherwise detailed.
9. Apply compounds with nozzle size to fit joint width.
10. Test sealants for compatibility with each other and substrate. Use only compatible sealant. Submit test reports.
11. Replace sealant which is damaged during construction process.

C. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise. Take all necessary steps to prevent three-sided adhesion of sealants.

D. Interior Sealants: Where gypsum board partitions are of sound rated, fire rated, or smoke barrier construction, follow requirements of ASTM C919 only to seal all cut-outs and intersections with the adjoining construction unless specified otherwise.

1. Apply a 6 mm (1/4 inch) minimum bead of sealant each side of runners (tracks), including those used at partition intersections with dissimilar wall construction.
2. Coordinate with application of gypsum board to install sealant immediately prior to application of gypsum board.
3. Partition intersections: Seal edges of face layer of gypsum board abutting intersecting partitions, before taping and finishing or application of veneer plaster-joint reinforcing.
4. Openings: Apply a 6 mm (1/4 inch) bead of sealant around all cutouts to seal openings of electrical boxes, ducts, pipes and similar penetrations. To seal electrical boxes, seal sides and backs.
5. Control Joints: Before control joints are installed, apply sealant in back of control joint to reduce flanking path for sound through control joint.

3.6 FIELD QUALITY CONTROL

A. Inspect tested joints and report on following:

1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
2. Compare these results to determine if adhesion passes sealant manufacturer’s field-adhesion hand-pull test criteria.
3. Whether sealants filled joint cavities and are free from voids.
4. Whether sealant dimensions and configurations comply with specified requirements.

B. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.7 CLEANING:

A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by manufacturer of the adjacent material or if not otherwise indicated by the caulking or sealant manufacturer.

B. Leave adjacent surfaces in a clean and unstained condition.

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SECTION 07 95 13
EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Prefabricated seismic and building expansion joint assemblies.
   a. Elastomeric joint covers at wall joints.
   b. Exterior wall joints.

1.2 RELATED WORK

A. Section 07 60 00, FLASHING AND SHEET METAL: Sheet Metal Expansion Joint Seals.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this Section.

B. American Society of Civil Engineers (ASCE):

ASCE/SEI 7-10 - Minimum Design Loads For Buildings and Other Structures.

C. ASTM International (ASTM):

A36/A36M-19 - Structural Steel.

A240/A240M-20 - Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.

A283/A283M-18 - Low and Intermediate Tensile Strength Carbon Steel Plates.

A786/A786M-15 - Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.

B36/B36M-18 - Brass, Plate, Sheet, Strip, and Rolled Bar.

B121/B121M-16 - Leaded Brass Plate, Sheet, Strip and Rolled Bar.

B209-14 - Aluminum and Aluminum-Alloy Sheet and Plate.

B209M-14 - Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

B221-14 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

B221M-13 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

B455/B455M-20 - Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes.

C864-05(2019) - Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.

D1187/D1187M-97(2018) - Asphalt-Base Emulsions for Use as Protective Coatings for Metal.

E1399/E1399M-97(2017) - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.

E1966-15(2019) - Standard Test Method for Fire-Resistive Joint Systems.

D. National Association of Architectural Metal Manufacturers (NAAMM):
AMP 500-06 - Metal Finishes Manual.

E. UL LLC (UL):
2079-15 - Standard for Tests for Fire Resistance of Building Joint Systems.

1.4 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this Section.

1. Required Participants:
   a. Contracting Officer's Representative.
   b. Architect/Engineer.
   c. Contractor.
   d. Installer.
   e. Other installers responsible for adjacent and intersecting work,.
2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
   a. Installation schedule.
   b. Installation sequence.
   c. Preparatory work.
   d. Protection before, during, and after installation.
   e. Installation.
   f. Terminations.
   g. Transitions and connections to other work.
   h. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Include large-scale details indicating profiles of each type of expansion joint cover, splice joints between joint sections, transitions to other assemblies, terminations, anchorages, fasteners, and relationship to adjoining work and finishes.

2. Show size, configuration, and fabrication and installation details.
3. Include composite drawings showing work specified in other Sections coordinated with expansion joints.

C. Manufacturer's Literature and Data:
1. Description of each product specified.
2. Show movement capability of each cover assembly and suitability of material used in exterior seals for ultraviolet exposure.
3. Description of materials and finishes.
4. Installation instructions.

D. Samples: Submit 300 mm (12 inch) long samples.
1. Each type and color of metal finish for each required thickness and alloy.
2. Each type and color of flexible seal.

E. Sustainable Construction Submittals:
1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
2. Low Pollutant-Emitting Materials:
a. Identify volatile organic compound types and quantities.

F. Qualifications: Substantiate qualifications comply with specifications.
1. Installer with project experience list.

G. Certificates: Indicate products comply with specifications.

H. Operation and Maintenance Data:
1. Care instructions for each exposed finish product.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.

1.7 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.8 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify field conditions affecting expansion joint cover assembly fabrication and installation. Show field measurements on Submittal Drawings.

1. Coordinate field measurement and fabrication schedule to avoid delay.

1.10 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Provide joint cover assemblies that permit unrestrained movement of joint without disengagement of cover, and, where applicable, maintain moisture, watertight and fire-rated protection.

B. Provide templates to related trades for location of support and anchorage items.

2.2 SYSTEM PERFORMANCE

A. Design expansion joint cover assemblies complying with specified performance.

B. Joint Movement: ASTM E1399.

1. Nominal Joint Width: 100 mm (4 inches) plus or minus – for existing joint.
2. Minimum Movement Capability: 25 percent.
3. Movement Type: seismic.

2.3 MATERIALS

A. Stainless Steel: ASTM A240/A240M, Type 302 or 304.

B. Elastomeric Sealant: As specified in Section 07 92 00, JOINT SEALANTS.

C. Elastomeric Seals:

1. Flexible extruded polyvinyl chloride, meeting a Shore A hardness of 75 with UV stabilizer. Manufacturer's standard colors.

D. Thermoplastic Rubber:

1. ASTM C864.
2. Dense Neoprene or other material standard with expansion joint manufacturers having the same physical properties.

E. Compression Seals: Pre-compressed secondary sealant using preformed expanding foam sealant; open-cell polyurethane foam impregnated with polymer-modified acrylic adhesive.

F. Water Barrier Sheets: Neoprene or EPDM flexible sheet materials minimum 45 mils thick.
   1. Provide with drain tubes for horizontal applications.
G. Moisture Barrier: Fabric reinforced clear vinyl sheet material sized to accommodate opening.
H. Flexible Membrane: 1.5 mm (60 mil) EPDM sheet, with manufacturer's standard support foam.
I. Butyl Caulk Tape: Self adhering double sided butyl rubber sealant tape with easy-release silicone coated paper.

2.4 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.
B. Provide each product from one manufacturer.
   1. Provide ceiling and wall expansion joint cover assemblies design matching floor to wall and floor to floor expansion joint cover design.
   2. Provide expansion joint cover assembly designs, profiles, materials and configuration indicated, as required to accommodate joint size variations in adjacent surfaces, and anticipated movement.
C. Sustainable Construction Requirements:
   1. Steel Recycled Content: 30 percent total recycled content, minimum.
   2. Stainless Steel Recycled Content: 70 percent total recycled content, minimum.
   3. Aluminum Recycled Content: 80 percent total recycled content, minimum.
   4. Low Pollutant-Emitting Materials: Maximum VOC content by weight.
      a. Non-Flooring Adhesives and Sealants.

2.5 FABRICATION

A. Fabricate Expansion Joint Cover Assemblies:
   1. As complete assembly ready for installation.
   2. In longest practicable lengths to minimize number of end joints.
   3. With factory mitered corners where joint changes directions or abuts other materials.
      a. With closure materials and transition pieces, tee-joints, corners, curbs, cross-connections and other assemblies.
   4. Seal Strip: Factory-formed and bonded to metal frames and anchor members.
   5. Compression Seals: Fabricate from expanding foam as secondary seal and elastomeric sealant to sizes and profiles shown.

B. Floor-to-Floor Metal Plate Joints:
   1. Frames: Metal, continuous on both sides of joint designed to support cover plate.
      a. Flush Design: Seating surface and raised floor rim to accommodate adjacent flooring.
      b. Anchorage: Concealed bolt and steel anchors for embedment in concrete.
   2. Cover Plate: Metal, matching frames where exposed.
      a. Supported Load: 19.2 MPa (400 psf), minimum.
      b. Rattle-free due to traffic.
   3. Fillers: Resilient material between raised rim of frame and edge of cover plate, where shown.
      a. No gaps or bulges over full design range joint movement.
   4. Fire Barrier: As required for fire resistance rating.
   5. Water Stop: Manufacturer's standard, continuous, full length of joint.
   6. Seismic: As required by Code.
   7. Finishes: As specified in Section 09 06 00, SCHEDULE FOR FINISHES.
C. Floor-to-Wall Metal Plate Joints:
   1. Frames: Metal, continuous on floor side of joint only.
      a. Provide wall side frame where required by manufacturer's design.
   2. Cover Plates: Angle cover plates with countersunk flat-head exposed fasteners for securing cover plate to wall unless shown otherwise.
      a. Fastener Spacing: As recommended by manufacturer.
   3. Joint Design: Match adjacent floor to floor design.
   4. Fire Barrier: As required for fire resistance rating.
   5. Water Stop: Manufacturer's standard, continuous, full length of joint.
   6. Seismic: As required by Code.
   7. Finishes: As specified in Section 09 06 00, SCHEDULE FOR FINISHES.
D. Interior Wall Joint Cover Assemblies:
   1. Frame: Metal, surface mounted, concealed fastening to wall on one sides of joint.
   2. Cover Plate: Metal, smooth surface, lap both sides of joint and permitting free movement on one side.
      a. Fabricate with concealed attachment of cover to frame when cover is in close contact with adjacent wall surface finish.

b. Use angle cover plates at intersecting walls.

3. Joint Design: Match adjacent floor to floor design.
4. Fire Barrier: As required for fire resistance rating.
5. Seismic: As required by Code.
6. Finishes: As specified in Section 09 06 00, SCHEDULE FOR FINISHES.

E. Exterior Wall Joint Assemblies:

1. Design seal for variable movement and prevention of water and air infiltration.
2. Frame: Metal, concealed, for fastening to wall on one side of joint.
3. Cover Plate: Metal, surface mounted, lap both sides of joint, permitting free movement on one side.
   a. Fabricate with concealed attachment of cover to frame for cover with cover in close contact with adjacent finish surfaces.
   b. Use angle cover plate at intersecting walls.
4. Water Seal: Vinyl seal strip as secondary seal behind primary seal.
5. Seismic: As required by Code.
6. Finish: As specified in Section 09 06 00, SCHEDULE FOR FINISHES.

F. Extruded Thermoplastic Rubber Joint Assemblies:

1. Frames: Aluminum, both sides of joint.
2. Primary Seal: Flexible rubber on exposed face after frame installation with factory welded watertight miters and transitions.
   a. Anchor spaced at ends and not over 600 mm (24 inches).
      1) Variable movement extruded rubber primary seal designed to remain in aluminum frame, throughout movement of joint.
   b. Seismic seal minimum 3 mm (0.12 inch) thick with multi-movement grooves designed for plus or minus 100 percent movement of joint width.
3. Secondary Seal: Continuous vinyl sheet seal.

G. Ceiling and Soffit Assemblies:

1. Frames: Metal, continuous on both sides of joint, flush mounted with no exposed fasteners.
2. Flexible Insert: Variable movement semi-rigid vinyl locked into frame.
   a. Face Style: Flush or accordion, as shown, to span joint width without sagging.
3. Seismic: As required by Code.

2.6 FINISHES

A. Carbon Steel: NAAMM AMP 500, Galvanized G90.

B. Stainless Steel: NAAMM AMP 500, No. 2B bright finish.

C. Aluminum Anodized Finish: NAAMM AMP 500.

1. Clear Anodized Finish: AA-C22A41; Class I Architectural, 0.018 mm (0.7 mil) thick.

2.7 ACCESSORIES

A. General: Manufacturer's standard anchors, fasteners, set screws, spaces, protective coating, and filler materials, adhesive and other accessories required for installation.

B. Barrier Coating: ASTM D1187/D1187M.

C. Adhesives: Low pollutant-emitting, water based type recommended by adhered product manufacturer for each application.

D. Fasteners: Type and size recommended by expansion joint cover assembly manufacturer.

1. Exterior Applications: Stainless steel.
2. Fasteners for Aluminum: Stainless steel.
3. Other Applications: Galvanized steel or stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

1. Provide items embedded in concrete and masonry in time for building into work without delaying work.

B. Protect existing construction and completed work from damage.

C. Apply barrier coating to aluminum, steel surfaces in contact with dissimilar metals and cementitious materials to minimum 0.7 mm (30 mils) dry film thickness.

3.2 INSTALLATION

A. Install products according to manufacturer's instructions and approved submittal drawings.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Install anchorage devices and fasteners for securing expansion joint assemblies to in-place construction where anchors are not embedded in concrete and masonry.

1. Secure with metal fasteners, type and size to suit application.

C. Perform cutting, drilling and fitting required for installation of expansion joint cover assemblies.

D. Install joint cover assemblies aligned and positioned in correct relationship to expansion joint opening and adjoining finished surfaces measured from established lines and levels.
   1. Allow for thermal expansion and contraction of metal to avoid buckling.
   2. Accommodate joint opening size at time of installation.

E. Set floor covers at elevations flush with adjacent finished flooring, unless shown otherwise.

F. Grout floor frames set in prepared recesses.

G. Locate wall, ceiling and soffit covers in continuous contact with adjacent surfaces. Secure with required accessories.

H. Locate anchors at interval recommended by manufacturer, but minimum 75 mm (3 inches) from each end, and, maximum 600 mm (24 inches) on centers.

I. Maintain continuity of expansion joint cover assemblies with end joints held to a minimum and metal members aligned mechanically using splice joints.

J. Cut and fit ends to accommodate thermal expansion and contraction of metal to avoid buckling of frames and cover plates.

K. Flush Metal Cover Plates:
   1. Secure flexible filler between frames to allow compression and expansion.
   2. Adhere flexible filler materials to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
   3. Use fire barrier sealant furnished with expansion joint assembly.

L. Apply sealant where required to prevent water and air infiltration.

M. Vertical Exterior Extruded Thermoplastic Rubber.
   1. Install side frames mounted on sealant or butyl caulk tape with appropriate anchors 600 mm (24 inches) on center complete with secondary seal.
   2. Install primary seals retained in extruded aluminum side frames.

N. Extruded Thermoplastic Rubber or Seals:
   1. For straight sections, install preformed seals in continuous lengths.

2. Vulcanize or heat-seal field spliced joints to provide watertight joints as recommended by manufacturer.

O. Preformed Elastomeric Sealant Joint:

1. Locate joint directly over joints in wall and floor substrates.
2. Fasten full length to substrate using construction adhesive.
3. Install flush or slightly below finish material.

3.3 CLEANING

A. Remove excess adhesive before adhesive sets.

B. Clean exposed metal surfaces. Remove contaminants and stains.

3.4 PROTECTION

A. Cover floor joints with plywood where wheel traffic occurs before Substantial completion.

B. Remove protective covering when adjacent work areas are completed. Clean exposed surfaces in compliance with manufacture's printed instructions.

- - E N D - -

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hollow metal doors hung in hollow metal frames at exterior locations.

1.2 RELATED WORK

A. Section 08 41 13, ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS: Aluminum frames entrance work.

B. Section 08 71 00, DOOR HARDWARE: Door Hardware:

C. Section 08 80 00, GLAZING: Glazing.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American National Standard Institute (ANSI):

A250.8-2014.....Standard Steel Doors and Frames

C. ASTM International (ASTM):

A240/A240M-15b.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A653/A653M-15.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip

A1008/A1008M-15.....Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy and High Strength Low Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

B209-14.....Aluminum and Aluminum-Alloy Sheet and Plate

B209M-14.....Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

B221-14.....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

B221M-13.....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

D3656/D3656M-13.....Insect Screening and Louver Cloth Woven from Vinyl Coated Glass Yarns

E90-09.....Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

D. Federal Specifications (Fed. Spec.):

L-S-125B.....Screening, Insect, Nonmetallic

E. Master Painters Institute (MPI):

No. 18.....Primer, Zinc Rich, Organic

F. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06.....Metal Finishes Manual

G. National Fire Protection Association (NFPA):

80-16.....Fire Doors and Other Opening Protectives

H. UL LLC (UL):

10C-09.....Positive Pressure Fire Tests of Door Assemblies

1784-15.....Air Leakage Tests of Door Assemblies and Other Opening Protectives

I. Department of Veterans Affairs

VA Physical Security and Resiliency Design Manual October 1, 2020

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show size, configuration, and fabrication and installation details.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Include schedule showing each door and frame requirements for openings.
3. Installation instructions.

D. Sustainable Construction Submittals:

1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.

E. Qualifications: Substantiate qualifications comply with specifications.

1. Manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Regularly manufactures specified products.
2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.

a. Project Experience List: Provide contact names and addresses for completed projects.

1.6 DELIVERY

A. Fasten temporary steel spreaders across the bottom of each door frame before shipment.

B. Deliver products in manufacturer's original sealed packaging.

C. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

D. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight // conditioned // facility.

B. Protect products from damage during handling and construction operations.

1.8 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design hollow metal doors and frames complying with specified performance:

1. Thermal Resistance: R-11 R-value minimum at exterior doors

2.2 MATERIALS

A. Sheet Steel: ASTM A1008/A1008M, cold-rolled.

B. Galvanized Sheet Steel: ASTM A653.

C. Aluminum Sheet: ASTM B209M (ASTM B209).

D. Aluminum Extrusions: ASTM B221M (ASTM B221).

2.3 PRODUCTS - GENERAL

A. Provide hollow metal doors and frames from one manufacturer.

B. Sustainable Construction Requirements:

1. Steel Recycled Content: 30 percent total recycled content, minimum.

2. Aluminum Recycled Content: 80 percent total recycled content, minimum.

2.4 HOLLOW METAL DOORS

A. Hollow Metal Doors: ANSI A250.8; 44 mm (1-3/4 inches) thick.

1. Exterior Doors: Level 4 and Physical Performance Level A, maximum heavy duty; Model 2, seamless

B. Door Faces:
   1. Exterior Doors: Galvanized sheet steel minimum Z120 or ZF120 (G40 or A40) coating.
C. Door Cores:
   1. Exterior Doors: Polystyrene or polyurethane.

2.5 HOLLOW METAL FRAMES

A. Hollow Metal Frames: ANSI A250.8; face welded. See drawings for sizes and designs.
   a. Exterior Frames:
      1) Level 4 Hollow Metal Doors: 1.7 mm (0.067 inch) thick.
B. Frame Materials:
   1. Exterior Frames: Galvanized sheet steel minimum Z120 or ZF120 (G40 or A40) coating.

2.6 FABRICATION

A. Hardware Preparation: ANSI A250.8; for hardware specified in Section 08 71 00, DOOR HARDWARE.
B. Hollow Metal Door Fabrication:
   1. Close top edge of exterior doors flush and seal to prevent water intrusion.
   2. Fill spaces between vertical steel stiffeners with insulation.
   3. Two Piece Frames:
      a. One piece unequal leg finished rough buck sub-frames as shown, drilled for anchor bolts.
      b. Unequal leg finished frames formed to fit subframes and secured to subframe legs with countersunk, flat head screws, spaced 300 mm (12 inches) on center at head and jambs on both sides.
      c. Preassemble at factory for alignment.
   4. Frame Anchors:
      a. Floor anchors:
         1) Provide extension type floor anchors to compensate for depth of floor fills.
         2) Provide 1.3 mm (0.053 inch) thick steel clip angles welded to jamb and drilled to receive floor fasteners.
         3) Provide 50 mm by 50 mm by 9 mm (2 inch by 2 inch by 3/8 inch) clip angle for lead lined frames, drilled for floor fasteners.

4) Provide mullion 2.3 mm (0.093 inch) thick steel channel anchors, drilled for two floor fasteners and frame anchor screws.
5) Provide continuous 1 mm (0.042 inch) thick steel rough bucks drilled for floor fasteners and frame anchor screws for sill sections.
   a) Space floor bolts50 mm (24 inches) on center.

b. Jamb anchors:
1) Place anchors on jambs:
   a) Near top and bottom of each frame.
   b) At intermediate points at maximum 600 mm (24 inches) spacing.
2) Form jamb anchors from steel minimum 1 mm (0.042 inch) thick.
   a)
3) Anchors for stud partitions: Provide tabs for securing anchor to sides of studs. Provide one of the following:
   a) Welded type.
   b) Lock-in snap-in type.
4) Anchors for frames set in prepared openings:
   a) Steel pipe spacers 6 mm (1/4 inch) inside diameter, welded to plate reinforcing at jamb stops, or hat shaped formed strap spacers 50 mm (2 inches) wide, welded to jamb near stop.
   b) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass through frame and spacers.
   c) Two piece frames: Subframe or rough buck drilled for 6 mm (1/4 inch) bolts.
5) Modify frame anchors to fit special frame and wall construction.
6) Provide special anchors where shown on drawings and where required to suit application.

2.7 FINISHES

A. Steel and Galvanized Steel: ANSI A250.8; shop primed.
B. Finish exposed surfaces after fabrication.
C. Aluminum Anodized Finish: NAAMM AMP 500.
1. Clear Anodized Finish: AA-C22A41; Class I Architectural, 0.018 mm (0.7 mil) thick.

2.8 ACCESSORIES

A. Primers: ANSI A250.8.

B. Barrier Coating: ASTM D1187/D1187M.

C. Welding Materials: AWS D1.1/D1.1M, type to suit application.

D. Clips Connecting Members and Sleeves: Match door faces.

E. Fasteners: Galvanized steel.

1. Metal Framing: Steel drill screws.

F. Anchors: Galvanized steel

G. Galvanizing Repair Paint: MPI No. 18.

H. Insulation: Unfaced mineral wool.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Apply barrier coating to metal surfaces in contact with cementitious materials to minimum 0.7 mm (30 mils) dry film thickness.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.

When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.3 FRAME INSTALLATION

A. Apply barrier coating to concealed surfaces of frames built into masonry.

B. Plumb, align, and brace frames until permanent anchors are set.

1. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint.

2. Use wood spreaders at bottom of frame when shipping spreader is removed.

3. Where construction permits concealment, leave shipping spreaders in place after installation, otherwise remove spreaders when frames are set and anchored.

4. Remove wood spreaders and braces when walls are built and jamb anchors are secured.

C. Floor Anchors:

1. Anchor frame jambs to floor with two expansion bolts.

a. Lead Lined Frames: Use 9 mm (3/8 inch) diameter bolts.

b. Other Frames: Use 6 mm (1/4 inch) diameter bolts.

2. Power actuated drive pins are acceptable to secure frame anchors to concrete floors.

D. Jamb Anchors:

1. Metal Framed Walls: Secure anchors to sides of studs with two fasteners through anchor tabs.

2. Prepared Masonry and Concrete Openings:

a. Direct Securement: 6 mm (1/4 inch) diameter expansion bolts through spacers.

b. Subframe or Rough Buck Securement:

1) 6 mm (1/4 inch) diameter expansion bolts on 600 mm (24 inch) centers.

2) Power activated drive pins on 600 mm (24 inches) centers.

c. Secure two-piece frames to subframe or rough buck with machine screws on both faces.

E. Frames for Sound Rated Doors: Fill frames with insulation.

F. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.

2. Repair painted surfaces with touch up primer.

3.4 DOOR INSTALLATION

A. Install doors plumb and level.

B. Adjust doors for smooth operation.

C. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.

2. Repair painted surfaces with touch up primer.

3.5 CLEANING

A. Clean exposed door and frame surfaces. Remove contaminants and stains.

3.6 PROTECTION

A. Protect doors and frames from traffic and construction operations.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

- - - E N D - - -

SECTION 08 41 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed entrances and storefronts.

1.2 RELATED REQUIREMENTS

A. Glass and Glazing: Section 08 80 00, GLAZING.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Architectural Manufacturers Associations (AAMA):

2603-15.....Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

2604-13.....Performance Requirements and Test Procedures or High Performance Organic Coatings on Architectural Extrusions and Panels

2605-13.....Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

C. American Welding Society (AWS):

D1.2/D1.2M-14.....Structural Welding Code - Aluminum

D. ASTM International (ASTM):

A240/A240M-20.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

B209-14.....Aluminum and Aluminum-Alloy Sheet and Plate.

B209M-14.....Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

B221-14.....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

B221M-13.....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

D1187/D1187M-97(2018)...Asphalt-Base Emulsions for Use as Protective Coatings for Metal

E283/E283M-19.....Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

E330/E330M-14.....Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

E331-00(2016).....Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

E1886-19.....Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missiles and Exposes to Cyclic Pressure Differentials

E1996-17.....Performance of Exterior Windows, Curtain Walls, Doors, and impact Protective Systems Impacted by Windborne Debris in Hurricanes

F468-16.....Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

F593-17.....Stainless Steel Bolts, Hex Cap Screws, and Studs

E. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06.....Metal Finishes Manual

F. National Fenestration Rating Council (NFRC):

500-14(E1A0).....Determining Fenestration Product Condensation Resistance Values

G. Department of Veterans Affairs(VA):

1. VA Physical Security and Resiliency Design Manual October 1, 2020

SUBMITTALS

H. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

I. Submittal Drawings: Minimum 1 to 2 (half size) scale.

1. Show size, configuration, and fabrication and installation details.
2. Show anchorage and reinforcement.
3. Show interface and relationship to adjacent work, including thermal, air, and water barrier continuity.

J. Manufacturer's Literature and Data:

1. Description of each product.
2. Storefront construction.
3. Installation instructions.
4. Warranty.

K. Samples:

1. Aluminum Anodized Finish: wo sample extrusions minimum 150 mm (6 inches) long for each specified color in sets of three showing maximum color range.

L. Sustainable Construction Submittals:
1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.

M. Test reports: Certify each product complies with specifications.

N. Certificates: Certify each product complies with specifications.
1. Certify anodized finish thickness.

O. Qualifications: Substantiate qualifications comply with specifications.
1. Manufacturer.
2. Installer.
3. Welders and welding procedures.

P. Delegated Design Drawings and Calculations: Signed and sealed by responsible design professional.
1. Show location and magnitude of loads applied to building structural frame.
2. Identify deviations from details shown on drawings.

Q. Operation and Maintenance Data:
1. Care instructions for each exposed finish product.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Regularly manufactures specified products.
2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.

B. Installer Qualifications: Manufacturer authorized representative.
1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.

C. Welders and Welding Procedures Qualifications: AWS D1.2/D1.2M.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

D. Store products indoors in dry, weathertight conditioned facility.

E. Protect products from damage during handling and construction operations.

1.6 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant painted finish against material and manufacturing defects.

1. Warranty Period: 20 Years.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.

1. Minor deviations to details shown on drawings to accommodate manufacturer’s standard products may be accepted by Contracting Officer's Representative when deviations do not affect design concept and specified performance.

B. Design aluminum framed entrances and storefronts complying with performance specified in Section 07 54 23 TPO Roofing.

1. Thermal Movement: Accommodate ambient temperature range of 67 degrees C (120 degrees Fahrenheit).
2. Windborne-Debris Impact Resistance: Pass ASTM E1886.
3. Condensation Resistance: NFRC 500.
   a. Fixed Framing: 45 CRF, minimum.
4. Water Resistance: ASTM E331; No uncontrolled penetration at380 Pa (8 pounds/square foot), minimum, pressure differential.
5. Fixed Framing Air Infiltration Resistance: ASTM E283; 0.30 liter/second/square meter (0.06 cubic foot/minute/square foot), maximum at 300 Pa (6.24 pounds/square foot), minimum, pressure differential.

2.2 MATERIALS

A. Aluminum:

1. Extrusions: ASTM B221M (ASTM B221).
   a. Framing: Minimum 3 mm (0.125 inch) wall thickness.
   b. Glazing Beads, Moldings, and Trim: Minimum 1.25 mm (0.050 inch) thick.
2. Alloy 6063 temper T5 for doors, door frames,and fixed glass .

3. Alloy 6061 temper T6 for guide tracks for sliding doors and other extruded structural members.
   a. Color Anodized Aluminum: Provide aluminum alloy required to produce specified color.

B. Stainless Steel: ASTM A240/A240M; Type 302 or Type 304.

C. Thermal Break: Manufacturer standard low conductive material retarding heat flow in the framework, where insulating glass is scheduled.

2.3 PRODUCTS - GENERAL

A. Basis of Design: Match existing.

B. Provide aluminum framed entrances and storefronts from one manufacturer.

C. Provide aluminum entrances, windows, curtain wall systems from same manufacturer.

D. Sustainable Construction Requirements:
   1. Aluminum Recycled Content: 50 percent total recycled content, minimum.

2.4 FRAMES

A. Framing Members: Extruded aluminum, thermally broken

B. Stops: Provide integral fixed stops and glass rebates and snap-on removable stops.

C. Provide concealed screws, bolts and other fasteners.

D. Secure cover boxes to frames in back of lock strike cutouts.

2.5 FLUSH PANEL DOORS

A. Frames: Aluminum extrusions.

B. Doors: 45 mm (1-3/4 inches) thick or as shown on drawings.
   1. Door Edges and Internal Reinforcing: Extruded aluminum tubes, single piece full height and width, welded joints.
   2. Core: Manufacturer's standard non-combustible insulation.
   3. Faces: Aluminum sheet metal with internal impact reinforcement, laminated to the door edges and core.

2.6 FABRICATION

A. Form metal parts and fit and assemble joints, except joints designed to accommodate movement. Seal joints to resist air infiltration and water penetration.

B. Welding:
   1. Make welds without distorting and discoloring exposed surfaces.
   2. Clean and dress welds. Remove welding flux and weld spatter.

C. Prepare and reinforce doors and frames for hardware and accessories.

1. Coordinate preparation with specified hardware. See Section 08 71 00, DOOR HARDWARE.
2. Fabricate reinforcement from stainless steel plates.
   a. Hinge and pivot reinforcing: Minimum 4.5 mm (0.179 inch) thick.
   b. Lock Face, Flush Bolts, Concealed Holders, Concealed and Surface Mounted Closers Reinforcing: Minimum 2.6 mm (0.104 inch) thick.
   c. Other Surface Mounted Hardware Reinforcing: Minimum 1.5 mm (0.059 inch) thick.
3. Where concealed hardware is specified, provide space, cutouts, and reinforcement for installation and secure fastening.

D. Factory assembled doors.

2.7 FINISHES

A. Aluminum Anodized Finish: NAAMM AMP 500. Match existing per one of the below:
   1. Color Anodized Finish: AA-C22A42 or AA-C22A44; Class I Architectural, 0.018 mm (0.7 mil) thick.
   2. Color Anodized Finish: AA-C22A32 or AA-C22A34; Class II Architectural, 0.01 mm (0.4 mil) thick.

2.8 ACCESSORIES

A. Dielectric Tape: Plastic, non-absorptive, with pressure sensitive adhesive; 0.18 to 0.25 mm (7 to 10 mils) thick.

B. Barrier Coating: ASTM D1187/D1187M.

C. Welding Materials: AWS D1.2/D1.2M, type to suit application.

D. Fasteners:
   1. Aluminum: ASTM F468, Alloy 2024.
   2. Stainless Steel: ASTM F593, Alloy Groups 1, 2 and 3.

E. Anchors: Aluminum or stainless steel; type to suit application.

F. Galvanizing Repair Paint: MPI No. 18.

G. Touch-Up Paint: Match shop finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.
   1. Coordinate floor closer installation recessed into concrete slabs.
   2. Coordinate anchor installation built into masonry and concrete.

B. Protect existing construction and completed work from damage.

C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.

D. Apply dielectric tape or barrier coating to aluminum surfaces in contact with dissimilar metals and cementitious materials to minimum 0.7 mm (30 mils) dry film thickness.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Install aluminum framed entrances and storefronts plumb and true, in alignment and to lines shown on drawings.

C. Anchor frames to adjoining construction at heads, jambs and sills.

D. Provide concealed aluminum clips to connect adjoining frame sections.

E. Install door hardware and hang doors. See Section 08 71 00, DOOR HARDWARE.

F. Adjust doors and hardware uniform clearances and proper operation.

G. Touch up damaged factory finishes.
   1. Repair galvanized surfaces with galvanized repair paint.
   2. Repair painted surfaces with touch up primer.

H. Tolerances:
   1. Variation from Plumb, Level, Warp, and Bow: Maximum 3 mm in 3 meters (1/8 inch in 10 feet).
   2. Variation from Plane: Maximum3 mm in 3.65 meters (1/8 inch in 12 feet); 6 mm (1/4 inch) over total length.
   3. Variation from Alignment: Maximum 1.5 mm (1/16 inch) in-line offset and maximum3 mm (1/8 inch) corner offset.
   4. Variation from Square: Maximum 3 mm (1/8 inch) diagonal measurement differential.

3.3 PROTECTION, CLEANING AND REPAIRING

A. Clean exposed aluminum and glass surfaces. Remove contaminants and stains.

B. Protect aluminum-framed entrances and storefronts from construction operations.

C. Remove protective materials immediately before acceptance.

D. Repair damage.

- - - E N D - - -

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Door hardware and related items necessary for complete installation and operation of doors.

1.2 RELATED WORK

A. Caulking: Section 07 92 00 JOINT SEALANTS.

B. Application of Hardware: Section 08 11 13, HOLLOW METAL DOORS AND FRAMES Section 08 41 13, ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

C. Painting: Section 09 91 00, PAINTING.

1.3 GENERAL

A. All hardware shall comply with ABAAS, (Architectural Barriers Act Accessibility Standard) unless specified otherwise.

B. Provide rated door hardware assemblies where required by most current version of the International Building Code (IBC).

C. Hardware for Labeled Fire Doors and Exit Doors: Conform to requirements of NFPA 80 for labeled fire doors and to NFPA 101 for exit doors, as well as to other requirements specified. Provide hardware listed by UL, except where heavier materials, large size, or better grades are specified herein under paragraph HARDWARE SETS. In lieu of UL labeling and listing, test reports from a nationally recognized testing agency may be submitted showing that hardware has been tested in accordance with UL test methods and that it conforms to NFPA requirements.

D. Hardware for application on metal and wood doors and frames shall be made to standard templates. Furnish templates to the fabricator of these items in sufficient time so as not to delay the construction.

E. The following items shall be of the same manufacturer, except as otherwise specified:

1. Mortise locksets.
2. Hinges for hollow metal and wood doors.
3. Surface applied overhead door closers.
4. Exit devices.
5. Floor closers.

1.4 WARRANTY

A. Automatic door operators shall be subject to the terms of FAR Clause 52.246-21, except that the Warranty period shall be two years in lieu of one year for all items except as noted below:

1. Locks, latchsets, and panic hardware: 5 years.

2. Door closers and continuous hinges: 10 years.

1.5 MAINTENANCE MANUALS

A. In accordance with Section 01 00 00, GENERAL REQUIREMENTS Article titled "INSTRUCTIONS", furnish maintenance manuals and instructions on all door hardware. Provide installation instructions with the submittal documentation.

1.6 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submit 6 copies of the schedule per Section 01 33 23. Submit 2 final copies of the final approved schedules to VAMC Locksmith as record copies (VISN Locksmith if the VAMC does not have a locksmith).

B. Hardware Schedule: AHC certified hardware consultant to prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (if fire rated and listed)	ANSI/BHMA Finish Designation

C. Samples and Manufacturers' Literature:

1. Samples: All hardware items (proposed for the project) that have not been previously approved by Builders Hardware Manufacturers Association shall be submitted for approval. Tag and mark all items with manufacturer's name, catalog number and project number.
2. Samples are not required for hardware listed in the specifications by manufacturer's catalog number, if the contractor proposes to use the manufacturer's product specified.

D. Certificate of Compliance and Test Reports: Submit certificates that hardware conforms to the requirements specified herein. Certificates shall be accompanied by copies of reports as referenced. The testing shall have been conducted either in the manufacturer's plant and certified by an independent testing laboratory or conducted in an independent laboratory, within four years of submittal of reports for approval.

1.7 DELIVERY AND MARKING

A. Deliver items of hardware to job site in their original containers, complete with necessary appurtenances including screws, keys, and instructions. Tag one of each different item of hardware and deliver to COR for reference purposes. Tag shall identify items by Project Specification number and manufacturer's catalog number. These items shall remain on file in COR's office until all other similar items have been installed in project, at which time the COR will deliver items on file to Contractor for installation in predetermined locations on the project.

1.8 INSTRUCTIONS

A. Hardware Set Symbols on Drawings: Except for protective plates, door stops, mutes, thresholds and the like specified herein, hardware requirements for each door are indicated on drawings by symbols. Symbols for hardware sets consist of numbers. Each number designates a set of hardware items applicable to a door type.

B. Keying: All cylinders shall be keyed into existing Great Grand Master Key System. Where existing cylinders cannot be reused, provide removable core cylinders that are removable only with a special key or tool without disassembly of knob or lockset. Cylinders shall match existing

1.9 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. In text, hardware items are referred to by series, types, etc., listed in such specifications and standards, except as otherwise specified.

B. ASTM International(ASTM):

F883-13.....Padlocks

E2180-18.....Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) In Polymeric or Hydrophobic Materials

C. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):

A156.1-06.....Butts and Hinges

A156.2-03.....Bored and Pre-assembled Locks and Latches

A156.3-08.....Exit Devices, Coordinators, and Auto Flush Bolts

A156.4-08.....Door Controls (Closers)

A156.5-14.....Cylinders and Input Devices for Locks.

A156.6-05.....Architectural Door Trim
A156.8-05.....Door Controls-Overhead Stops and Holders
A156.11-14.....Cabinet Locks
A156.12-05 .....Interconnected Locks and Latches
A156.13-05.....Mortise Locks and Latches Series 1000
A156.14-07 .....Sliding and Folding Door Hardware
A156.15-06.....Release Devices-Closer Holder, Electromagnetic and Electromechanical
A156.16-08.....Auxiliary Hardware
A156.17-04 .....Self-Closing Hinges and Pivots
A156.18-06.....Materials and Finishes
A156.20-06 .....Strap and Tee Hinges, and Hasps
A156.21-09.....Thresholds
A156.22-05.....Door Gasketing and Edge Seal Systems
A156.23-04.....Electromagnetic Locks
A156.24-03.....Delayed Egress Locking Systems
A156.25-07 .....Electrified Locking Devices
A156.26-06.....Continuous Hinges
A156.28-07 .....Master Keying Systems
A156.29-07 .....Exit Locks and Alarms
A156.30-03 .....High Security Cylinders
A156.31-07 .....Electric Strikes and Frame Mounted Actuators
A156.36-10.....Auxiliary Locks
A250.8-03.....Standard Steel Doors and Frames

D. National Fire Protection Association (NFPA):
80-10.....Fire Doors and Other Opening Protectives
101-09.....Life Safety Code

E. Underwriters Laboratories, Inc. (UL):
Building Materials Directory (2008)

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. ANSI A156.1. Provide only three-knuckle hinges, except five-knuckle where the required hinge type is not available in a three-knuckle version (e.g., some types of swing-clear hinges). The following types of butt hinges shall be used for the types of doors listed, except where otherwise specified:

1. Exterior Doors: Type A2112/A5112 for doors 900 mm (3 feet) wide or less and Type A2111/A5111 for doors over 900 mm (3 feet) wide. Hinges

for exterior outswing doors shall have non-removable pins. Hinges for exterior fire-rated doors shall be of stainless steel material.

B. Provide quantity and size of hinges per door leaf as follows:
   1. Doors up to 1210 mm (4 feet) high: 2 hinges.
   2. Doors 1210 mm (4 feet) to 2260 mm (7 feet 5 inches) high: 3 hinges minimum.
   3. Doors up to 900 mm (3 feet) wide, standard weight: 114 mm x 114 mm (4-1/2 inches x 4-1/2 inches) hinges.
   4. Doors over 900 mm (3 feet) to 1065 mm (3 feet 6 inches) wide, standard weight: 127 mm x 114 mm (5 inches x 4-1/2 inches).

C. See Articles "MISCELLANEOUS HARDWARE" and "HARDWARE SETS" for pivots and hinges other than butts specified above and continuous hinges specified below.

2.2 DOOR CLOSING DEVICES

A. Closing devices shall be products of one manufacturer

2.3 OVERHEAD CLOSERS

A. Conform to ANSI A156.4, Grade 1.

B. Closers shall conform to the following:
   1. The closer shall have minimum 50 percent adjustable closing force over minimum value for that closer and have adjustable hydraulic back check effective between 60 degrees and 85 degrees of door opening.
   2. Where specified, closer shall have hold-open feature.
   3. Size Requirements: Provide multi-size closers, sizes 1 through 6, except where multi-size closer is not available for the required application.
   4. Material of closer body shall be forged or cast.
   5. Arm and brackets for closers shall be steel, malleable iron or high strength ductile cast iron.
   6. Where closers are exposed to the exterior or are mounted in rooms that experience high humidity, provide closer body and arm assembly of stainless steel material.
   7. Closers shall have full size metal cover; plastic covers will not be accepted.
   8. Closers shall have adjustable hydraulic back-check, separate valves for closing and latching speed, adjustable back-check positioning valve, and adjustable delayed action valve.
   9. Provide closers with any accessories required for the mounting application, including (but not limited to) drop plates, special

soffit plates, spacers for heavy-duty parallel arm fifth screws, bull-nose or other regular arm brackets, longer or shorter arm assemblies, and special factory templating. Provide special arms, drop plates, and templating as needed to allow mounting at doors with overhead stops and/or holders.

10. Closer arms or backcheck valve shall not be used to stop the door from overswing, except in applications where a separate wall, floor, or overhead stop cannot be used.
11. Provide parallel arm closers with heavy duty rigid arm.
12. Where closers are to be installed on the push side of the door, provide parallel arm type except where conditions require use of top jamb arm.
13. Provide all surface closers with the same body attachment screw pattern for ease of replacement and maintenance.
14. All closers shall have a 1 ½″ (38mm) minimum piston diameter.

2.4 DOOR STOPS

A. Conform to ANSI A156.16.

B. Provide door stops wherever an opened door or any item of hardware thereon would strike a wall, column, equipment or other parts of building construction. For concrete, masonry or quarry tile construction, use expansion shields for mounting door stops.

C. Where cylindrical locks with turn pieces or pushbuttons occur, equip wall bumpers Type L02251 (rubber pads having concave face) to receive turn piece or button.

D. Provide floor stops (Type L02141 or L02161) in office areas; Type L02121 x 3 screws into floor elsewhere. Wall bumpers, where used, must be installed to impact the trim or the door within the leading half of its width. Floor stops, where used, must be installed within 4-inches of the wall face and impact the door within the leading half of its width.

E. Where drywall partitions occur, use floor stops, Type L02141 or L02161 in office areas, Type L02121 elsewhere.

F. Provide stop Type L02011, as applicable for exterior doors. At outswing doors where stop can be installed in concrete, provide stop mated to concrete anchor set in 76mm (3-inch) core-drilled hole and filled with quick-setting cement.

G. Omit stops where floor mounted door holders are required and where automatic operated doors occur.

H. Provide appropriate door mounted stop on doors in individual toilets where floor or wall mounted stops cannot be used.

I.

J. Provide door stops on doors where combination closer magnetic holders are specified, except where wall stops cannot be used or where floor stops cannot be installed within 4-inches of the wall.

K. Where the specified wall or floor stop cannot be used, provide concealed overhead stops (surface-mounted where concealed cannot be used).

2.5 OVERHEAD DOOR STOPS AND HOLDERS

A. Conform to ANSI Standard A156.8. Overhead holders shall be of sizes recommended by holder manufacturer for each width of door. Set overhead holders for 110 degree opening, unless limited by building construction or equipment. Provide Grade 1 overhead concealed slide type: stop-only at rated doors and security doors, hold-open type with exposed hold-open on/off control at all other doors requiring overhead door stops.

2.6 LOCKS AND LATCHES

A. Conform to ANSI A156.2. Locks and latches for doors 45 mm (1-3/4 inch) thick or over shall have beveled fronts. Lock cylinders shall have not less than six pins . Cylinders for all locksets shall be removable core type. Cylinders shall be furnished with construction removable cores and construction master keys. Cylinder shall be removable by special key or tool. Construct all cores so that they will be interchangeable into the core housings of all mortise locks, rim locks, cylindrical locks, and any other type lock included in the Great Grand Master Key System. Disassembly of lever or lockset shall not be required to remove core from lockset. All locksets or latches on double doors with fire label shall have latch bolt with 19 mm (3/4 inch) throw, unless shorter throw allowed by the door manufacturer’s fire label. Provide temporary keying device or construction core to allow opening and closing during construction and prior to the installation of final cores.

B. In addition to above requirements, locks and latches shall comply with following requirements:

1. Mortise Lock and Latch Sets: Conform to ANSI/BHMA A156.13. Mortise locksets shall be series 1000, minimum Grade 2. All locksets and latchsets, except on designated doors in Psychiatric (Mental Health) areas, shall have lever handles fabricated from cast stainless steel. Provide sectional (lever x rose) lever design matching [_____]. No substitute lever material shall be accepted. All locks and

latchsets shall be furnished with 122.55 mm (4-7/8-inch) curved lip strike and wrought box. At outswing pairs with overlapping astragals, provide flat lip strip with 21mm (7/8-inch) lip-to-center dimension. Lock function F02 shall be furnished with emergency tools/keys for emergency entrance. All lock cases installed on lead lined doors shall be lead lined before applying final hardware finish. Furnish armored fronts for all mortise locks. Where mortise locks are installed in high-humidity locations or where exposed to the exterior on both sides of the opening, provide non-ferrous mortise lock case.

2. Cylindrical Lock and Latch Sets: levers shall meet ADA (Americans with Disabilities Act) requirements. Cylindrical locksets shall be series 4000 Grade I. All locks and latchsets shall be furnished with 122.55 mm (4-7/8-inch) curved lip strike and wrought box. At outswing pairs with overlapping astragals, provide flat lip strip with 21mm (7/8-inch) lip-to-center dimension. Provide lever design to match design selected by Architect or to match existing lever design. Where two turn pieces are specified for lock F76, turn piece on inside knob shall lock and unlock inside knob, and turn piece on outside knob shall unlock outside knob when inside knob is in the locked position. (This function is intended to allow emergency entry into these rooms without an emergency key or any special tool.)
3. Auxiliary locks shall be as specified under hardware sets and conform to ANSI A156.36.
4. Locks on designated doors in Psychiatric (Mental Health) areas shall be paddle type with arrow projection covers and be UL Listed. Provide these locks with paddle in the down position on both sides of the door. Locks shall be fabricated of wrought stainless steel.

2.7 KEYS

A. Stamp all keys with change number and key set symbol. Furnish keys in quantities as follows:

Locks/Keys	**Quantity**
Cylinder locks	2 keys each

2.8 ARMOR PLATES, KICK PLATES, MOP PLATES AND DOOR EDGING

A. Conform to ANSI Standard A156.6.

B. Provide protective plates as specified below:

1. Kick plates, mop plates and armor plates of metal, Type J100 series.
2. Provide kick plates and mop plates where specified. Kick plates shall be 254 mm (10 inches) or 305 mm (12 inches) high. Mop plates shall be 152 mm (6 inches) high. Both kick and mop plates shall be minimum 1.27 mm (0.050 inches) thick. Provide kick and mop plates beveled on all 4 edges (B4E). On push side of doors where jamb stop extends to floor, make kick plates 38 mm (1-1/2 inches) less than width of door, except pairs of metal doors which shall have plates 25 mm (1 inch) less than width of each door. Extend all other kick and mop plates to within 6 mm (1/4 inch) of each edge of doors. Kick and mop plates shall butt astragals. For jamb stop requirements, see specification sections pertaining to door frames.
3. Kick plates and/or mop plates are not required on following door sides:
   a. Armor plate side of doors;
   b. Exterior side of exterior doors;
   c. Closet side of closet doors;
   d. Both sides of aluminum entrance doors.
4. Armor plates for doors are listed under Article "Hardware Sets". Armor plates shall be thickness as noted in the hardware set, 875 mm (35 inches) high and 38 mm (1-1/2 inches) less than width of doors, except on pairs of metal doors. Provide armor plates beveled on all 4 edges (B4E). Plates on pairs of metal doors shall be 25 mm (1 inch) less than width of each door. Where top of intermediate rail of door is less than 875 mm (35 inches) from door bottom, extend armor plates to within 13 mm (1/2 inch) of top of intermediate rail. On doors equipped with panic devices, extend armor plates to within 13 mm (1/2 inch) of panic bolt push bar.

2.9 EXIT DEVICES

A. Conform to ANSI Standard A156.3. Exit devices shall be Grade 1; type and function are specified in hardware sets. Provide flush with finished floor strikes for vertical rod exit devices in interior of building. Trim shall have cast satin stainless steel lever handles of design similar to locksets, unless otherwise specified. Provide key cylinders for keyed operating trim and, where specified, cylinder dogging.

B. Concealed vertical rod panics shall be provided less bottom rod at interior doors, unless lockable or otherwise specified; provide fire pins as required by exit device and door fire labels. Where concealed

vertical rod panics are specified at exterior doors, provide with both top and bottom rods.

C. At non-rated openings with panic hardware, provide panic hardware with key cylinder dogging feature.

D. Exit devices for fire doors shall comply with Underwriters Laboratories, Inc., requirements for Fire Exit Hardware. Submit proof of compliance.

2.10 FLUSH BOLTS (LEVER EXTENSION)

A. Conform to ANSI A156.16. Flush bolts shall be Type L24081 unless otherwise specified. Furnish proper dustproof strikes conforming to ANSI A156.16, for flush bolts required on lower part of doors.

B. Lever extension manual flush bolts shall only be used at non-fire-rated pairs for rooms only accessed by maintenance personnel.

C. Face plates for cylindrical strikes shall be rectangular and not less than 25 mm by 63 mm (1 inch by 2-1/2 inches).

D. Friction-fit cylindrical dustproof strikes with circular face plate may be used only where metal thresholds occur.

E. Provide extension rods for top bolt where door height exceeds 2184 mm (7 feet 2 inches).

2.11 THRESHOLDS

A. Conform to ANSI A156.21, mill finish extruded aluminum, except as otherwise specified. In existing construction, thresholds shall be installed in a bed of sealant with ¼-20 stainless steel machine screws and expansion shields. In new construction, embed aluminum anchors coated with epoxy in concrete to secure thresholds. Furnish thresholds for the full width of the openings.

B. At exterior doors and any interior doors exposed to moisture, provide threshold with non-slip abrasive finish.

C. Provide with miter returns where threshold extends more than 12 mm (0.5 inch) beyond face of frame.

2.12 WEATHERSTRIPS (FOR EXTERIOR DOORS)

A. Conform to ANSI A156.22. Air leakage shall not to exceed 0.50 CFM per foot of crack length (0.000774m^3/s/m).

2.13 FINISHES

A. Hardware Finishes for Existing Buildings: U.S. Standard finishes shall match finishes of hardware in (similar) existing spaces except where otherwise specified.

B. Special Finish: Exposed surfaces of hardware for dark bronze anodized aluminum doors shall have oxidized oil rubbed bronze finish (dark bronze) finish on door closers shall closely match doors.

2.14 BASE METALS

A. Apply specified U.S. Standard finishes on different base metals as following:

Finish	Base Metal
652	Steel
626	Brass or bronze
630	Stainless steel

PART 3 - EXECUTION

3.1 HARDWARE HEIGHTS

A. For existing buildings locate hardware on doors at heights to match existing hardware. The Contractor shall visit the site, verify location of existing hardware and submit locations to VA COR for approval.

3.2 INSTALLATION

A. Closer devices, including those with hold-open features, shall be equipped and mounted to provide maximum door opening permitted by building construction or equipment. Closers shall be mounted on side of door inside rooms, inside stairs, and away from corridors // except security bedroom, bathroom and anteroom doors which shall have closer installed parallel arm on exterior side of doors. //. At exterior doors, closers shall be mounted on interior side. Where closers are mounted on doors they shall be mounted with hex nuts and bolts; foot shall be fastened to frame with machine screws.

B. Hinge Size Requirements:

Door Thickness	Door Width	Hinge Height
45 mm (1-3/4 inch)	900 mm (3 feet) and less	113 mm (4-1/2 inches)
45 mm (1-3/4 inch)	Over 900 mm (3 feet) but not more than 1200 mm (4 feet)	125 mm (5 inches)
35 mm (1-3/8 inch) (hollow core wood doors)	Not over 1200 mm (4 feet)	113 mm (4-1/2 inches)

C. Hinge leaves shall be sufficiently wide to allow doors to swing clear of door frame trim and surrounding conditions.

D. Where new hinges are specified for new doors in existing frames or existing doors in new frames, sizes of new hinges shall match sizes of existing hinges; or, contractor may reuse existing hinges provided hinges are restored to satisfactory operating condition as approved by COR. Existing hinges shall not be reused on door openings having new doors and new frames. Coordinate preparation for hinge cut-outs and screw-hole locations on doors and frames.

E. Hinges Required Per Door:

Door Description	**Number butts**
Doors 1500 mm (5 ft) or less in height	2 butts
Doors over 1500 mm (5 ft) high and not over 2280 mm (7 ft 6 in) high	3 butts

F. Fastenings: Suitable size and type and shall harmonize with hardware as to material and finish. Provide machine screws and lead expansion shields to secure hardware to concrete, ceramic or quarry floor tile, or solid masonry. Fiber or rawl plugs and adhesives are not permitted. All fastenings exposed to weather shall be of nonferrous metal.

G. After locks have been installed; show in presence of COR that keys operate their respective locks in accordance with keying requirements. (All keys, Master Key level and above shall be sent Registered Mail to the Medical Center Director along with the bitting list. Also a copy of the invoice shall be sent to the COR for his records.) Installation of locks which do not meet specified keying requirements shall be considered sufficient justification for rejection and replacement of all locks installed on project.

3.3 FINAL INSPECTION

A. Installer to provide letter to VA Resident/Project Engineer that upon completion, installer has visited the Project and has accomplished the following:

1. Re-adjust hardware.
2. Evaluate maintenance procedures and recommend changes or additions, and instruct VA personnel.
3. Identify items that have deteriorated or failed.
4. Submit written report identifying problems.

3.4 DEMONSTRATION

A. Demonstrate efficacy of mechanical hardware and electrical, and electronic hardware systems, including adjustment and maintenance procedures, to satisfaction of Resident/Project Engineer and VA Locksmith.

3.5 HARDWARE SETS

A. Following sets of hardware correspond to hardware symbols shown on drawings. Only those hardware sets that are shown on drawings will be required. Disregard hardware sets listed in specifications but not shown on drawings.

B. Hardware Consultant working on a project will be responsible for providing additional information regarding these hardware sets. The numbers shown in the following sets come from BHMA standards.

ELECTRIC HARDWARE ABBREVIATIONS LEGEND:

ADO = Automatic Door Operator

EMCH = Electro-Mechanical Closer-Holder

MHO = Magnetic Hold-Open (wall- or floor-mounted)

C. **EXTERIOR SINGLE DOORS: BELOW HARDWARE SETS ARE TAKEN FROM THE RECORD SPECIFICATIONS FOR THE DOORS AND FRAMES IDENTIFIED. WHERE EXISTING HARDWARE CANNNOT BE REUSED, NEW HARDWARE SHALL MATCH EXISTING.**

4.203 HARDWARE GROUP HW 202:

A. Butts as required.
B. Exit device Type 3, F08.
C. Closer C02031.
D. Overhead stop C02511.
E. Gasket R3A166
F. Threshold.
G. Overhead rain drip.

4.205 HARDWARE GROUP HW 204:

A. Butts as required.
B. Exit device Type 3, F08.
C. Closer C020 31.
D. Overhead stop C02511.
E. Gasket R3A166
F. Threshold.
G. Overhead rain drip.

4.206 HARDWARE GROUP HW 205:

A. Butts as required.
B. Exit device Type 3, F08.
C. Closer C02031.
D. Overhead stop C02511.
E. Gasket R3A166
F. Threshold.
G. Overhead rain drip.

4.207 HARDWARE GROUP HW 206:

A. Butts as required.
B. Exit device Type 3, F08.
C. Closer C02031.
D. Overhead stop C02511.
E. Gasket R3A166
F. Threshold.
G. Overhead rain drip.

4.208 HARDWARE GROUP HW 207:

A. Butts as required.
B. Exit device Type 3, F08.
C. Closer C02031.
D. Overhead stop C02511.
E. Gasket R3A166
F. Threshold.
G. Overhead rain drip.

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SECTION 08 80 00
GLAZING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the following:
   1. Glass.
   2. Glazing materials and accessories for both factory and field glazed assemblies.

1.2 RELATED WORK

A. Section 08 11 13, HOLLOW METAL DOORS AND FRAMES, and Section 08 14 00, WOOD DOORS: Sound resistant doors.
B. Section 08 51 13, ALUMINUM WINDOWS: Aluminum Windows.
C. Section 08 44 13, GLAZED ALUMINUM CURTAIN WALLS Glazed Curtain Walls: Glazed Curtain Walls.

1.3 LABELS

A. Temporary labels:
   1. Provide temporary label on each light of glass identifying manufacturer or brand and glass type, quality and nominal thickness.
   2. Label in accordance with NFRC label requirements.
   3. Temporary labels are to remain intact until glass is approved by Contracting Officer Representative (COR).
B. Permanent labels:
   1. Locate in corner for each pane.
   2. Label in accordance with ANSI Z97.1 and SGCC label requirements.
      a. Tempered glass.
      b. Laminated glass or have certificate for panes without permanent label.
      c. Organic coated glass.

1.4 PERFORMANCE REQUIREMENTS

A. General: Design glazing system consistent with guidance and practices presented in the GANA Glazing Manual, GANA Laminated Glazing Manual, and GANA Sealant Manual, as applicable to project. Installed glazing is to withstand applied loads, thermal stresses, thermal movements, building movements, permitted tolerances, and combinations of these conditions without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; unsafe engagement of the framing

system; deflections beyond specified limits; or other defects in construction.

B. Glazing Unit Design: Design glass, including engineering analysis meeting requirements of authorities having jurisdiction. Thicknesses listed are minimum. Coordinate thicknesses with framing system manufacturers.
   1. Design glass in accordance with ASTM E1300, and for conditions beyond the scope of ASTM E1300, by a properly substantiated structural analysis.
   2. Reference Section 07 54 23 TPO Roofing for design requirements.
   3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than the structural capacity of the glazing unit, the threshold at which frame engagement is no longer safely assured, 1/175thtimes the short-side length, or 19 mm (0.75 inch) , whichever is less.

C. Building Enclosure Vapor Retarder and Air Barrier:
   1. Utilize the inner pane of multiple pane sealed units for the continuity of the air barrier and vapor retarder seal.
   2. Maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

1.5 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Certificates:
   1. Certificate stating that fire-protection and fire-resistive glazing units meet code requirements for fire-resistance-rated assembly and applicable safety glazing requirements.
   2. Certificate on solar heat gain coefficient when value is specified.
   3. Certificate on "R" value when value is specified.

C. Manufacturer Warranty.

D. Manufacturer's Literature and Data:
   1. Glass, each kind required.
   2. Insulating glass units.
   3. Transparent (one-way vision glass) mirrors.
   4. Elastic compound for metal sash glazing.
   5. Putty, for wood sash glazing.
   6. Glazing cushion.
   7. Sealing compound.

E. Samples:
   1. Size: 305 mm by 305 mm (12 inches by 12 inches).
   2. Tinted glass.
   3. Reflective glass.
   4. Transparent (one-way vision glass) mirrors.

F. Preconstruction Adhesion and Compatibility Test Report: Submit glazing sealant manufacturer’s test report indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery: Schedule delivery to coincide with glazing schedules so minimum handling of crates is required. Do not open crates except as required for inspection for shipping damage.

B. Storage: Store cases according to printed instructions on case, in areas least subject to traffic or falling objects. Keep storage area clean and dry.

C. Handling: Unpack cases following printed instructions on case. Stack individual windows on edge leaned slightly against upright supports with separators between each.

D. Protect laminated security glazing units against face and edge damage during entire sequence of fabrication, handling, and delivery to installation location. Provide protective covering on exposed faces of glazing plastics, and mark inside as "INTERIOR FACE" or "PROTECTED FACE":
   1. Sealed-air-space insulating glazing units shall not be transported via non-pressurized aircraft.
   2. Temporary protections: The glass front and polycarbonate back of glazing are to be temporarily protected with compatible, peelable, heat-resistant film which will be peeled for inspections and re-applied and finally removed after doors and windows are installed at destination. Since many adhesives will attack polycarbonate, the film used on exposed polycarbonate surfaces is to be approved and applied by manufacturer.
   3. Edge protection: To cushion and protect glass clad, and polycarbonate edges from contamination or foreign matter, the four (4) edges are to be sealed the depth of glazing with continuous standard-thickness thermoplastic rubber tape. Alternatively,

continuous channel shaped extrusion of thermoplastic rubber are to be used, with flanges extending into face sides of glazing.

4. Protect "Constant Temperature" units including every unit where glass sheet is directly laminated to or directly sealed with metal-tube type spacer bar to polycarbonate sheet, from exposures to ambient temperatures outside the range of 16 to 24 degrees C (60 to 75 degrees F), during the fabricating, handling, shipping, storing, installation, and subsequent protection of glazing.

1.7 PROJECT CONDITIONS:

A. Field Measurements: Field measure openings before ordering tempered glass products to assure for proper fit of field measured products.

1.8 WARRANTY

A. Construction Warranty: Comply with the FAR clause 52.246-21 “Warranty of Construction”.

B. Manufacturer Warranty: Manufacturer shall warranty their glazing from the date of installation and final acceptance by the Government as follows. Submit manufacturer warranty.

1. Insulating glass units to remain sealed for ten (10) years.
2. Laminated glass units to remain laminated for five (5) years.
3. Polycarbonate to remain clear and ultraviolet light stabilized for five (5) years.
4. Insulating plastic to not have more than 6 percent decrease in light transmission and be ultraviolet light stabilized for ten (10) years.

1.9 APPLICABLE PUBLICATIONS:

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Architectural Manufacturers Association (AAMA):
800.....Test Methods for Sealants
810.1-77.....Expanded Cellular Glazing Tape

C. American National Standards Institute (ANSI):
Z97.1-14.....Safety Glazing Material Used in Building - Safety Performance Specifications and Methods of Test

D. American Society of Civil Engineers (ASCE):
7-10.....Wind Load Provisions

E. ASTM International (ASTM):
C542-05(2017).....Lock-Strip Gaskets

C716-06(2020).....Installing Lock-Strip Gaskets and Infill Glazing Materials
C794-18.....Adhesion-in-Peel of Elastomeric Joint Sealants
C864-05(2019).....Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
C920-18.....Elastomeric Joint Sealants
C964-20.....Standard Guide for Lock-Strip Gasket Glazing
C1036-16.....Flat Glass
C1048-18.....Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
C1172-19.....Laminated Architectural Flat Glass
C1349-17.....Standard Specification for Architectural Flat Glass Clad Polycarbonate
C1376-15.....Pyrolytic and Vacuum Deposition Coatings on Flat Glass
D635-18.....Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastic in a Horizontal Position
D4802-16.....Poly (Methyl Methacrylate) Acrylic Plastic Sheet
E84-20.....Surface Burning Characteristics of Building Materials
E119-20.....Standard Test Methods for Fire Test of Building Construction and Material
E1300-16.....Load Resistance of Glass in Buildings
E1886-19.....Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
E1996-17.....Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
E2141-14.....Test Methods for Assessing the Durability of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units
E2190-19.....Insulating Glass Unit

E2240-06.....Test Method for Assessing the Current-Voltage Cycling Stability at 90 Degree C (194 Degree F) of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units

E2241-06.....Test Method for Assessing the Current-Voltage Cycling Stability at Room Temperature of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units

E2354-10.....Assessing the Durability of Absorptive Electrochromic Coatings within Sealed Insulating Glass Units

E2355-10.....Test Method for Measuring the Visible Light Transmission Uniformity of an Absorptive Electrochromic Coating on a Glazing Surface

F1233-08(2019).....Standard Test Method for Security Glazing Materials and Systems

F1642/F1642M-17.....Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

F. Code of Federal Regulations (CFR):

16 CFR 1201-10.....Safety Standard for Architectural Glazing Materials

G. Glass Association of North America (GANA):

2010 Edition.....GANA Glazing Manual

2008 Edition.....GANA Sealant Manual

2009 Edition.....GANA Laminated Glazing Reference Manual

2010 Edition.....GANA Protective Glazing Reference Manual

H. International Code Council (ICC):

IBC.....International Building Code

I. Insulating Glass Certification Council (IGCC)

J. Insulating Glass Manufacturer Alliance (IGMA):

TB-3001-13.....Guidelines for Sloped Glazing

TM-3000.....North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use

K. Intertek Testing Services – Warnock Hersey (ITS-WHI)

L. National Fire Protection Association (NFPA):

80-16.....Fire Doors and Windows

252-12.....Fire Tests of Door Assemblies

257-12.....Standard on Fire Test for Window and Glass Block Assemblies

M. National Fenestration Rating Council (NFRC)

N. Safety Glazing Certification Council (SGCC) 2012:
Certified Products Directory (Issued Semi-Annually).

O. Underwriters Laboratories, Inc. (UL):
9-08(R2009).....Fire Tests of Window Assemblies
263-14.....Fire Tests of Building Construction and Materials
752-11.....Bullet-Resisting Equipment.

P. Department of Veterans Affairs:

Q. //Physical Security Design Manual for VA Mission Critical Protected Facilities January 2015//

R. Architectural Design Manual for VA Facilities (VASDM)

S. Environmental Protection Agency (EPA):
40 CFR 59(2014).....National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 GLASS

A. Provide minimum thickness stated and as additionally required to meet performance requirements.
   1. Provide minimum 6 mm (1/4 inch) thick glass units unless otherwise indicated.

B. Obtain glass units from single source from single manufacturer for each glass type.

C. Clear Glass:
   1. ASTM C1036, Type I, Class 1, Quality q3

2.2 INSULATING GLASS UNITS

A. Provide factory fabricated, hermetically sealed glass unit consisting of two panes of glass separated by a dehydrated air space and comply with ASTM E2190.

2.3 GLAZING ACCESSORIES

A. As required to supplement the accessories provided with the items to be glazed and to provide a complete installation. Ferrous metal accessories exposed in the finished work are to have a finish that will not corrode or stain while in service.

B. Setting Blocks: ASTM C864:
   1. Silicone type.

2. Channel shape; having 6 mm (1/4 inch) internal depth.
3. Shore A hardness of 80 to 90 Durometer.
4. Block lengths: 50 mm (2 inches) except 100 to 150 mm (4 to 6 inches) for insulating glass.
5. Block width: Approximately 1.6 mm (1/16 inch) less than the full width of the rabbet.
6. Block thickness: Minimum 4.8 mm (3/16 inch). Thickness sized for rabbet depth as required.

C. Spacers: ASTM C864:
1. Channel shape having a 6 mm (1/4 inch) internal depth.
2. Flanges not less 2.4 mm (3/32 inch) thick and web 3 mm (1/8 inch) thick.
3. Lengths: 25 to 76 mm (1 to 3 inches).
4. Shore A hardness of 40 to 50 Durometer.

D. Glazing Tapes:
1. Semi-solid polymeric based closed cell material exhibiting pressure-sensitive adhesion and withstanding exposure to sunlight, moisture, heat, cold, and aging.
2. Shape, size and degree of softness and strength suitable for use in glazing application to prevent water infiltration.
3. Complying with AAMA 800 for the following types:
   a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

E. Spring Steel Spacer: Galvanized steel wire or strip designed to position glazing in channel or rabbeted sash with stops.

F. Glazing Gaskets: ASTM C864:
1. Firm dense wedge shape for locking in sash.
2. Soft, closed cell with locking key for sash key.
3. Flanges may terminate above the glazing-beads or terminate flush with top of beads.

G. Lock-Strip Glazing Gaskets: ASTM C542, shape, size, and mounting as indicated.

H. Glazing Sealants: ASTM C920, silicone neutral cure:
1. Type S.
2. Class 25 or 50 as recommended by manufacturer for application.
3. Grade NS.

4. Shore A hardness of 25 to 30 Durometer.

I. Structural Sealant: ASTM C920, silicone acetoxy cure:
1. Type S.
2. Class 25.
3. Grade NS.
4. Shore a hardness of 25 to 30 Durometer.

J. Neoprene, or EPDM, Glazing Gasket: ASTM C864.
1. Channel shape; flanges may terminate above the glazing channel or flush with the top of the channel.
2. Designed for dry glazing.

K. Color:
1. Color of glazing compounds, gaskets, and sealants used for aluminum color frames to match color of the finished aluminum and be nonstaining.
2. Color of other glazing compounds, gaskets, and sealants which will be exposed in the finished work and unpainted are to be black, gray, or neutral color.

L. Smoke Removal Unit Targets: Adhesive targets affixed to glass to identify glass units intended for removal for smoke control. Comply with requirements of local Fire Department.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine openings for glass and glazing units; determine they are proper size; plumb; square; and level before installation is started.
2. Verify that glazing openings conform with details, dimensions and tolerances indicated on manufacturer is approved shop drawings.

B. Review for conditions which may adversely affect glass and glazing unit installation, prior to commencement of installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Verify that wash down of adjacent masonry is completed prior to erection of glass and glazing units.

3.2 PREPARATION

A. For sealant glazing, prepare glazing surfaces in accordance with GANA Sealant Manual.

B. Determine glazing unit size and edge clearances by measuring the actual unit to receive the glazing.

C. Shop fabricate and cut glass with smooth, straight edges of full size required by openings to provide GANA recommended edge clearances.
D. Verify that components used are compatible.
E. Clean and dry glazing surfaces.
F. Prime surfaces scheduled to receive sealants, as determined by preconstruction sealant-substrate testing.

3.3 INSTALLATION – GENERAL

A. Install in accordance with GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, and IGMA TM-3000 unless specified otherwise.
B. Glaze in accordance with recommendations of glazing and framing manufacturers, and as required to meet the Performance Test Requirements specified in other applicable sections of specifications.
C. Set glazing without bending, twisting, or forcing of units.
D. Do not allow glass to rest on or contact any framing member.
E. Glaze doors and operable sash, in a securely fixed or closed and locked position, until sealant, glazing compound, or putty has thoroughly set.
F. Tempered Glass: Install with roller distortions in horizontal position unless otherwise directed.
G. Insulating Glass Units:
   1. Glaze in compliance with glass manufacturer's written instructions.
   2. When glazing gaskets are used, they are to be of sufficient size and depth to cover glass seal or metal channel frame completely.
   3. Do not use putty or glazing compounds.
   4. Do not grind, nip, cut, or otherwise alter edges and corners of fused glass units after shipping from factory.
   5. Install with tape or gunnable sealant in wood sash.

3.4 REPLACEMENT AND CLEANING

A. Clean new glass surfaces removing temporary labels, paint spots, and defacement after approval by COR.
B. Replace cracked, broken, and imperfect glass, or glass which has been installed improperly.
C. Leave glass, putty, and other setting material in clean, whole, and acceptable condition.

3.5 PROTECTION

A. Protect finished surfaces from damage during erection, and after completion of work. Strippable plastic coatings on colored anodized finish are not acceptable.

3.6 INSULATING GLASS SCHEDULE

A. Glass Type G-1 (to match existing)

2.1 GLAZING TYPE G-1:

A. Clear insulated glass units shall be double glazed, consisting of a lite, and air space, a lite, and overall thickness shall be 25 mm (1 inch) nominal.
B. Outer lite shall comply with the requirements for ASTM C 1036, Type I - Flat Transparent Glass, Class 1 - Clear, Quality q3 - Glazing Select, with Low E coating on #2 surface.
C. Inner lite shall comply with the requirements for ASTM C 1036, Type I - Flat Transparent Glass, Class 1 - Clear, Quality q3 - Glazing Select.
D. Lite thickness shall be 6 mm (0.25 inches), nominal, or as required by IBC.
E. Air spaces shall be minimum 95 Percent (95%) Argon-filled.
F. Unit shall have the following values +/- 10%:
   1. Winter U Value of 1.53 (0.27).
   2. Summer U Value of 1.42 (0.25).
   3. Shading Coefficient of 0.45.
   4. Relative Heat Gain of 296 (94).
   5. LSG of 1.27.
   6. Visible Light Transmittance 50%.
   7. Solar Transmittance 32%.
   8. Ultraviolet Transmittance 21%.
   9. Visible Light Reflectance Outwards 16%.
   10. Visible Light Reflectance Inwards 11%.
   11. Solar Reflectance 20%.
G. Overall insulated unit thickness shall be one inch (1).
H. Color shall be as specified in Section 09050, INTERIOR/ EXTERIOR FINISHES, MATERIALS AND FINISH SCHEDULE.
I. Provide at all exterior lites, except where the safety glazing is required by the IBC, or where design calculations require stronger lite, or where another glass pattern is specifically specified.

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SECTION 08 90 00
LOUVERS AND VENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies fixed and operable wall louvers, door louvers and wall vents.

1.2 RELATED WORK

A. Section 08 11 13, HOLLOW METAL DOORS AND FRAMES: Louvers in Steel Doors.

B. Section 09 06 00, SCHEDULE FOR FINISHES: Color of finish.

C. Section 13 49 00, RADIATION PROTECTION: Louvers in lead lined wood doors.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop Drawings:

1. Each type, showing material, finish, size of members, operating devices, method of assembly, and installation and anchorage details.

C. Manufacturer's Literature and Data:

1. Each type of louver and vent.

D. Color samples.

1.4 APPLICABLE PUBLICATIONS:

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. The Master Painters Institute (MPI):
Approved Product List – Updated Monthly

C. ASTM International (ASTM):

A240/A240M-20.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A653/A653M-20.....Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process

A1008/A1008M-20.....Steel, Sheet, Carbon, Cold Rolled, Structural, and High Strength Low-Alloy with Improved Formability

B209-14.....Aluminum and Aluminum Alloy, Sheet and Plate

B209M-14.....Aluminum and Aluminum Alloy, Sheet and Plate (Metric)

B221-14.....Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

B221M-13.....Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes (Metric)

D1187/D1187M-97(2018)...Asphalt-Base Emulsions for Use as Protective Coatings for Metal

D. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06.....Metal Finishes Manual

E. National Fire Protection Association (NFPA):

90A-15.....Installation of Air Conditioning and Ventilating Systems

F. American Architectural Manufacturers Association (AAMA):

2605-13.....High Performance Organic Coatings on Architectural Extrusions and Panels

G. Air Movement and Control Association, Inc. (AMCA):

500-L-07 Testing Louvers

H Department of Veterans Affairs:

//VA Physical Security Design Manual for Life Safety Protected Facilities January 2015//

// VA Physical Security Design Manual for Mission Critical Protected Facilities January 2015//

I. Protective Design Center

PDC-TR-08 Single Degree of Freedom Structural Response Limits for Antiterrorism Design

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Aluminum, Extruded: ASTM B221M (B221).

B. Stainless Steel: ASTM A240/A240M, Type 302B.

C. Galvanized Steel Sheet: ASTM A653/A653M; G90 min.

D. Carbon Steel and Sheet: ASTM A1008/A1008M (interior use louvers only).

E. Aluminum, Plate and Sheet: ASTM B209M (B209); alloy 3003 or 5005 with temper as required for forming.

F. Fasteners: Fasteners for securing louvers and wall vents to adjoining construction, except as otherwise specified or indicated in construction documents, to be toggle or expansion bolts of size and

type as required for each specific type of installation and service condition.

1. Where type, size, or spacing of fasteners is not shown or specified, submit shop drawings showing proposed fasteners, and method of installation.
2. Fasteners for louvers, louver frames, and wire guards to be of stainless steel or aluminum with same finish as louvers.
3. Fasteners for louvers, louver frames and wire guards within mental health areas to be non-removable/tamper-proof type.

G. Inorganic Zinc Primer: MPI No. 19.

H. Bituminous Coating: ASTM D1187/D1187M; cold applied asphalt mastic emulsion.

2.2 EXTERIOR WALL LOUVERS:

A. General:

1. Provide fixed and operable type louvers of size and design shown.
2. Heads, sills and jamb sections are to have formed caulking slots or be designed to retain caulking. Head sections are to have exterior drip lip, and sill sections an integral water stop.
3. Furnish louvers with sill extension or separate sill as shown.
4. Frame is to be mechanically fastened or welded construction with welds dressed smooth and flush.

B. Performance Characteristics:

1. Weather louvers are to MATCH EXISTING.
2. Louvers are to bear AMCA certified rating seals for air performance and water penetration ratings.

C. Aluminum Louvers: MATCH EXISTING

1. General: Frames, blades, Match exiting
2. Louvers, fixed: Match exiting.
3. Louvers, operable: Louver frame opening sizes, single louver sizes and mullion requirements are to be as specified for fixed louvers.
   a. Blades: Match exiting.
   b. Automatic operation: Match exiting.

D. Stainless Steel Louvers: Form stainless steel louvers using 1.6 mm (0.063-inch) thick sheet for frames, blades, sills and mullions.

1. Provide louver with fixed 45 degree drainable blades with water baffle. Make overall frame size 13 mm (1/2-inch) less than opening, unless otherwise indicated in construction documents.

2. Single louver sections are not to exceed 1676 mm (66 inches) in width. For openings larger than 1676 mm (66 inches) wide, provide multiple sections not larger than 1676 mm (66 inches) wide separated by mullions.

E. Formed Steel Louvers: Match exiting

2.3 CLOSURE ANGLES AND CLOSURE PLATES:

A. Fabricate from 2 mm (0.078-inch) thick stainless steel or aluminum.

B. Provide continuous closure angles and closure plates on inside head, jambs and sill of exterior wall louvers.

C. Secure angles and plates to louver frames with screws, and to masonry or concrete with fasteners as indicated in construction documents.

2.4 WIRE GUARDS:

A. Provide wire guards on outside of all exterior louvers, except on exhaust air louvers.

B. Fabricate frames to Match exiting.

C. Wire mesh to Match exiting.

D. Miter corners and join by concealed corner clips or locks extending not less than 57 mm (2-1/4 inches) into rails and stiles. Equip wire guards over 1219 mm (4 feet) in height with a mid-rail constructed as specified for frame components.

E. Fasten frames to outside of louvers with aluminum or stainless steel devices of same finish as louvers designed to allow removal and replacement without damage to the wire guard or the louver.

2.5 WALL VENTS:

A. Fabricate exterior wall vents from either 4.7 mm (0.185-inch) thick aluminum plate or 6 mm (1/4-inch) thick cast iron, perforated in diamond lattice pattern, with not over 19 mm (3/4-inch) openings.

B. Vents are to have aluminum screen frame with aluminum alloy insect screening mounted on back of vent by means of 19 mm x 5 mm (3/4-inch by 3/16-inch) top and bottom bars screwed to grille.

C. Vent Frames in Masonry: Fabricate of 45 mm x 30 mm x 5 mm (1-3/4 inch by 1-1/4 inch by 3/16-inch) steel angles bolted with 6 mm (1/4-inch) diameter expansion bolts at jambs.

2.6 AIR INTAKE VENTS:

A. Fabricate exterior louvered wall ventilators for fresh air intake for air conditioning units from extruded aluminum, ASTM B221M (B221). Form with integral horizontal louvers and frame, with drip extending beyond face of wall and integral water stops.

2.7 FINISH:

A. In accordance with NAAMM Metal Finishes Manual: AMP 500-505

B. Aluminum Louvers Match exiting

C. Steel: Surfaces of steel work, for which no other finish is specified, are to be cleaned free from scale, rust, oil and grease, and then given a light colored prime paint after fabrication, except ferrous metals concealed in finished work. Paint all contact surfaces of assembled work (except welded contact surfaces) with an additional shop coat of similar paint.

2.8 PROTECTION:

A. Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact, by painting the contact surfaces of the dissimilar material with a heavy coat of bituminous coating (complete coverage), or by separating the contact surfaces with a performed synthetic rubber tape having pressure sensitive adhesive coating on one side.

B. Isolate the aluminum from plaster, concrete and masonry by coating aluminum with zinc-chromate primer.

C. Protect finished surfaces from damage during fabrication, erection, and after completion of the work. Strippable plastic coating on colored anodized finish is not approved.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Set work accurately, in alignment and where indicated in construction documents. Install plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.

B. Furnish setting drawings and instructions for installation of anchors and for the positioning of items having anchors to be built into masonry construction. Provide temporary bracing for such items until masonry is set.

C. Provide anchoring devices and fasteners as shown and as necessary for securing louvers and vents to building construction as specified. Power actuated drive pins may be used, except for removal items and where members would be deformed or substrate damaged by their use.

D. Set wall louvers and vents in masonry walls during progress of the work. If wall louvers and vents are not delivered to job in time for

installation in prepared openings, make provision for later installation. Set in cast-in-place concrete in prepared openings.

3.2 CLEANING AND ADJUSTING:

A. After installation, all exposed prefinished and plated items and all items fabricated from stainless steel and aluminum are to be cleaned as recommended by the manufacturer and protected from damage until completion of the project.

B. All movable parts, including hardware, are to be cleaned and adjusted to operate as designed without binding or deformation of the members, so as to be centered in the opening of frame, and where applicable, to have all contact surfaces fit tight and even without forcing or warping the components.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Contracting Officer Representative (COR) damaged units and replace with new units.

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SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies steel studs wall systems, shaft wall systems, ceiling or soffit suspended or furred framing, wall furring, fasteners, and accessories for the screw attachment of gypsum board, plaster bases or other building boards.

1.2 RELATED WORK

A. Gypsum Board: Section 09 29 00, GYPSUM BOARD.

1.3 TERMINOLOGY

A. Description of terms shall be in accordance with ASTM C754, ASTM C11, ASTM C841 and as specified.

B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by beams, trusses, or bar joists. In interstitial spaces with walk-on floors the underside of the walk-on floor is the underside of structure overhead.

C. Thickness of steel specified is the minimum bare (uncoated) steel thickness.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Studs, runners and accessories.
2. Hanger inserts.
3. Channels (Rolled steel).
4. Furring channels.
5. Screws, clips and other fasteners.

C. Shop Drawings:

1. Typical ceiling suspension system.
2. Typical metal stud and furring construction system including details around openings and corner details.
3. Typical shaft wall assembly
4. Typical fire rated assembly and column fireproofing showing details of construction same as that used in fire rating test.

D. Test Results: Fire rating test designation, each fire rating required for each assembly.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

In accordance with the requirements of ASTM C754.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society For Testing And Materials (ASTM)

A641-09.....Zinc-Coated (Galvanized) Carbon Steel Wire

A653/653M-11.....Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

C11-10.....Terminology Relating to Gypsum and Related Building Materials and Systems

C635-07.....Manufacture, Performance, and Testing of Metal Suspension System for Acoustical Tile and Lay-in Panel Ceilings

C636-08.....Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels

C645-09.....Non-Structural Steel Framing Members

C754-11.....Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

C841-03(R2008).....Installation of Interior Lathing and Furring

C954-10.....Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness

E580-11.....Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint.

PART 2 - PRODUCTS

2.1 PROTECTIVE COATING

Galvanize steel studs, runners (track), rigid (hat section) furring channels, "Z" shaped furring channels, and resilient furring channels, with coating designation of G40 or equivalent.

2.2 STEEL STUDS AND RUNNERS (TRACK)

A. ASTM C645, modified for thickness specified and sizes as shown.

1. Use C 645 steel, 0.75 mm (0.0296-inch) minimum base-metal (30 mil).
2. Runners same thickness as studs.

3. Exception: Members that can show certified third party testing with gypsum board in accordance with ICC ES AC86 (Approved May 2012) need not meet the minimum thickness limitation or minimum section properties set forth in ASTM C 645. The submission of an evaluation report is acceptable to show conformance to this requirement. Use C 645 steel, 0.48mm (0.019 inch) minimum base-metal (19 mil).

B. Provide not less than two cutouts in web of each stud, approximately 300 mm (12 inches) from each end, and intermediate cutouts on approximately 600 mm (24-inch) centers.

C. Doubled studs for openings and studs for supporting concrete backer-board.

D. Studs 3600 mm (12 feet) or less in length shall be in one piece.

2.3 FURRING CHANNELS

A. Rigid furring channels (hat shape): ASTM C645.

B. Resilient furring channels:

1. Not less than 0.45 mm (0.0179-inch) thick bare metal.
2. Semi-hat shape, only one flange for anchorage with channel web leg slotted on anchorage side, channel web leg on other side stiffens fastener surface but shall not contact anchorage surface other channel leg is attached to.

C. "Z" Furring Channels:

1. Not less than 0.45 mm (0.0179-inch)-thick base metal, with 32 mm (1-1/4 inch) and 19 mm (3/4-inch) flanges.
2. Web furring depth to suit thickness of insulation.

D. Rolled Steel Channels: ASTM C754, cold rolled; or, ASTM C841, cold rolled.

2.4 FASTENERS, CLIPS, AND OTHER METAL ACCESSORIES

A. ASTM C754, except as otherwise specified.

B. For fire rated construction: Type and size same as used in fire rating test.

C. Fasteners for steel studs thicker than 0.84 mm (0.033-inch) thick. Use ASTM C954 steel drill screws of size and type recommended by the manufacturer of the material being fastened.

D. Clips: ASTM C841 (paragraph 6.11), manufacturer’s standard items. Clips used in lieu of tie wire shall have holding power equivalent to that provided by the tie wire for the specific application.

E. Concrete ceiling hanger inserts (anchorage for hanger wire and hanger straps): Steel, zinc-coated (galvanized), manufacturers standard items,

designed to support twice the hanger loads imposed and the type of hanger used.

F. Tie Wire and Hanger Wire:
   1. ASTM A641, soft temper, Class 1 coating.
   2. Gage (diameter) as specified in ASTM C754 or ASTM C841.

G. Attachments for Wall Furring:
   1. Manufacturers standard items fabricated from zinc-coated (galvanized) steel sheet.

H. Power Actuated Fasteners: Type and size as recommended by the manufacturer of the material being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION CRITERIA

A. Where fire rated construction is required for walls, partitions, columns, beams and floor-ceiling assemblies, the construction shall be same as that used in fire rating test.

B. Construction requirements for fire rated assemblies and materials shall be as shown and specified, the provisions of the Scope paragraph (1.2) of ASTM C754 and ASTM C841 regarding details of construction shall not apply.

3.2 INSTALLING STUDS

A. Install studs in accordance with ASTM C754, except as otherwise shown or specified.

B. Space studs not more than 610 mm (24 inches) on center.

C. Cut studs 6 mm to 9 mm (1/4 to 3/8-inch) less than floor to underside of structure overhead when extended to underside of structure overhead.

D. Where studs are shown to terminate above suspended ceilings, provide bracing as shown or extend studs to underside of structure overhead.

E. Extend studs to underside of structure overhead for fire, rated partitions, smoke partitions, shafts, and sound rated partitions and insulated exterior wall furring.

G. Openings:
   1. Frame jambs of openings in stud partitions and furring with two studs placed back to back or as shown.
   2. Fasten back to back studs together with 9 mm (3/8-inch) long Type S pan head screws at not less than 600 mm (two feet) on center, staggered along webs.
   3. Studs fastened flange to flange shall have splice plates on both sides approximately 50 X 75 mm (2 by 3 inches) screwed to each stud

with two screws in each stud. Locate splice plates at 600 mm (24 inches) on center between runner tracks.

H. Fastening Studs:
   1. Fasten studs located adjacent to partition intersections, corners and studs at jambs of openings to flange of runner tracks with two screws through each end of each stud and flange of runner.
   2. Do not fasten studs to top runner track when studs extend to underside of structure overhead.

I. Chase Wall Partitions:
   1. Locate cross braces for chase wall partitions to permit the installation of pipes, conduits, carriers and similar items.
   2. Use studs or runners as cross bracing not less than 63 mm (2-1/2 inches wide).

J. Form building seismic or expansion joints with double studs back to back spaced 75 mm (three inches) apart plus the width of the seismic or expansion joint.

K. Form control joint, with double studs spaced 13 mm (1/2-inch) apart.

3.3 INSTALLING WALL FURRING FOR FINISH APPLIED TO ONE SIDE ONLY

A. In accordance with ASTM C754, or ASTM C841 except as otherwise specified or shown.

B. Wall furring-Stud System:
   1. Framed with 63 mm (2-1/2 inch) or narrower studs, 600 mm (24 inches) on center.
   2. Brace as specified in ASTM C754 for Wall Furring-Stud System or brace with sections or runners or studs placed horizontally at not less than three foot vertical intervals on side without finish.
   3. Securely fasten braces to each stud with two Type S pan head screws at each bearing.

C. Direct attachment to masonry or concrete; rigid channels or "Z" channels:
   1. Install rigid (hat section) furring channels at 600 mm (24 inches) on center, horizontally or vertically.
   2. Install "Z" furring channels vertically spaced not more than 600 mm (24 inches) on center.
   3. At corners where rigid furring channels are positioned horizontally, provide mitered joints in furring channels.
   4. Ends of spliced furring channels shall be nested not less than 200 mm (8 inches).

5. Fasten furring channels to walls with power-actuated drive pins or hardened steel concrete nails. Where channels are spliced, provide two fasteners in each flange.
6. Locate furring channels at interior and exterior corners in accordance with wall finish material manufacturers printed erection instructions. Locate "Z" channels within 100 mm (4 inches) of corner.

D. Installing Wall Furring-Bracket System: Space furring channels not more than 400 mm (16 inches) on center.

3.4 INSTALLING SUPPORTS REQUIRED BY OTHER TRADES

A. Provide for attachment and support of electrical outlets, plumbing, laboratory or heating fixtures, recessed type plumbing fixture accessories, access panel frames, wall bumpers, wood seats, toilet stall partitions, dressing booth partitions, urinal screens, chalkboards, tackboards, wall-hung casework, handrail brackets, recessed fire extinguisher cabinets and other items like auto door buttons and auto door operators supported by stud construction.

B. Provide additional studs where required. Install metal backing plates, or special metal shapes as required, securely fastened to metal studs.

3.7 TOLERANCES

A. Fastening surface for application of subsequent materials shall not vary more than 3 mm (1/8-inch) from the layout line.

B. Plumb and align vertical members within 3 mm (1/8-inch.)

C. Level or align ceilings within 3 mm (1/8-inch.)

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SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies installation and finishing of gypsum board.

1.2 RELATED WORK

A. Installation of steel framing members for walls, partitions, and furring Section 09 22 16, NON-STRUCTURAL METAL FRAMING.

1.3 TERMINOLOGY

A. Definitions and description of terms shall be in accordance with ASTM C11, C840, and as specified.

B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by the trusses or bar joists.

C. "Yoked": Gypsum board cut out for opening with no joint at the opening (along door jamb or above the door).

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Cornerbead and edge trim.
2. Finishing materials.
3. Laminating adhesive.
4. Gypsum board, each type.

C. Shop Drawings:

1. Typical gypsum board installation, showing corner details, edge trim details and the like.

D. Test Results:

1. Fire rating test, each fire rating required for each assembly.
2. Sound rating test.

E. Certificates: Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos material.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

In accordance with the requirements of ASTM C840.

1.6 ENVIRONMENTAL CONDITIONS

In accordance with the requirements of ASTM C840.

1.7 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing And Materials (ASTM):

C11-15.....Terminology Relating to Gypsum and Related Building Materials and Systems

C475-15.....Joint Compound and Joint Tape for Finishing Gypsum Board

C840-13.....Application and Finishing of Gypsum Board

C919-12.....Sealants in Acoustical Applications

C954-15.....Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Stud from 0.033 in. (0.84mm) to 0.112 in. (2.84mm) in thickness

C1002-14.....Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

C1047-14.....Accessories for Gypsum Wallboard and Gypsum Veneer Base

C1177-13.....Glass Mat Gypsum Substrate for Use as Sheathing

C1178/C1178M-18.....Specification for Coated Glass Mat Water Resistant Backing Panel

C1658-13.....Glass Mat Gypsum Panels

C1396-14.....Gypsum Board

C. Underwriters Laboratories Inc. (UL):

Latest Edition.....Fire Resistance Directory

D. Inchcape Testing Services (ITS):

Latest Editions.....Certification Listings

PART 2 - PRODUCTS

2.1 GYPSUM BOARD

A. Gypsum Board: ASTM C1396, Type X, 16 mm (5/8 inch) thick unless shown otherwise.

2.3 ACCESSORIES

A. ASTM C1047, except form of 0.39 mm (0.015 inch) thick zinc coated steel sheet or rigid PVC plastic.

B. Flanges not less than 22 mm (7/8 inch) wide with punchouts or deformations as required to provide compound bond.

2.4 FASTENERS

A. ASTM C1002 and ASTM C840, except as otherwise specified.

B. ASTM C954, for steel studs thicker than 0.04 mm (0.33 inch).

C. Select screws of size and type recommended by the manufacturer of the material being fastened.

D. For fire rated construction, type and size same as used in fire rating test.

E. Clips: Zinc-coated (galvanized) steel; gypsum board manufacturer's standard items.

2.5 FINISHING MATERIALS AND LAMINATING ADHESIVE

ASTM C475 and ASTM C840. Free of antifreeze, vinyl adhesives, preservatives, biocides and other VOC. Adhesive shall contain a maximum VOC content of 50 g/l.

PART 3 - EXECUTION

3.1 GYPSUM BOARD HEIGHTS

A. Extend all layers of gypsum board from floor to underside of structure overhead on following partitions and furring:

1. Two sides of partitions:
   a. Fire rated partitions.
   b. Smoke partitions.
   c. Sound rated partitions.
   d. Full height partitions shown (FHP).
   e. Corridor partitions.
2. One side of partitions or furring:
   a. Inside of exterior wall furring or stud construction.
   b. Room side of room without suspended ceilings.
   c. Furring for pipes and duct shafts, except where fire rated shaft wall construction is shown.
3. Extend all layers of gypsum board construction used for fireproofing of columns from floor to underside of structure overhead, unless shown otherwise.

B. In locations other than those specified, extend gypsum board from floor to heights as follows:

1. Not less than 100 mm (4 inches) above suspended acoustical ceilings.
2. At ceiling of suspended gypsum board ceilings.
3. At existing ceilings.

3.2 INSTALLING GYPSUM BOARD

A. Coordinate installation of gypsum board with other trades and related work.

B. Install gypsum board in accordance with ASTM C840, except as otherwise specified.

C. Moisture and Mold–Resistant Assemblies: Provide and install moisture and mold-resistant glass mat gypsum wallboard products with moisture-resistant surfaces complying with ASTM C1658 where shown and in locations which might be subject to moisture exposure during construction.

D. Use gypsum boards in maximum practical lengths to minimize number of end joints.

E. Bring gypsum board into contact, but do not force into place.

F. Ceilings:

1. For single-ply construction, use perpendicular application.
2. For two-ply assembles:
   a. Use perpendicular application.
   b. Apply face ply of gypsum board so that joints of face ply do not occur at joints of base ply with joints over framing members.

G. Walls (Except Shaft Walls):

1. When gypsum board is installed parallel to framing members, space fasteners 300 mm (12 inches) on center in field of the board, and 200 mm (8 inches) on center along edges.
2. When gypsum board is installed perpendicular to framing members, space fasteners 300 mm (12 inches) on center in field and along edges.
3. Stagger screws on abutting edges or ends.
4. For single-ply construction, apply gypsum board with long dimension either parallel or perpendicular to framing members as required to minimize number of joints except gypsum board shall be applied vertically over "Z" furring channels.
5. For two-ply gypsum board assemblies, apply base ply of gypsum board to assure minimum number of joints in face layer. Apply face ply of wallboard to base ply so that joints of face ply do not occur at joints of base ply with joints over framing members.
6. For three-ply gypsum board assemblies, apply plies in same manner as for two-ply assemblies, except that heads of fasteners need only be driven flush with surface for first and second plies. Apply third

ply of wallboard in same manner as second ply of two-ply assembly, except use fasteners of sufficient length enough to have the same penetration into framing members as required for two-ply assemblies.

7. No offset in exposed face of walls and partitions will be permitted because of single-ply and two-ply or three-ply application requirements.
8. Control Joints ASTM C840 and as follows:
   a. Locate at both side jambs of openings if gypsum board is not "yoked". Use one system throughout.
   b. Not required for wall lengths less than 9000 mm (30 feet).
   c. Extend control joints the full height of the wall or length of soffit/ceiling membrane.

I. Electrical and Telecommunications Boxes:
   1. Seal annular spaces between electrical and telecommunications receptacle boxes and gypsum board partitions.

J. Accessories:
   1. Set accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces as specified.
   2. Install in one piece, without the limits of the longest commercially available lengths.
   3. Corner Beads:
      a. Install at all vertical and horizontal external corners and where shown.
      b. Use screws only. Do not use crimping tool.
   4. Edge Trim (casings Beads):
      a. At both sides of expansion and control joints unless shown otherwise.
      b. Where gypsum board terminates against dissimilar materials and at perimeter of openings, except where covered by flanges, casings or permanently built-in equipment.
      c. Where gypsum board surfaces of non-load bearing assemblies abut load bearing members.
      d. Where shown.

3.5 FINISHING OF GYPSUM BOARD

A. Finish joints, edges, corners, and fastener heads in accordance with ASTM C840. Use Level 4 finish for al finished areas open to public view.

B. Before proceeding with installation of finishing materials, assure the following:

1. Gypsum board is fastened and held close to framing or furring.
2. Fastening heads in gypsum board are slightly below surface in dimple formed by driving tool.

C. Finish joints, fasteners, and all openings, including openings around penetrations, on that part of the gypsum board extending above suspended ceilings to seal surface of non decorated gypsum board construction.

3.6 REPAIRS

A. After taping and finishing has been completed, and before decoration, repair all damaged and defective work, including nondecorated surfaces.

B. Patch holes or openings 13 mm (1/2 inch) or less in diameter, or equivalent size, with a setting type finishing compound or patching plaster.

C. Repair holes or openings over 13 mm (1/2 inch) diameter, or equivalent size, with 16 mm (5/8 inch) thick gypsum board secured in such a manner as to provide solid substrate equivalent to undamaged surface.

3.7 INACCESSIBLE CEILINGS

At Mental Health and Behavioral Nursing Units, areas accessible to patients and not continuously observable by staff (e.g., patient bedrooms, day rooms), ceilings should be a solid material such as gypsum board. This will limit patient access. Access doors are needed to access electrical and mechanical equipment above the ceiling. These doors should be locked to prevent unauthorized access and secured to ceiling using tamper resistant fasteners.

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SECTION 09 91 00
PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the painting and finishing as shown on the construction documents and/or specified herein, including, but not limited to, the following:

1. Prime coats which may be applied in shop under other sections.
2. Prime painting unprimed surfaces to be painted under this Section.
3. Painting items furnished with a prime coat of paint, including touching up of or repairing of abraded, damaged or rusted prime coats applied by others.
4. Painting ferrous metal (except stainless steel) exposed to view.
5. Painting galvanized ferrous metals exposed to view.
6. Painting interior concrete block exposed to view.
7. Painting gypsum drywall exposed to view.
8. Painting of wood exposed to view, except items which are specified to be painted or finished under other Sections of these specifications. Back painting of all wood in contact with concrete, masonry or other moisture areas.
9. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.
10. Painting surfaces above, behind or below grilles, gratings, diffusers, louvers lighting fixtures, and the like, which are exposed to view through these items.
11. Painting includes shellacs, stains, varnishes, coatings specified, and striping or markers and identity markings.
12. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.
13. Painting of any surface not specifically mentioned to be painted herein or on construction documents, but for which painting is obviously necessary to complete the job, or work which comes within the intent of these specifications, is to be included as though specified.

1.2 RELATED WORK

A. Section 01 35 26, SAFETY REQUIREMENTS: Activity Hazard Analysis.

B. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Sustainable Design Requirements.

C. Section 08 14 00, INTERIOR WOOD DOORS: Prefinished flush doors with transparent finishes.

1.3 **SUBMITTALS**

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals as described below:

1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.

C. Painter qualifications.

D. Manufacturer's Literature and Data:

1. Before work is started, or sample panels are prepared, submit manufacturer's literature and technical data, the current Master Painters Institute (MPI) "Approved Product List" indicating brand label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use subsequent MPI "Approved Product List", however, only one (1) list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI "Approved Product List" where applicable is acceptable.

E. Sample Panels:

1. After painters' materials have been approved and before work is started, submit sample panels showing each type of finish and color specified.
2. Panels to Show Color: Composition board, 100 x 250 mm (4 x 10 inch).
3. Panel to Show Transparent Finishes: Wood of same species and grain pattern as wood approved for use, 100 x 250 mm (4 x 10 inch face) minimum, and where both flat and edge grain will be exposed, 250 mm (10 inches) long by sufficient size, 50 x 50 mm (2 x 2 inch) minimum or actual wood member to show complete finish.
4. Attach labels to panel stating the following:
   a. Federal Specification Number or manufacturers name and product number of paints used.
   b. Specification code number specified in Section 09 06 00, SCHEDULE FOR FINISHES.

c. Product type and color.

d. Name of project.

5. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.

F. Sample of identity markers if used.

G. Manufacturers' Certificates indicating compliance with specified requirements:

1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.
2. High temperature aluminum paint.
3. Epoxy coating.
4. Intumescent clear coating or fire-retardant paint.
5. Plastic floor coating.

1.4 DELIVERY AND STORAGE

A. Deliver materials to site in manufacturer's sealed container marked to show following:

1. Name of manufacturer.
2. Product type.
3. Batch number.
4. Instructions for use.
5. Safety precautions.

B. In addition to manufacturer's label, provide a label legibly printed as following:

1. Federal Specification Number, where applicable, and name of material.
2. Surface upon which material is to be applied.
3. Specify Coat Types: Prime; body; finish; etc.

C. Maintain space for storage, and handling of painting materials and equipment in a ventilated, neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.

D. Store materials at site at least 24 hours before using, at a temperature between 7 and 30 degrees C (45 and 85 degrees F).

1.5 QUALITY ASSURANCE

A. Qualification of Painters: Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. Submit evidence that key personnel have successfully performed surface preparation and application of coating on a minimum of three (3) similar projects within the past three (3) years.

B. Paint Coordination: Provide finish coats which are compatible with the prime paints used. Review other Sections of these specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. Upon request from other subcontractors, furnish information on the characteristics of the finish materials proposed to be used, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify the Contracting Officer Representative (COR) in writing of any anticipated problems using the coating systems as specified with substrates primed by others.

1.6 **REGULATORY REQUIREMENTS**

A. Paint materials are to conform to the restrictions of the local Environmental and Toxic Control jurisdiction.

1. Volatile Organic Compounds (VOC) Emissions Requirements: Field-applied paints and coatings that are inside the waterproofing system to not exceed limits of authorities having jurisdiction.
2. Lead-Base Paint:
   a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
   b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
   c. Do not use coatings having a lead content over 0.06 percent by weight of non-volatile content.
   d. For lead-paint removal, see Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.
3. Asbestos: Provide materials that do not contain asbestos.
4. Chromate, Cadmium, Mercury, and Silica: Provide materials that do not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.
5. Human Carcinogens: Provide materials that do not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.
6. Use high performance acrylic paints in place of alkyd paints.

1.7 **SAFETY AND HEALTH**

A. Apply paint materials using safety methods and equipment in accordance with the following:

1. Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis (AHA) as specified in Section 01 35 26, SAFETY REQUIREMENTS. The AHA is to include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

B. Safety Methods Used During Paint Application: Comply with the requirements of SSPC PA Guide 10.

C. Toxic Materials: To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

1. The applicable manufacturer’s Material Safety Data Sheets (MSDS) or local regulation.
2. 29 CFR 1910.1000.
3. ACHIH-BKLT and ACGHI-DOC, threshold limit values.

1.8 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. American Conference of Governmental Industrial Hygienists (ACGIH):

ACGIH TLV-BKLT-2012.....Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)

ACGIH TLV-DOC-2012.....Documentation of Threshold Limit Values and Biological Exposure Indices, (Seventh Edition)

C. ASME International (ASME):

A13.1-07(R2013).....Scheme for the Identification of Piping Systems

D. Code of Federal Regulation (CFR):

40 CFR 59.....Determination of Volatile Matter Content, Water Content, Density Volume Solids, and Weight Solids of Surface Coating

E. Commercial Item Description (CID):

A-A-1272A.....Plaster Gypsum (Spackling Compound)

F. Federal Specifications (Fed Spec):

TT-P-1411A.....Paint, Copolymer-Resin, Cementitious (For Waterproofing Concrete and Masonry Walls) (CEP)

G. Master Painters Institute (MPI):

1.....Aluminum Paint

3.....Primer, Alkali Resistant, Water Based

4.....Interior/ Exterior Latex Block Filler
5.....Exterior Alkyd Wood Primer
6.....Exterior, Latex for Exterior Wood Primer
7.....Exterior Oil Wood Primer
8.....Exterior Alkyd, Flat MPI Gloss Level 1
9.....Exterior Alkyd Enamel MPI Gloss Level 6
10.....Exterior Latex, Flat
11.....Exterior Latex, Semi-Gloss
15.....Exterior Latex, Low Sheen (MPI Gloss Level 3-4)
17.....Primer, Bonding, Waterbased
18.....Organic Zinc Rich Primer
22.....Aluminum Paint, High Heat (up to 590% - 1100F)
23.....Primer, Metal, Surface Tolerant

27.....Exterior / Interior Alkyd Floor Enamel, Gloss
31.....Polyurethane, Moisture Cured, Clear Gloss
36.....Knot Sealer
39.....Primer, Latex, for Interior Wood
40.....Exterior, Latex High Build
42.....Textured Coating, Latex, Flat
43.....Interior Satin Latex, MPI Gloss Level 4
44.....Interior Low Sheen Latex, MPI Gloss Level 2
45.....Interior Primer Sealer
46.....Interior Enamel Undercoat
47.....Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
48.....Interior Alkyd, Gloss, MPI Gloss Level 6
50.....Interior Latex Primer Sealer
51.....Interior Alkyd, Eggshell, MPI Gloss Level 3
52.....Interior Latex, MPI Gloss Level 3
53.....Interior Latex, Flat, MPI Gloss Level 1
54.....Interior Latex, Semi-Gloss, MPI Gloss Level 5
59.....Interior/Exterior Alkyd Porch & Floor Enamel, Low Gloss
60.....Interior/Exterior Latex Porch & Floor Paint, Low Gloss
66.....Interior Alkyd Fire Retardant, Clear Top-Coat (ULC Approved)

67.....Interior Latex Fire Retardant, Top-Coat (ULC Approved)
68.....Interior/ Exterior Latex Porch & Floor Paint, Gloss
71.....Polyurethane, Moisture Cured, Clear, Flat
77.....Epoxy Cold Cured, Gloss
79.....Marine Alkyd Metal Primer
90.....Interior Wood Stain, Semi-Transparent
91.....Wood Filler Paste
94.....Exterior Alkyd, Semi-Gloss
95.....Fast Drying Metal Primer
98.....High Build Epoxy Coating
99.....Sealer, Water-based, for Concrete Floors
101.....Epoxy Anti-Corrosive Metal Primer
107.....Primer, Rust-Inhibitive, Water-based

108.....High Build Epoxy Coating, Low Gloss
113.....Elastomeric, Pigmented, Exterior, Water-based, Flat
114.....Interior Latex, Gloss
115.....Epoxy-Modified Latex, Interior Gloss (MPI gloss level 6)
118.....Dry Fall, Latex Flat
119.....Exterior Latex, High Gloss (acrylic)
134.....Galvanized Water Based Primer
135.....Non-Cementitious Galvanized Primer
138.....Interior High Performance Latex, MPI Gloss Level 2
139.....Interior High Performance Latex, MPI Gloss Level 3
140.....Interior High Performance Latex, MPI Gloss Level 4
141.....Interior High Performance Latex (SG) MPI Gloss Level 5
144.....Latex, Interior, Institutional Low Odor / VOC, (MPI Gloss Level 2)
145.....Latex, Interior, Institutional Low Odor / VOC, (MPI Gloss Level 3)
146.....Latex, Interior, Institutional Low Odor / VOC, (MPI Gloss Level 4)

151.....Light Industrial Coating, Interior, Water-based, (MPI Gloss Level 3)

153.....Light Industrial Coating, Interior, Water-based, (MPI Gloss Level 4)

163.....Exterior Water Based Semi-Gloss Light Industrial Coating, MPI Gloss Level 5

164.....Exterior, Water Based, Gloss, Light Industrial Coating, MPI Gloss Level 6

H. Society for Protective Coatings (SSPC):

SSPC SP 1-82(R2004).....Solvent Cleaning

SSPC SP 2-82(R2004).....Hand Tool Cleaning

SSPC SP 3-28(R2004).....Power Tool Cleaning

SSPC SP 10/NACE No.2....Near-White Blast Cleaning

SSPC PA Guide 10.....Guide to Safety and Health Requirements

I. Maple Flooring Manufacturer’s Association (MFMA):

J. U.S. National Archives and Records Administration (NARA):

29 CFR 1910.1000.....Air Contaminants

K. Underwriter’s Laboratory (UL)

PART 2 - PRODUCTS

2.1 **MATERIALS:**

A. Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer’s technical data sheets for specified coatings and solvents.

2.2 **PAINT PROPERTIES:**

A. Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, paints having metallic powders packaged separately and paints requiring specified additives.

B. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

C. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer and use only to recommended limits.

D. VOC Content: For field applications that are inside the weatherproofing system, paints and coating to comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 gram/liter.
2. Non-flat Paints and Coatings: 150 gram/liter.

3. Dry-Fog Coatings: 400 gram/liter.
4. Primers, Sealers, and Undercoaters: 200 gram/liter.
5. Anticorrosive and Antirust Paints applied to Ferrous Metals: 250 gram/liter.
6. Zinc-Rich Industrial Maintenance Primers: 340 gram/liter.
7. Pretreatment Wash Primers: 420 gram/liter.
8. Shellacs, Clear: 730 gram/liter.
9. Shellacs, Pigmented: 550 gram/liter.

E. VOC test method for paints and coatings is to be in accordance with 40 CFR 59 (EPA Method 24). Part 60, Appendix A with the exempt compounds' content determined by Method 303 (Determination of Exempt Compounds) in the South Coast Air Quality Management District's (SCAQMD) "Laboratory Methods of Analysis for Enforcement Samples" manual.

2.3 **BIOBASED CONTENT**

A. Paint products shall comply with following bio-based standards for biobased materials:

Material Type	Percent by Weight
Interior Paint	20 percent biobased material
Interior Paint- Oil Based and Solvent Alkyd	67 percent biobased material
Exterior Paint	20 percent biobased material
Wood & Concrete Stain	39 percent biobased content
Polyurethane Coatings	25 percent biobased content
Water Tank Coatings	59 percent biobased content
Wood & Concrete Sealer- Membrane Concrete Sealers	11 percent biobased content
Wood & Concrete Sealer- Penetrating Liquid	79 percent biobased content

B. The minimum-content standards are based on the weight (not the volume) of the material.

PART 3 - EXECUTION

3.1 **JOB CONDITIONS:**

A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.
1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.

2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each day's work.

B. Atmospheric and Surface Conditions:

1. Do not apply coating when air or substrate conditions are:
   a. Less than 3 degrees C (5 degrees F) above dew point.
   b. Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the COR and the product manufacturer. Under no circumstances are application conditions to exceed manufacturer recommendations.
   c. When the relative humidity exceeds 85 percent; or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.
2. Maintain interior temperatures until paint dries hard.
3. Do no exterior painting when it is windy and dusty.
4. Do not paint in direct sunlight or on surfaces that the sun will warm.
5. Apply only on clean, dry and frost-free surfaces except as follows:
   a. Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces only when allowed by manufacturer's printed instructions.
   b. Concrete and masonry when permitted by manufacturer's recommendations, dampen surfaces to which water thinned acrylic and cementitious paints are applied with a fine mist of water on hot dry days to prevent excessive suction and to cool surface.

3.2 INSPECTION:

A. Examine the areas and conditions where painting and finishing are to be applied and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.3 GENERAL WORKMANSHIP REQUIREMENTS:

A. Application may be by brush or roller. Spray application only upon acceptance from the COR in writing.

B. Furnish to the COR a painting schedule indicating when the respective coats of paint for the various areas and surfaces will be completed. This schedule is to be kept current as the job progresses.

C. Protect work at all times. Protect all adjacent work and materials by suitable covering or other method during progress of work. Upon completion of the work, remove all paint and varnish spots from floors, glass and

other surfaces. Remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and leave work in a clean condition.

D. Remove and protect hardware, accessories, device plates, lighting fixtures, and factory finished work, and similar items, or provide in place protection. Upon completion of each space, carefully replace all removed items by workmen skilled in the trades involved.

E. When indicated to be painted, remove electrical panel box covers and doors before painting walls. Paint separately and re-install after all paint is dry.

F. Materials are to be applied under adequate illumination, evenly spread and flowed on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.

G. Apply materials with a coverage to hide substrate completely. When color, stain, dirt or undercoats show through final coat of paint, the surface is to be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Government.

H. All coats are to be dry to manufacturer’s recommendations before applying succeeding coats.

I. All suction spots or “hot spots” in plaster after the application of the first coat are to be touched up before applying the second coat.

J. Do not apply paint behind frameless mirrors that use mastic for adhering to wall surface.

3.4 **SURFACE PREPARATION:**

A. General:

1. The Contractor shall be held wholly responsible for the finished appearance and satisfactory completion of painting work. Properly prepare all surfaces to receive paint, which includes cleaning, sanding, and touching-up of all prime coats applied under other Sections of the work. Broom clean all spaces before painting is started. All surfaces to be painted or finished are to be completely dry, clean and smooth.
2. See other sections of specifications for specified surface conditions and prime coat.
3. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer’s instructions and as herein specified, for each particular substrate condition.

4. Clean surfaces before applying paint or surface treatments with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   a. Concrete: 12 percent.
   b. Fiber-Cement Board: 12 percent.
   c. Masonry (Clay and CMU’s): 12 percent.
   d. Wood: 15 percent.
   e. Gypsum Board: 12 percent.
   f. Plaster: 12 percent.

B. Ferrous Metals:
1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning).
3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with TT-F-322D (Filler, Two-Component Type, For Dents, Small Holes and Blow-Holes). Finish flush with adjacent surfaces.
   a. Fill flat head countersunk screws used for permanent anchors.
   b. Do not fill screws of item intended for removal such as glazing beads.
4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.

C. Zinc-Coated (Galvanized) Metal, Surfaces Specified Painted:
1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).

2. Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non-Cementitious Galvanized Primer) depending on finish coat compatibility.

D. Gypsum Plaster and Gypsum Board:

1. Remove efflorescence, loose and chalking plaster or finishing materials.
2. Remove dust, dirt, and other deterrents to paint adhesion.
3. Fill holes, cracks, and other depressions with CID-A-A-1272A finished flush with adjacent surface, with texture to match texture of adjacent surface. Patch holes over 25 mm (1-inch) in diameter as specified in Section for plaster or gypsum board.

3.5 **PAINT PREPARATION:**

A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.

B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.

C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.

D. Mix two (2) component and two (2) part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.

E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

3.6 **APPLICATION:**

A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.

B. Unless otherwise specified, apply paint in three (3) coats; prime, body, and finish. When two (2) coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.

C. Apply each coat evenly and cover substrate completely.

D. Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by COR.

E. Apply by brush or roller. Spray application for new or existing occupied spaces only upon approval by acceptance from COR in writing.

1. Apply painting materials specifically required by manufacturer to be applied by spraying.
2. In new construction and in existing occupied spaces, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in “Building and Structural Work Field Painting”; “Work not Painted”; motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.

F. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

3.7 **PRIME PAINTING:**

A. After surface preparation, prime surfaces before application of body and finish coats, except as otherwise specified.

B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.

C. Additional field applied prime coats over shop or factory applied prime coats are not required except for exterior exposed steel apply an additional prime coat.

D. Prime rabbets for stop and face glazing of wood, and for face glazing of steel.

E. Gypsum Board:

1. Surfaces scheduled to have MPI 53 (Interior Latex, Flat).
2. Primer: MPI 50 (Interior Latex Primer Sealer)

3.8 **REFINISHING EXISTING PAINTED SURFACES:**

A. Clean, patch and repair existing surfaces as specified under “Surface Preparation”. No “telegraphing” of lines, ridges, flakes, etc., through new surfacing is permitted. Where this occurs, sand smooth and re-finish until surface meets with COR’s approval.

B. Remove and reinstall items as specified under “General Workmanship Requirements”.

C. Remove existing finishes or apply separation coats to prevent non compatible coatings from having contact.

D. Patched or Replaced Areas in Surfaces and Components: Apply spot prime and body coats as specified for new work to repaired areas or replaced components.

E. Except where scheduled for complete painting apply finish coat over plane surface to nearest break in plane, such as corner, reveal, or frame.

F. In existing rooms and areas where alterations occur, clean existing stained and natural finished wood retouch abraded surfaces and then give entire surface one (1) coat of MPI 31 (Polyurethane, Moisture Cured, Clear Gloss).

G. Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.

H. Coat knots and pitch streaks showing through old finish with MPI 36 (Knot Sealer) before refinishing.

I. Sand or dull glossy surfaces prior to painting.

J. Sand existing coatings to a feather edge so that transition between new and existing finish will not show in finished work.

3.9 **PAINT COLOR:**

A. Color and gloss of finish coats is to match existing.

B. For additional requirements regarding color see Articles, “REFINISHING EXISTING PAINTED SURFACE” and “MECHANICAL AND ELECTRICAL FIELD PAINTING SCHEDULE”.

C. Coat Colors:

1. Color of priming coat: Lighter than body coat.
2. Color of body coat: Lighter than finish coat.
3. Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.

D. Painting, Caulking, Closures, and Fillers Adjacent to Casework:

1. Paint to match color of casework where casework has a paint finish.
2. Paint to match color of wall where casework is stainless steel, plastic laminate, or varnished wood.

3.10 **PROTECTION CLEAN UP, AND TOUCH-UP:**

A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.

B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.

C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:
   1. Planning systematic TAB procedures.
   2. Design Review Report.
   3. Systems Inspection report.
   4. Systems Readiness Report.
   5. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
   6. Recording and reporting results.
   7. Document critical paths of flow on reports.

B. Definitions:
   1. Basic TAB used in this Section: Chapter 39, "Testing, Adjusting and Balancing" of 2019 ASHRAE Handbook, "HVAC Applications".
   2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
   3. AABC: Associated Air Balance Council.
   4. NEBB: National Environmental Balancing Bureau.
   5. TABB: Testing Adjusting and Balancing Bureau
   6. SMACNA: Sheet Metal Contractors National Association
   7. Hydronic Systems: Includes glycol chilled water, glycol heating hot water systems.
   8. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
   9. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.2 RELATED WORK

A. TAB for AC-16
   1. TAB contractor to verify chilled water flow, airflow and adjust fan speed if necessary.
   3. Record unit amps and volts.
   4. Include in TAB report.

B. Retro Commissioning Reports:

1. Final RCx Report 5/15/2014 - Alaska Rev7.
2. Final RCx Plan 11/26/2013.
3. Final RCx Report Building Occupant Interviews and Goals 01/28/2013.
4. Final RCx Facility Performance Analysis and Performance Baseline 02/25/2014.
5. Final RCx Systems Functional Testing Plan 01/28/2013.
6. Final RCx Systems Testing Report 01/28/2013.
7. Final RCx Simple Repair Report 4/16/2014.
8. Final RCx Minor & Major Repair Recommendations 4/16/2014.
9. Final RCx Equipment List 4/16/2014.

C. New VA Outpatient Clinic and Regional Office Building Record Drawings Volumes: 1, 2, 3, 4, February 26, 2007.

D. Specification volumes: 1, 2, 3, 4, 5 for New VA Outpatient Clinic and Regional Office Building, March 23, 2007.

1.3 QUALITY ASSURANCE

A. Refer to Articles, Quality Assurance and Submittals, in Section Section 01 45 00, QUALITY CONTROL, and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

B. Qualifications:

1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
2. The TAB agency shall be either a certified member of AABC, NEEB, TABB or NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the COR and submit another qualified TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC, TABB or NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency’s review shows unsatisfactory work performed by the predecessor agency.

3. TAB Specialist: The TAB specialist shall be either a member of AABC or TABB or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
   a. Shall directly supervise all TAB work.
   b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC, TABB or NEBB.
   c. Would follow all TAB work through its satisfactory completion.
   d. Shall provide final markings of settings of all HVAC adjustment devices.
   e. Permanently mark location of duct test ports.
   f. Shall document critical paths from the fan or pump. These critical paths are ones in which are 100% open from the fan or pump to the terminal device. This will show the least amount of restriction is being imposed on the system by the TAB firm.
5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC, TABB or NEBB

C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards, TABB/SMACNA International Standards, or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.

D. TAB Criteria:

1. One or more of the applicable AABC, NEBB,TABB or SMACNA publications, supplemented by ASHRAE Handbook "2019 HVAC Applications" Chapter 39, and requirements stated herein shall be the basis for planning, procedures, and reports.
2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow 2011 ASHRAE Handbook "2019 HVAC Applications", Chapter 39, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
   a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus l0 percent.
   b. Air terminal units (maximum values): Minus 2 percent to plus l0 percent.
   c. Exhaust hoods/cabinets: 0 percent to plus l0 percent.
   d. Minimum outside air: 0 percent to plus 10 percent.
   e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus l0 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
   f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
   g. Chilled water and condenser water pumps: Minus 0 percent to plus 5 percent.
   h. Chilled water coils: Minus 0 percent to plus 5 percent.
3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and critical path results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms

randomly selected by the COR one of which shall be a critical path) and one hydronic system (pumps and three coils) as follows:

a. When field TAB work begins.

b. During each partial final inspection and the final inspection for the project if requested by VA.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.

C. For use by the Resident Engineer staff, submit one complete set of applicable AABC, NEBB or TABB publications that will be the basis of TAB work.

D. Submit Following for Review and Approval:

1. Systems inspection report on equipment and installation for conformance with design.
2. Systems Readiness Report.
3. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
4. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
5. Include in each report the critical path for each balanced branch (air and hydronic. Every branch shall have at least one terminal device damper 100% open.

1.5 APPLICABLE PUBLICATIONS

A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

Handbook 2019.....HVAC Applications ASHRAE Handbook, Chapter 39, Testing, Adjusting, and Balancing and Chapter 49, Sound and Vibration Control

C. Associated Air Balance Council (AABC):

7th Edition 2016 .....AABC National Standards for Total System Balance

D. National Environmental Balancing Bureau (NEBB):
9th Edition 2019.....Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
3rd Edition 2015 .....Procedural Standards for the Measurement of Sound and Vibration
3rd Edition 2019 ... Technical Retro-Commissioning of Existing Construction

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
3rd Edition 2005 .....HVAC SYSTEMS Testing, Adjusting and Balancing
TABB- TAB Procedural Guide Current Edition

PART 2 - PRODUCTS

2.1 PLUGS

Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.2 INSULATION REPAIR MATERIAL

Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to TAB Criteria in Article, Quality Assurance.

B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

3.2 DESIGN REVIEW REPORT

The TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.3 SYSTEMS INSPECTION REPORT

A. Inspect equipment and installation for conformance with record drawings.

B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

C. Reports: Follow check list format developed by AABC, NEBB or SMACNA (TABB), supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

3.4 SYSTEM READINESS REPORT

A. The TAB Contractor shall measure existing air and water flow rates associated with existing systems. Submit report of findings to resident engineer.

B. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to RE in standard format and forms prepared and or approved by the Commissioning Agent.

C. Verify that all items such as ductwork piping, dampers, valves, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

3.5 TAB REPORTS

A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.

B. The TAB contractor shall provide raw data immediately in writing to the Resident Engineer if there is a problem in achieving intended results before submitting a formal report.

C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated after engineering and construction have been evaluated and re-submitted for approval at no additional cost to the owner.

D. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

3.6 TAB PROCEDURES

A. TAB shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC, TABB or NEBB. Balancing shall be done proportionally to all applicable systems.

1. At least one trunk damper shall be 100% open.
2. At least one branch damper shall be 100%open per trunk.
3. At least one terminal device duct be 100% open per branch.

B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration

shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

C. Allow 14 days time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.

E. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets, computer room AC units, and laboratory fume hoods and biological safety cabinets.

1. Artificially load air filters by partial blanking to produce static air pressure drop of manufacturer’s recommended pressure drop.
2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements.
3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other HVAC controls function properly.
4. Variable air volume (VAV) systems:
   a. Coordinate TAB, including system volumetric controls, with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
   b. Section 23 36 00, AIR TERMINAL UNITS, specifies that maximum and minimum flow rates for air terminal units (ATU) be factory set. Check and readjust ATU flow rates if necessary to meet design criteria. Balance air distribution from ATU on full cooling maximum scheduled cubic meters per minute (cubic feet per minute). Reset room thermostats and check ATU operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode. Record and report outdoor air flow rates under all operating conditions (The test shall demonstrate that the minimum outdoor air ventilation rate shall remain constant under al operating conditions).
   c. Adjust operating pressure control setpoint to maintain the design flow to each space with the lowest setpoint.
5. Record final measurements for air handling equipment performance data sheets.

F. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers:
   2. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
   3. Primary-secondary (variable volume) systems: Balance systems at design water flow and then verify that variable flow controls function as designed.
   4. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

3.7 MARKING OF SETTINGS

Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Resident Engineer.

3.8 IDENTIFICATION OF TEST PORTS

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

3.9 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.10 CRITICAL FLOW PATH

A. Provide a documented critical path for all fluid flows. There shall be at least one terminal device that can be traced back to the fan or pump where there is no damper or valves that are less than 100% open.

- - E N D - - -

SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 23.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 33 00 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

D. Section 23 05 41 NOISE AND VIBRATION CONTROL for HVAC PIPING AND EQUIPMENT.

E. Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

F. Section 23 09 23 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

G. Commissioning for AC-16.

H. Retro Commissioning Reports:

1. Final RCx Report 5/15/2014 - Alaska Rev7.
2. Final RCx Plan 11/26/2013.
3. Final RCx Report Building Occupant Interviews and Goals 01/28/2013.
4. Final RCx Facility Performance Analysis and Performance Baseline 02/25/2014.
5. Final RCx Systems Functional Testing Plan 01/28/2013.
6. Final RCx Systems Testing Report 01/28/2013.
7. Final RCx Simple Repair Report 4/16/2014.
8. Final RCx Minor & Major Repair Recommendations 4/16/2014.
9. Final RCx Equipment List 4/16/2014.

I. New VA Outpatient Clinic and Regional Office Building Record Drawings Volumes: 1, 2, 3, 4, February 26, 2007.

J. Specification volumes: 1, 2, 3, 4, 5 for New VA Outpatient Clinic and Regional Office Building, March 23, 2007.

1.3 SUMMARY

A. This Section includes requirements for commissioning the HVAC systems of the related subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA’s Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and of Division 23, is required in cooperation with the VA and the Commissioning Agent.

B. The Facility HVAC systems commissioning will include the systems listed in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.7 APPLICABLE PUBLICATIONS

A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.

B. Department of Veterans Affairs (VA):

PG 18-10 2007.....Mission Critical Facilities - DRAFT

PG 18-10 2007.....Life-Safety Protected Facilities - DRAFT

C. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

HANDBOOK 2019.....HVAC Applications ASHRAE Handbook, Chapter 39, Testing, Adjusting, and Balancing, Chapter 44, HVAC Commissioning and Chapter 49, Sound and Vibration Control

HANDBOOK 2021.....HVAC Fundamentals ASHRAE Handbook, Chapter 8, Sound and Vibration

D. Associated Air Balance Council (AABC):

7th Edition 2016.....AABC National Standards for Total System Balance

E. National Environmental Balancing Bureau (NEBB):

9th Edition 2019.....Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

3rd Edition 2015 .....Procedural Standards for the Measurement of Sound and Vibration

2nd Edition 2019 ..... Standard for Whole Building Technical Commissioning of New Construction

F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

0062006.....HVAC Duct Construction Standard – Metal and Flexible Duct

3rd Edition 2005 ..... HVAC Systems Testing, Adjusting and Balancing

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. Refer to Sections 23 05 41 NOISE

AND VIBRATION CONTROL for HVAC PIPING AND EQUIPMENT, Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and Section 23 09 23 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC requirements. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure

to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional requirements.

3.5 TRAINING OF VA PERSONNEL

A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

----- END -----

VISN 20 Alaska VA

Healthcare System

Final RCx Report

MAY 15, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126AA and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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Report Certification Page

Anchorage Alaska Outpatient Clinic

The data, conclusions and recommendations presented in this report are a record of the retro-commissioning (RCx) process utilized on this project in accordance with RCx procedural standards and the contract requirements. The results shown and information given in this report are certified to be true and accurate to the extent possible based on the operating parameters at the time the systems were tested. The RCx provider makes no claims or warranties stated or implied concerning the continued performance or operation of the facility past the date that testing was completed. Conditions may change as operating parameters or physical equipment and systems are altered by others in the future.

_____

Michael B. Rogers, P.E.

California P.E. #M30484 Exp: 3/31/2016

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Abbreviations/Acronyms

AC/ACU	Air conditioning / Air conditioning unit	HW	Hot water
AH/AHU	Air handler / Air handling unit	HWS/ HWR	Hot water supply/Hot water return
BAS	Building automation system	HX	Heat exchanger
BTU	British thermal unit	kBtu	Thousand British thermal units
CBECS	Commercial building energy consumption survey	kLb	Thousand pounds
CCF	Hundred cubic feet (measure of natural gas usage)	kW	Thousand watts
CDD	Cooling degree days	kWh	Kilowatt hour
CFM	Cubic feet per minute	MA/ MAT	Mixed air / Mixed air temperature
CFR	Current facility requirements	MAU	Makeup air unit
CHW	Chilled water	MMBtu	Million British thermal units
CHWS/ CHWR	Chilled water supply / Chilled water return	MW	Mega watt
CO_2	Carbon dioxide	MZ/MZU	Multiple zone / Multiple zone units
COV	Change of value	OA/OSA	Outside air
CT	Cooling tower	OAT	Outside air temperature
CV	Constant volume	PTAC	Packaged terminal air conditioner
CW	Condenser water	RA/ RAT	Return air / Return air temperature
CWS/ CWR	Condenser water supply / condenser water return	RCx	Retro-commissioning
DA/ DAT	Discharge air / Discharge air temperature	RF	Return fan
DDC	Direct digital control	RH	Relative humidity
DHW	Domestic hot water	RTU	Rooftop (packaged HVAC) unit
DX	Direct expansion	SA/ SAT	Supply air / Supply air temperature
EA/ EAT	Exhaust air / Exhaust air temperature	SF	Supply fan
EF	Exhaust fan	SP	Static pressure
ERC	Energy recovery coil(s)	SPD	Supply processing and distribution
EUI	Energy utilization index	Sq Ft	Square Foot
F	Fahrenheit	TAB	Test, adjust and balance
FCU	Fan coil unit	Therms	Energy equal to 100,000 British Thermal units (BTU)
FY	Fiscal year	TU	Terminal unit
GPM	Gallons per minute	VAV	Variable air volume
HDD	Heating degree days	VFD	Variable frequency drive
HP	Horsepower	VHA	Veterans Health Administration
HVAC	Heating, ventilating, and air-conditioning	WC	Water Column
HV/ HVU	Heating ventilating unit		

1.0 EXECUTIVE SUMMARY

The U.S. Department of Veterans Affairs (VA) sought professional retro-commissioning (RCx) services at the Anchorage Alaska Outpatient Clinic for the purpose of establishing and altering Heating, Ventilation, Air Conditioning (HVAC) and related energy-using systems to proper operational capabilities. The RCx process used a systematic and documented process that identified operational and maintenance improvements to bring the site up to the design intentions of its current usage. The main objectives of the RCx process were to:

1. Identify and prioritize operational and maintenance enhancements in major building systems that result in improvements in infection control, energy efficiency, occupant comfort, and indoor air quality.
2. Evaluate design adequacy of major building systems in ensuring infection control is achieved in critical patient care areas.
3. Evaluate system performance in relation to design specifications and characterize deviations.
4. Optimize control systems through calibration of sensors and modifications to set points and sequences of operation using information obtained through meters, trend logs, and functional testing of equipment.
5. Evaluate the 'Preventive Maintenance Program (PMP)' and assess its effectiveness in maintaining operating systems. Provide the necessary corrections to improve PMP and to train essential staff in its application.
6. Establish a system to benchmark current energy consumption so that future energy needs can be realistically assessed and then documented.
7. Identify options and cost estimates for energy savings throughout the campus.
8. Identify the Operations & Maintenance (O&M) personnel training needs to improve the skills/abilities to respond effectively to changing needs of the building/occupants.

Buildings and spaces included in the RCx process are identified below:

Table 1. Building List

Building Name	Building Area
Anchorage Outpatient Clinic	190,817 SF

1.1 RETRO-COMMISSIONING PROJECT PROCESSES

The project was completed in three phases: the Planning Phase, the Investigation Phase, and the Equipment List. During the Planning Phase, DAV Energy Solutions conducted a kick-off meeting, reviewed available building documentation, interviewed building managers, performed building walk-throughs, reviewed VA standards, and incorporated observations and information into a RCx Plan (summarized in Section 2 and included as **Appendix A**). The Investigation Phase compared the actual building conditions and system performance with the VA's current operational needs and requirements and made adjustments and simple repairs. This report is the conclusion of the Investigation Phase and includes measures to improve building and system performance, reduce energy and O&M costs, and improve the indoor environmental quality and air quality.

During the RCx process, DAV Energy Solutions submitted the following deliverables:

Table 2. Deliverable Submittal Schedule

Deliverable #	Description	Submittal Date
1	Retro-Commissioning (RCx) Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	Complete
10	Repair Report Summary	Complete
11	Minor & Major Repair Recommendations Report	Complete
12	**Final Retro-commissioning Report**	**Current**
13	Out-briefing	5/14/2012
14	Equipment List	Complete

1.2 PROCEDURAL STANDARDS

The objectives for this project were guided by the Statement of Work issued by the VA for VISN 20 and the unique conditions at the Anchorage Alaska Outpatient DAV Energy Solutions delivered work elements in a manner that was consistent with Existing Building Commissioning Best Practices. These Best Practices, originally developed by the Building Commissioning Association (BCA), provide a disciplined criteria for performing commissioning activities in existing buildings that draws from RCx resources created by the California Commissioning Collaborative, the Handbook by the BCA, the

National Environmental Balancing Bureau, the Associated Air Balance Council, and Guidelines produced by ASHRAE.

By delivering the services of this project against the guidelines outlined under the BCA Best Practices approach, DAV Energy Solutions provided a systematic process for investigating, analyzing and documenting the project in a manner that is generally consistent across the VISN sites.

1.3 DEVIATIONS FROM THE STATEMENT OF WORK

Deviations relative to the statement of work included the following:

- The Building Automation system is monitoring CO2 levels which allowed removal of stand-alone monitoring from scope. Based on data, there was no indication of issues.

- Fewer VAV terminal units were measured as compared to the original scope of work because a very detailed, comprehensive combined procedure of reviewing detailed trend data for each terminal unit was completed in conjunction with physical airflow measurements and detailed functional testing. As the trend data was analyzed and air measurements were being taken it was very apparent that the excellent maintenance seen on other pieces of equipment carried forward at the terminal unit level. It was determined that a sufficient number of terminal units were evaluated since there were no deviations relative to desired design conditions compared to the monitored values and the occupant interviews showed no know issues.

No other deviations to the scope of work are noted.

1.4 RECOMMENDED CORRECTIVE ACTIONS

The investigation phase activities identified issues and improvements with significant impact on the overall HVAC system operation and energy usage. The recommended corrective actions for these issues are presented in Section 9.0 of this report. The following table (Table 3) summarizes the recommendations, while Table 4 shows only the key energy saving measures.

Table 3. Recommended Actions – Summary

LOG #	MECH EQUIP NAME	RECOMMENDED MEASURE
1	ACU-15	Install RA plenum duct remaining 6 inches through wall and install a register. On other side of wall is intended RA plenum location, which is under stairs. This will allow cooling system to function more effectively by supplying the air at the top of the stairs and returning it to the FCU at the bottom. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.
2	EF-13	Change units on BAS.
3	AHU-9	1. Reposition terminal ductwork and registers (or add an additional register) in lab space to better capture warm exhaust air from the refrigeration equipment condensers. 2. Install 4 ton split system cooling unit to serve Lab 1C147.
4	AHU-4	Use multiple thermostats and balance using logic to determine if the baseboard should be enabled.
5	0	The airflow to the space terminal box should be increased if possible.
7	AHU-8 and 9	Install Reverse Osmosis filtration equipment to serve the humidification systems in all penthouses. TAB contactor has determied that coil airflow is reduced in AHU 7, 8, & 9 due to scaling, therefore coils immediately next to the humidifier spray bar should be replaced on an as-needed basis if AHU cannot meet load. This is costly and should only be done as a last resort.
8	AHU- 8	Changing the coil capacity and possibly try to reduce airflow to certain zones if able to in effort to reduce load on the AHU during severe weather conditions. TAB test performed in 2014 under RCx scope confirmed Pre-Heat coil is undersized. Recommend: replace Pre-Heat Coil.
9	Chilled Water HX	1.) Run the DX unit for AHU #8 when cooling load exceeds threshold 2.) Remove load from the central plant - this could be done on a permanent basis or on a dispatchable basis to get through a tough high load period. This issue is not going to get better only worse. Recommend to look at removing 24/7 load for IT closets, etc. and put in dedicated small DX units for those spaces and/or look into utilizing OSA for free cooling in the winter. 3.) for those critical cooling spaces look at offsetting load with DX such as was done with AHU #8
10	Compressor	Investigate compressed air system for leaks, stop leaks as found.
11	AHU-5	Well water temperature is too high, must reduce CHG temperature and/or increase coil physical size to accommodate the very small delta T. In order to reduce the CHG temperature, the well water flow rate must be increased or the well water temperature must be lowered on the primary side of the heat exchangers.
13	VAV boxes	Institute a preventative maintenance program to periodically replace valve cartridges, targeting VAV boxes that have trouble meeting load especially in cooling mode.
14	AHU-3	Heating coil is too small or the amount of OSA is too large when conditions are severe.
22	AHU-1	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-1 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
24	AHU-2	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-2 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
25	AHU-2	Energy Savings Measure: Schedule AHU-2 Return Fan to match supply fan schedule
27	AHU-3	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-3 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
28	AHU-4	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-4 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
29	Lobby Lighting	Install an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights.
30	IT/data closet FCUs	To reduce load on the CHG loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs be augmented by rooftop mini-split system type air conditioning units with air cooled condenser and premium efficiency compressor. Each space would be served by a separate unit.
31	CHWWS	Install BTU metering (temperatures & flow) to measure the BTU delivered via the chilled (well) water loop from Elmendorf.
32	HGS	Install BTU metering (temperatures & flow) to measure the BTU delivered via the hot water loop from Elmendorf.

Table 4. Recommended Actions – Energy Savings Measures

LOG #	MECH EQUIPMENT NAME	RECOMMENDED MEASURE	MEASURE TYPE	ECM #	ENERGY SAVINGS (kWh/yr)	ENERGY $ SAVINGS ($/yr)	EST. MEASURE COST ($)	SIMPLE PAYBACK (yrs)
10	Compressor	Investigate compressed air system for leaks, stop leaks as found.	Major	1	70,192	$ 7,370	$ 2,000	0.3
22	AHU-1	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-1 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	2	12,750	$ 1,339	$ -	0.0
24	AHU-2	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-2 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	3	41,970	$ 4,407	$ -	0.0
25	AHU-2	Energy Savings Measure: Schedule AHU-2 Return Fan to match supply fan schedule	Minor	4	460	$ 48	$ -	0.0
27	AHU-3	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-3 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	5	25,184	$ 2,644	$ -	0.0
28	AHU-4	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-4 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	6	82,939	$ 8,709	$ -	0.0
29	Lobby Lighting	Install an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights.	Minor	7	26,981	$ 2,833	$ 2,500	0.9
TOTAL					**260,476**	**$ 27,350**	**$ 4,500**	**0.2**

1.5 AREAS OF CONCERN

Areas of concern for Anchorage Alaska Outpatient Clinic identified during the investigation phase are presented in the Issues Log contained in **Appendix K**. Section 9.0, *Recommended Corrective Actions and Simple Repairs,* provides additional information. Briefly the Primary Areas of Concern are as follows:

- AHU-9 Cooling in the Lab 1C147 – Concerned that the lab will become too hot in the summer and prevent normal operations.
- Hard-Water Scaling is building up on all coil surfaces which are sprayed by the humidification system – Concerned that this is impacting coil lifespan.
- AHU-8 Pre-Heat Coil is undersized – Concerned that the Pre-Heat Coil and Humidification Spray Bar will continue to freeze up in extreme weather.
- Compressed Air System Leaks – Concerned that this is costing the VA money.
- ACU-15 in Stairwell 2 return air duct is not connected to the space and register never installed – Concerned that the hot temperatures in the stairwell are unduly impacting occupant comfort.

1.6 MAINTENANCE PRACTICES

In general, the current maintenance of the HVAC systems across the campus is exceptional. HVAC systems were observed to be in very good working condition with the exception of the issues noted in the Issues Log in **Appendix K** and this report. While the maintenance of the HVAC systems generally is exceptional, there are operational and maintenance enhancements in major building systems that may result in improvements in infection control, energy efficiency, and occupant comfort. These enhancements are captured in the Issues Log.

2.0 RETRO-COMMISSIONING (RCx) PLAN

After reviewing the building campus information and gaining an understanding of the buildings within the scope of work, energy use, and staff expectations, DAV Energy Solutions developed the RCx Plan for the campus. The RCx Plan was based on the goals for the project, findings from the initial site visit and information gathered. The RCx Plan identified the project activities to occur during the Investigation Phases. The RCx Plan is included as **Appendix A**.

3.0 SCOPING MEETING

After the RCx Plan was submitted to the VA, a Scoping Meeting was arranged with the Site COTR and Facilities Management personnel to review the RCx Plan, obtain comments, discuss those comments, and agree to the finalized Plan.

Key items discussed in this meeting included:

- Discussed the basic goals of the project, including:
  - Reducing energy,
  - Equipment maintenance – ensuring proper function of existing equipment, preventing premature equipment failure, reducing occupant complaints, and improving indoor air quality,
  - Improve infection control, and
  - Enhance occupant comfort.
- Retro-Commissioning Process and Scope.
- Retro-Commissioning Team Members' Roles and Responsibilities.
- Project Schedule.
- Available Documentation.
- Planning Phase Activities.
- Investigation Scope and Methods.
- Out-Briefing and Implementation Position.
- Presentation of RCx Plan Appendices.

The Scoping Meeting Minutes are included as **Appendix B**.

4.0 FACILITY INFORMATION DOCUMENTS AND EQUIPMENT INVENTORY

DAV Energy Solutions conducted a thorough site survey and completed the following activities:

- Reviewed relevant design drawings, Building Automation System (BAS) information and equipment data and walked facilities to evaluate whether current conditions such as occupancy and space utilization have changed from the original design.
- Identified systems to be monitored and tested including logistical issues affecting access to equipment.

- Obtained relevant BAS equipment information and identified current sequences of operation.
- Reviewed control components of existing equipment.
- Assessed current controls for systems not on a BAS.

To further expand on the facility information documents gathered for the site, an equipment inventory was prepared; a drawing inventory was prepared; sequences of operation and schematics were reviewed and compiled; and zoning plans were compiled or created.

4.1 EQUIPMENT INVENTORY

A mechanical equipment inventory was compiled for ongoing use by the campus. The equipment inventory workbook lists key information available from nameplates and drawings for major HVAC equipment, including the following:

- Location, such as building, floor, wing, room number and description, room type and area reference (where room number is not available).
- Area served.
- Manufacturer and model number.
- Serial number.
- Energy input ratings (volts, amps, phases, kW, and/or Btu/hour).
- Output capacity ratings, where available (HP, cooling tons, heating MBH, CFM/static pressure, GPM/head, etc.).
- Coil ratings (where applicable).
- Rated efficiency (where applicable).
- Date of manufacture and/or installation (where available, most equipment is new at building construction since it is a relatively new building).

The following table summarizes the major equipment that has been included in the Equipment Inventory:

Table 5. Summary of Equipment Inventory

Building No	Description of Equipment
Clinic	(11) Air Handling Units
Clinic	(30) Pumps (HVAC system only)
Clinic	(452) VAV Terminal Units
Clinic	(1)DX Condensing Unit
Clinic	(3) Air Compressors (HVAC system only)
Clinic	(5) Heat Exchangers
Clinic	(15) Exhaust Fans
Clinic	(10) Terminal Heating Units

The equipment inventory can be found in **Appendix C**. An Excel version was provided to the Site COTR per the due dates shown in Table 2.

4.2 AHU ZONE PLANS

General AHU zoning maps were collected and compiled from existing sources. The accuracy of these drawings depended on the accuracy of the source documents. Also, they were presented before conducting field-variation. Updated zoning plans for the spaces included in the RCx project can be found in **Appendix C**.

4.3 DRAWING INVENTORY

A drawing log has been prepared, by building, documenting the drawings available by area affected and brief notes on contents (such as title). A summary drawing log is presented below.

Table 6. Drawing and Document Inventory Summary

Building No.	Documentation Available	Description
Clinic	YES	Design Drawings
Clinic	YES	As-Built Drawings
Clinic	YES	2010 TAB Report
Clinic	YES	Sequence of Operations
Clinic	YES	AHU Data Sheets
Clinic	YES	Commissioning Report

4.4 SEQUENCES OF OPERATION/SCHEMATICS

Control sequences of operation, point lists, and schematics for major mechanical equipment were compiled and reviewed. Sequences of operation available in documentation and on the BAS were reviewed and compiled in one document. Hydronic central plant schematics, AHU schematics for typical AHUs showing flow paths and screen shots from the BAS were used in some cases for these schematics. See **Appendix C**.

5.0 BUILDING OCCUPANT INTERVIEWS

Interviews with facility operators and VA staff are important to understand the needs and issues related to system operation and maintenance, known design and space deficiencies, equipment deficiencies, facility operator training and occupant education needs, indoor air and environmental quality, occupant comfort/satisfaction, and potential energy reduction measures. The intent of the interviews was to help uncover potential improvement opportunities, and confirm the CFR.

The Site COTR determined which staff members should be interviewed for the campus. Each interview included the same set of questions for facility operators and a different set of questions for VA staff. The completed Building Occupant Interview Forms can be found in **Appendix D**.

The following table lists the titles of facility operators and VA staff members who were interviewed:

Table 7. Occupant Interview Summary

Name	Building Area
Calvin Jackson	Operating Room Area of Clinic
Judie Jordan	Laboratory
David Mausent	2C Wing of Clinic
Julie Reloza-Keating	1D Wing of Clinic
Diane Walters	2D Wing of Clinic
Nicole Perry	2D Wing of Clinic

Findings from the interviews can be summarized into key identified issues and potential improvement opportunities. Interviews were also used as a tool to fine tune the focus of the monitoring and testing activities. The following summarizes the key issues and opportunities identified:

- Most building occupants were found to be comfortable, with the most common comfort complaints related to occupant hot/cold issues.
- Some comfort complaints were due to the thermostat located in separate offices and often stem from differences in personal preferences. PC lab Rm. 2D116 can get uncomfortably warm when fully occupied as well as stairwell located in the sound east corner of A-wing with solar load on the glass walls.
- Air quality issues were not noted to be an issue for any portion of the building.
- Infection control issue with the lab doors open while temporary fan running.
- HVAC system airflow balance and energy conservation measures also were not noted to be an issue for any portion of the building.
- The humidification dispersion units in AHU-8 and AHU-9 freeze up when the outside air temperature approaches the design conditions for the building, causing operators to have to physically remove them to allow them to defrost.
- There are issues with evenly distributed airflow over the preheat coil in AHU-9 and the heating coil in AHU-3. A temporary fix has been implemented with a few pieces of cardboard added in the air stream to redistribute airflow and preventing sections of coil from freezing out and blocking flow.

Identified Goals:

- TAB measurements should assist in identifying or diagnosing if airflow, cooling coil and heating water coil issues are present for AHU-8 and AHU-9.
- A representative sample of VAV boxes and space temperatures should be trended to further understand the space comfort issues.

Potential Improvement Opportunities:

- The medical gas exhaust fan is ducted into exhaust for EF-11. Should EF-11 be disabled when the medical gas exhaust fan is on, medical gas would be dispersed into the building. A controls interlock should be implemented to prevent this from occurring.
- Treatment of water going to the humidifiers. The purpose of Humidifier Water Treatment Systems would be to prevent scaling and precipitation of source water minerals which cause low heat transfer efficiency, high maintenance costs and affect the longevity of the coils. Reverse osmosis filtration of the humidification water should be implemented.
- Revise ACCU-15 to better remove heat from Stair 2 (change return duct location).

6.0 FACILITY PERFORMANCE ANALYSIS AND BENCHMARK

The facility energy consumption was summarized for the past three years based on the utility information provided by the VA facilities. Energy utility data is presented in **Appendix E**. No meter data was available at the building level so the energy use was evaluated at the campus level.

Maintenance work order data and comfort complaint information were also reviewed. However, due to the limitations of the tracking systems in place, numerical baselines of work orders and comfort complaints were not available. All Preventative Maintenance (PM) schedules are adequate to keep the mechanical equipment in top condition. Pump seals have been an ongoing issue per the maintenance contractor (FSI). A glycol leak can, and has flooded a penthouse.

The following sections present the total energy use and cost data, the energy use baseline and benchmarking data, and a summary of non-energy baselines where available. Please see the *Facility Performance Analysis and Benchmarking* report in **Appendix E** for additional details.

6.1 TOTAL ENERGY USE AND COSTS

The table below summarizes the rates for all utilities used on site. This campus receives electricity from Anchorage Municipal Light and Power, heating and cooling is supplied from a central boiler plant located on Joint Base Elmendorf-Richardson.

Table 7: Utility Rates below summarized the utility rates for all utilities used on site. These rates were used in the energy use evaluation and will be used for energy calculations. These rates include all applicable surcharges and taxes.

Table 8. Utility Rates

Rate Period	Average Use Rate
Electric:	$0.105 /kWh
Natural Gas	$0.80 / Therm

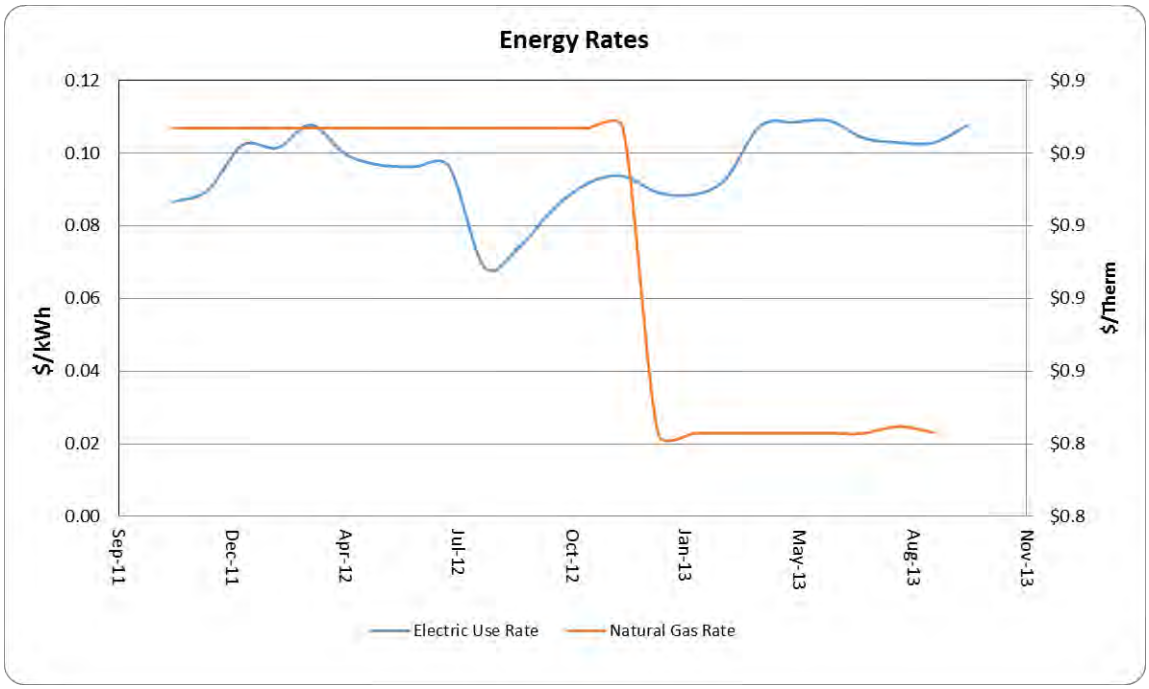

Figure 1. Combined Monthly Energy Consumption

Figure 1 illustrates the change in the electric and natural gas rate over the last two years. The electric rate has trended slightly upward. It is unknown what caused the dip in August of 2012. The natural gas rate was the same throughout fiscal year 2012 and was lowered for fiscal year 2013.

Electric Demand and Consumption

The building electricity is provided by Anchorage Municipal Light and Power, under the rate structure Large Commercial with a monthly demand above 20kW. A copy of the rate structure is included in **Appendix E**. The current cost for electricity consumption is $0.082128 per kWh. The current cost is for electricity demand is $16.96 per kW of demand. Demand is determined by using the maximum average rate of energy use for any 15-minute interval. The billing demand shall be the greater of the following: the recorded maximum demand for the month, or 80% of the maximum demand recorded during the preceding 11 months.

Figure 2 illustrates the monthly electricity consumption which has averaged 260,690 kWh per month over the past two years. Electricity consumption varies between 236,700 and 299,100 kWh per month, and shows very little seasonal variation. The average monthly (and annual) electricity consumption has remained fairly constant since October 2011.

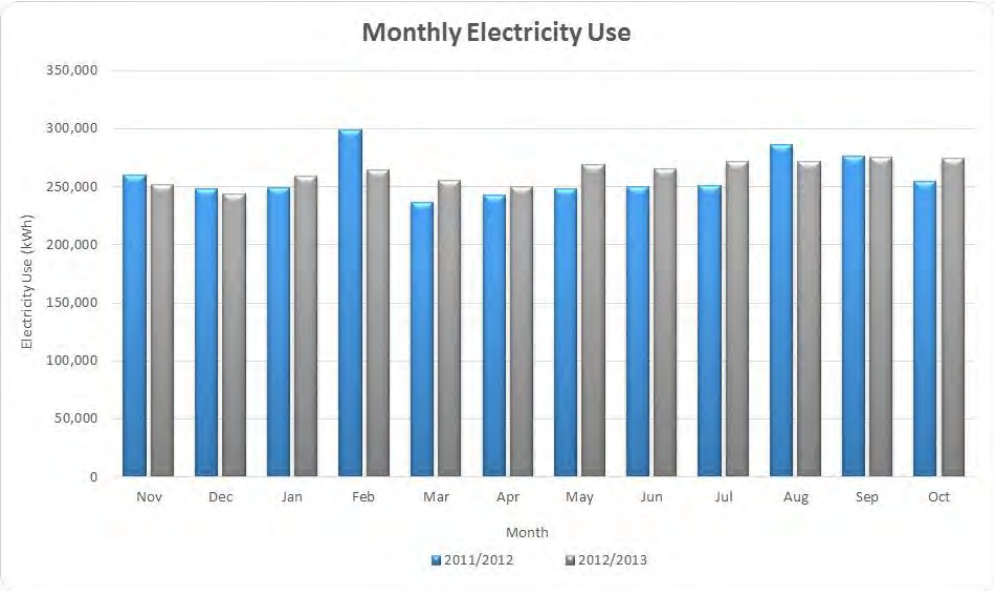

Figure 2. Electricity use profile

Figure 3 illustrates the electric consumption compared to monthly average outside air temperatures. This graph shows the same electric use regardless of outside air temperature. Warmer temperatures are usually associated with higher electric costs when a building has mechanical cooling. At the Anchorage VA the summer outside air temperatures are in the 60s and 70s, air handling unit fans run at relatively constant speed throughout the year and the cooling pumps supplying cooling well water from JBEAR operate year around to supply cooling to the clinic.

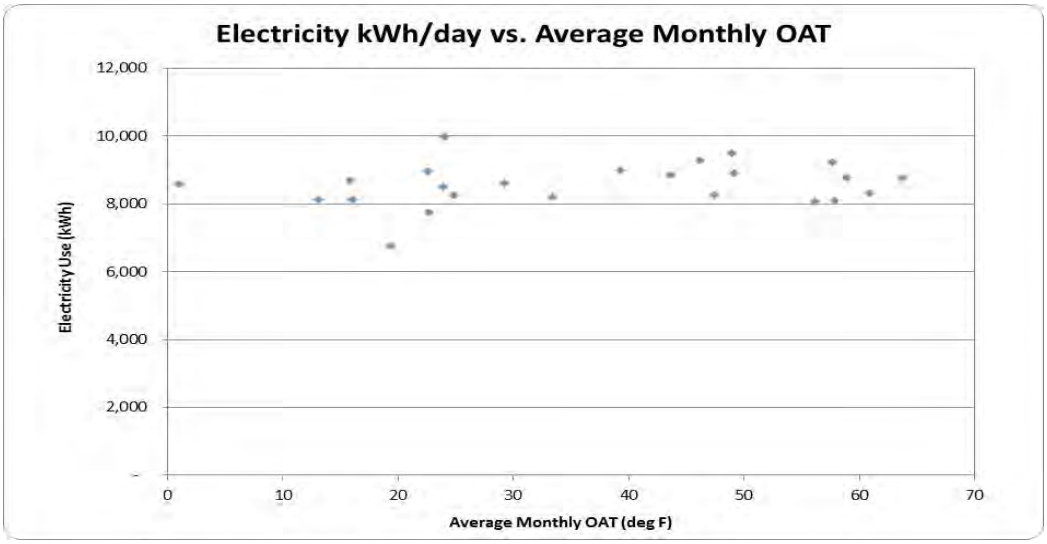

Figure 3. Electric Consumption Profile vs Average Monthly Outside Air Temperature

Gas Consumption

The heating water to the Anchorage VA Hospital is supplied from a central boiler plant at nearby Joint Base Elmendorf-Richardson (JBEAR) Hospital. A flow meter tracks building flow and the Anchorage VA hospital pays for the natural gas use that is calculated based on the measured flow at the flow meter. The average cost for FY2013 is $0.80 per therm.

Figure 4Error! Reference source not found. illustrates the monthly natural gas consumption over the past two years. Natural gas consumption reflects some seasonal variation peaking during the winter months and bottoming in the summer months. The average maximum monthly natural gas consumption is approximately 42,000 Therms. The summer minimum fluctuated between 16,500 and 25,000 Therms. Natural Gas use during the summer is for domestic hot water heating and reheats in the zones.

There are large differences between the reported natural gas uses in FY2013 versus FY2012. As the average outside air temperature has remained in the same range and the use and HVAC equipment operation is similar, the most likely cause of the differences is inaccurate flow meter readings. The flow meter is installed at a 90 degree bend and without sufficient straight pipe the turbulence can cause errors in the readings.

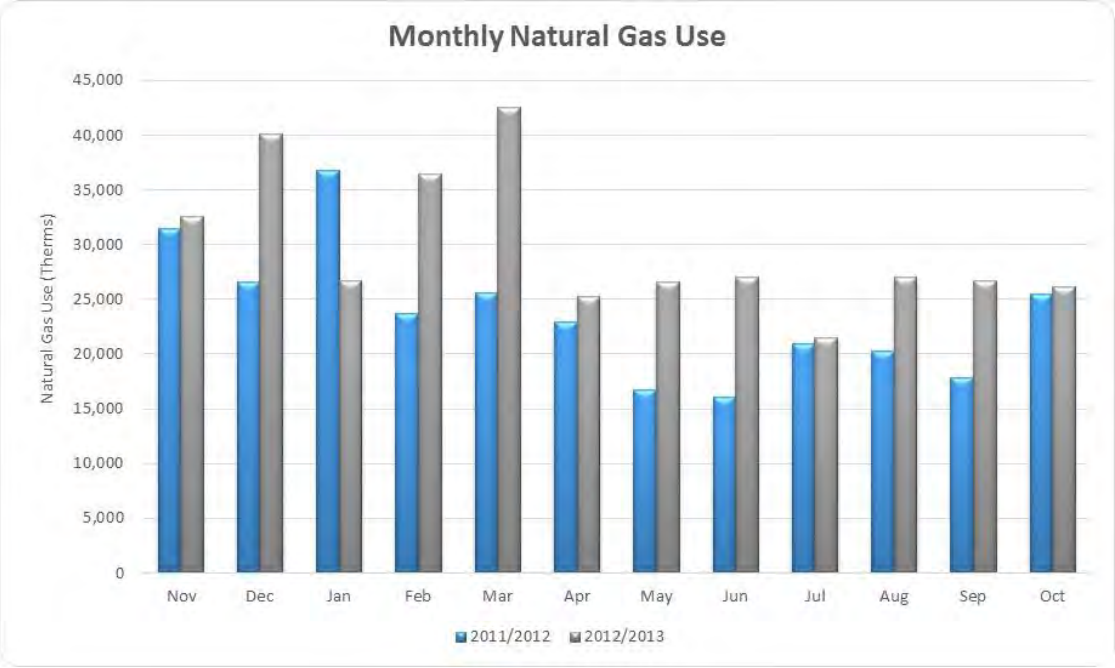

Figure 4. Natural Gas Consumption Profile

Figure 5 illustrates the natural gas consumption compared to monthly average outside air temperatures. This graph shows some correlation to average monthly outside air

temperatures with an expected increase during colder temperatures due to increased heating loads.

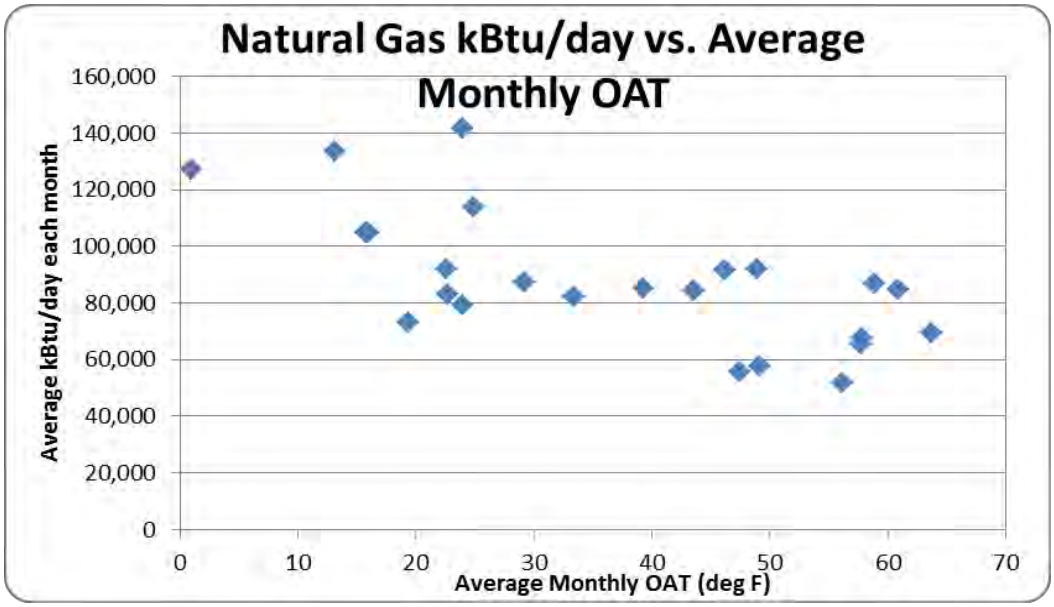

Figure 5. Natural Gas consumption vs Average Monthly Outside Air Temperature

Total Energy Consumption and Cost

The total annual energy cost for FY2013 was $650,000 including electricity and natural gas costs. **Figure 6** and **Figure 7** illustrate two years of monthly energy consumption and expenses for the Anchorage VA. Electric consumption has remained steady over the period while the cost of electricity has increased some. The reported natural gas data shows a large increase in FY 2013 use, while the natural gas rate was decreased.

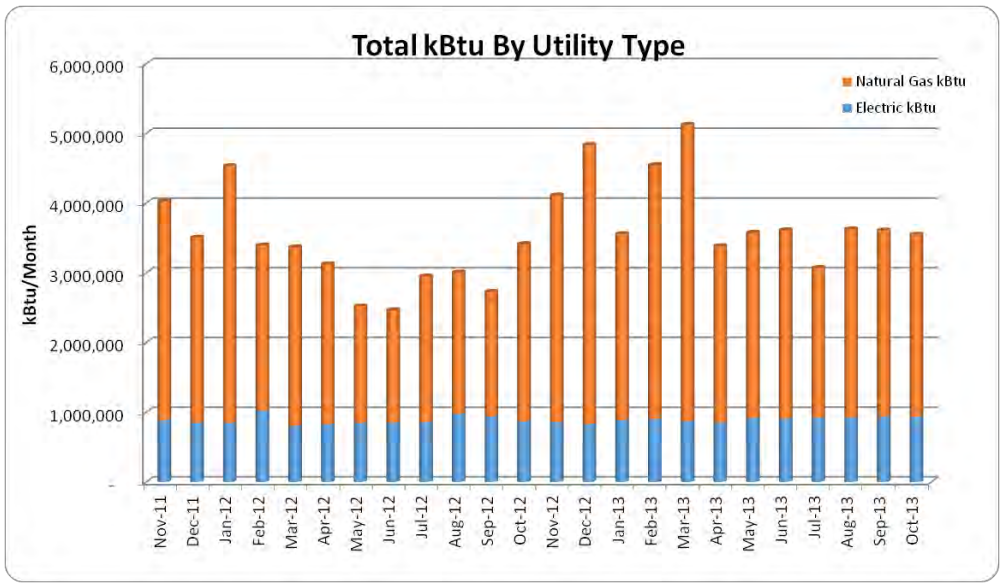

Figure 6. Total Energy Consumption by Utility

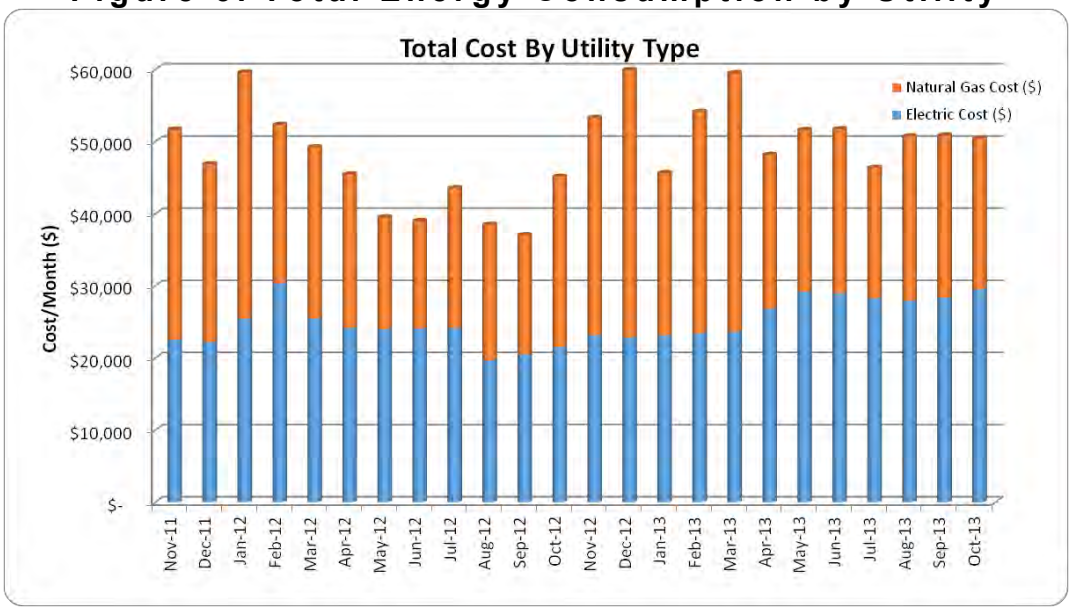

Figure 7. Total Energy Cost by Utility Type

Figure 8 and Figure 9 show the breakdown of FY2013 energy consumption and energy cost by utility type. The figures make clear the large difference in cost per unit of energy for electricity compared to natural gas.

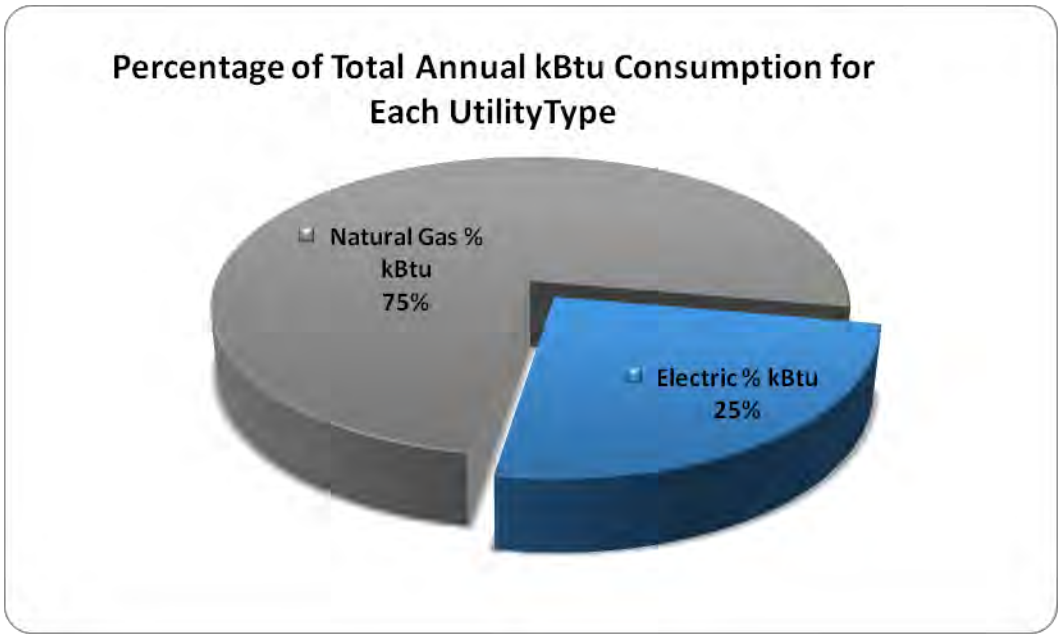

Figure 8. FY2013 Energy Consumption Breakdown

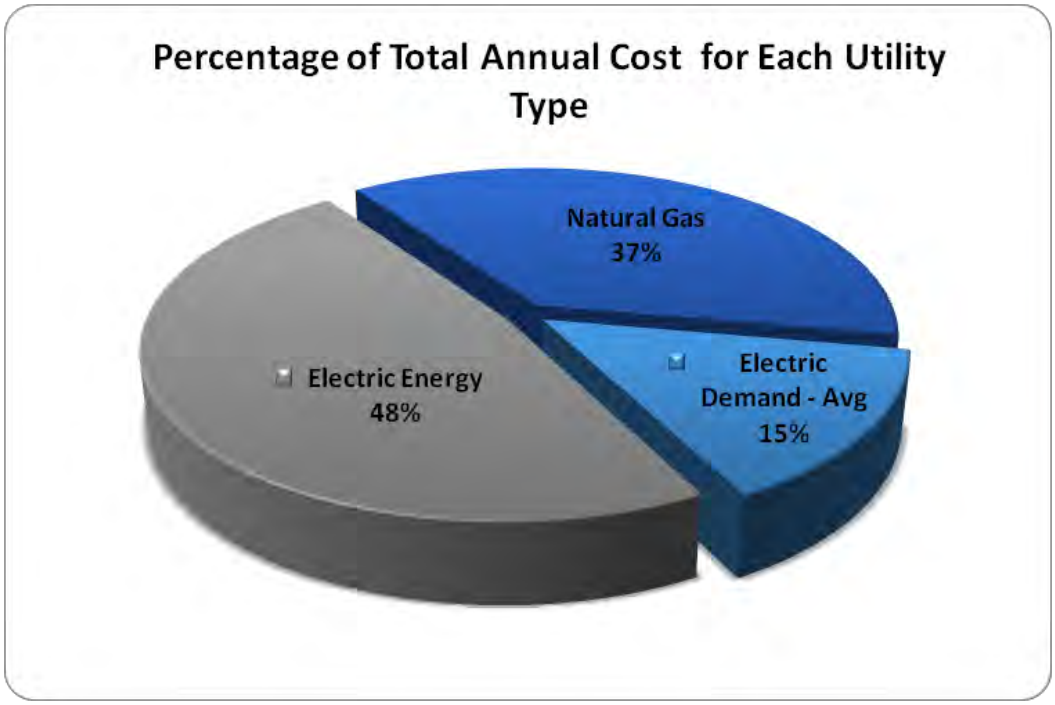

Figure 9. FY2013 Energy Cost Breakdown

6.2 ENERGY USE BASELINE AND BENCHMARKING

Energy Use Intensity (EUI) is one of the key metrics used to evaluate building energy performance. It can be used to track progress of energy reduction goals over time and to compare the energy use of similar facilities. Generally, a low EUI signifies good energy performance. However, certain property types will always use more energy than others. For example, an elementary school uses relatively little energy compared to a hospital.

EUI is calculated by dividing the total energy consumed by the building in one year by the total conditioned floor area of the building. This building was built in 2010 and has been Energy Star Rated with a score of 79. This was based on utility data ending in April 2012. The electric use has remained constant for the facility since construction. The reported natural gas use varies widely and has increased dramatically. It is believed that the flow meter is reading incorrectly due to the location of the installation.

Table 8: Energy Star Score

Year	Period Ending April 2012*	FY 2012	FY 2013
kBtu/Sq Ft/year	179	204	257
Energy Star Rating (period ending April 2012):	**79**		
*This number comes from provided Energy Star Summary			

Energy Star reports the national median site EUI at 211 kBtu/sq.ft. In the 2007 Commercial Buildings Energy Consumption Survey (CBECS) database reports a large hospital at 235 kBtu/sq.ft. The energy consumption is slightly above the national average, which is within expectations based on the location of Anchorage Alaska which is well below the mean national average temperature.

Total Energy Consumption and Cost

The building electrical data was disaggregated into the major energy users. Figures 10 & 11 show that Air Handling unit fans are the biggest electrical users, followed by lighting, plug loads and air compressors.

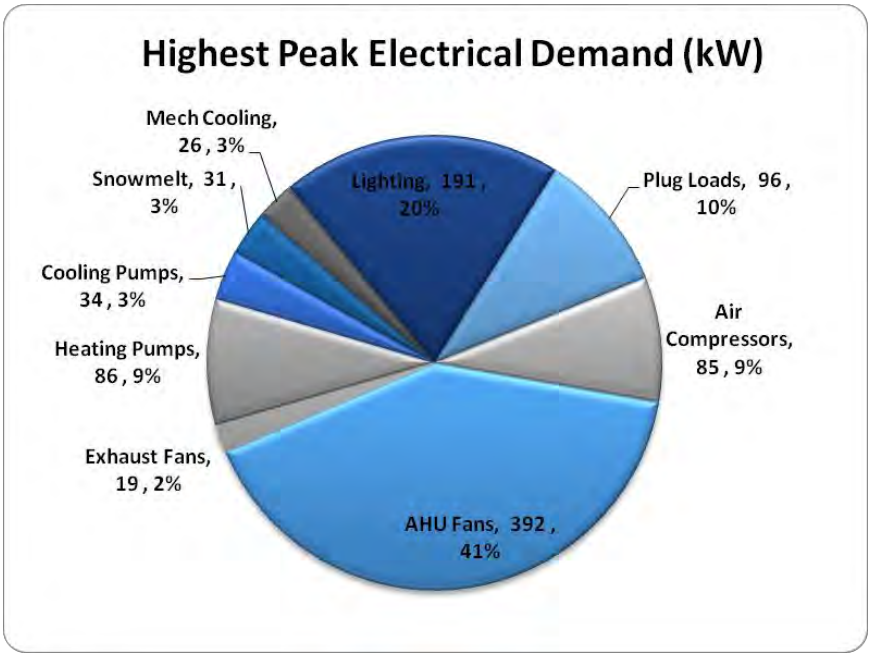

Figure 10. Electrical Demand Allocation

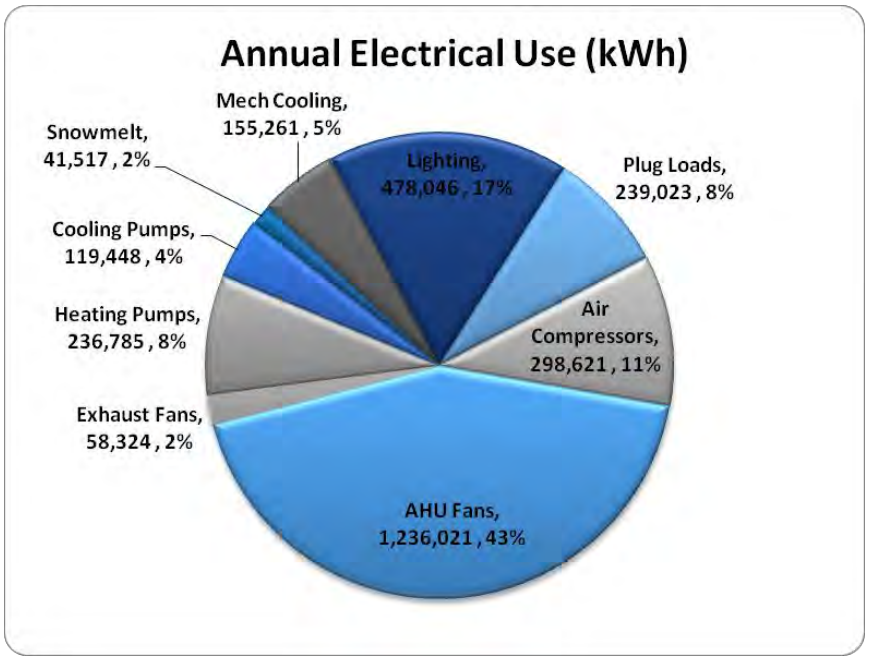

Figure 11. Electrical Use Allocation

Natural Gas Energy and Cost Allocation

Natural gas is used for heating, domestic hot water and snowmelt. A disaggregation of the natural gas use can be seen below.

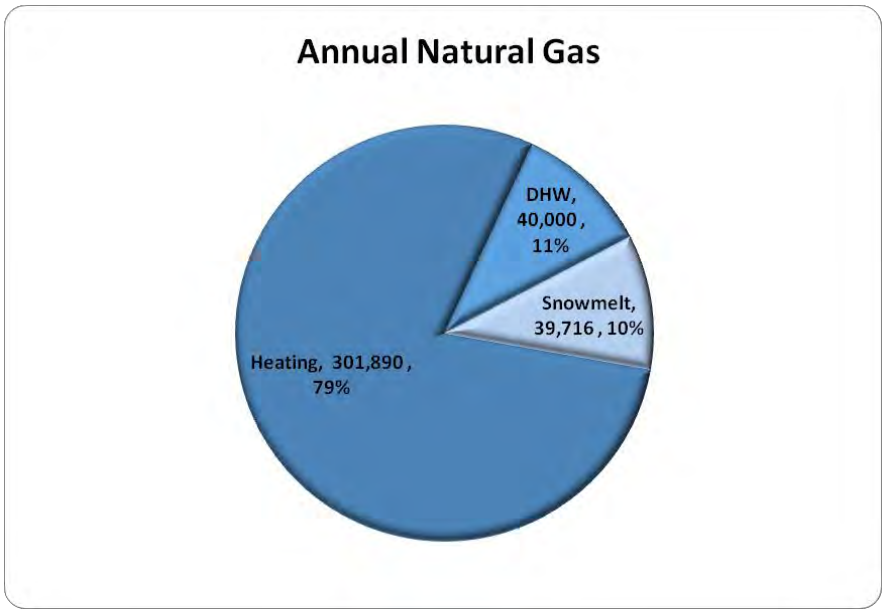

Figure 12. Natural Gas Allocation

7.0 SYSTEM DIAGNOSTIC MONITORING PLAN AND MONITORING RESULTS

The *Systems Diagnostic Monitoring Plan* (see **Appendix F**) organized the activities that took place during the diagnostic monitoring portion of the RCx project. This included addressing the systems to be monitored, the parameters to be monitored, the duration and frequency of data collection, the devices to be used for monitoring, and locations of portable data logging devices to be installed. Diagnostic monitoring provides quantifiable measurements of system performance over time, providing the means to confirm and quantify already known issues and to uncover additional issues in regards to system performance and control functionality. The objectives of diagnostic monitoring include the following:

- Confirm apparent operating issues from empirical field observations.
- Identify operating hours and cycling patterns of equipment.
- Identify operating temperatures, pressures, humidity, speeds, and flow rates where available.
- Evaluate correlations between system operating variables and other parameters (e.g. ambient temperature, occupancy) for the purpose of establishing long-term patterns.
- Determine and confirm as-built control sequences of operation.
- Identify when changes in load occur and how systems respond to those changes.
- Identify systems that do not respond to control set points or cannot maintain set points.
- Identify control loops that are hunting.
- Find incidents of simultaneous heating and cooling, inappropriate economizer operation, excessive variable frequency drive (VFD) speeds, and other operating parameters that indicate non-optimal operating conditions.
- Identify sensors whose values do not correspond to operating conditions, indicating a need for calibration or replacement.
- Identify extreme excursions in system parameters that may indicate operational problems.

Diagnostic Monitoring Results

The following sections present key issues found during the diagnostic monitoring of equipment through DDC trending and portable data logging. Each section presents the most common issues identified and locations in which the issues were seen. Graphs displaying different instances of the issues for various pieces of equipment can be found in **Appendix F**.

The *Systems Diagnostic Monitoring Report* (see **Appendix F**) presents findings and issues identified from data trended from the controls system and data collected through portable data loggers. The data gathered through diagnostic monitoring was prepared in graphical format and analyzed for potential issues and improvement opportunities. Analysis was performed to assess operation with respect to the understood Sequence of Control, which was presented in the *Facility Information Documents,* and control strategies for energy efficient operation. The diagnostic monitoring data and graphs can be found in **Appendix F.**

Key findings from the diagnostic monitoring include:

- Cooling Glycol is maintained at approximately 51 degrees F. This is higher than design.
- On All AHUs, a Pre-Cooling routine between 2:00 AM and 7:00 AM engages the cooling valve and fans, this was observed to be operating correctly per the sequence of operations.
- The heating loop is enabled continuously; this was observed to be operating correctly per the sequence of operations.
- The Heating Glycol supply temperature closely matches the set-point of 195 degrees F. This indicated the equipment is operating correctly.
- AHU supply and return fans run extended hours to satisfy the pre-occupancy set-points per the sequence of operation. There are energy savings opportunities, but they are currently operating correctly.
- Terminal Unit VAV 1-221, 3-215, 4-216, 5-220: Temperature consistently above set point.

The observations are discussed in greater detail below.

COOLING SYSTEM / CHILLED GLYCOL SYSTEM

Cooling plant operation was assessed primarily using diagnostic monitoring data. The data was also used to identify additional issues for repair and potential energy saving

measures. Trend data indicated that the delivered chilled water temperature was above the design set point in the summer. If the chilled well water temperature was lower, or the delivered flow-rate was higher, then the clinic would be able to deliver the designed cooling capacity. Currently, the cooling system is at maximum capacity. The Elmendorf hospital may initiate the procedure of rationing or completely cutting off cooling well water to the Clinic if the hospital requires the cooling well water.

SCHEDULE CONTROL

The scheduling of equipment was analyzed to determine if any of the equipment was operating contrary to its Sequence of Operations. Equipment was also analyzed to determine if there was any unnecessarily runtime outside of building occupancy hours that could be an energy conservation improvement. A graphical example is shown below in Figure 13.

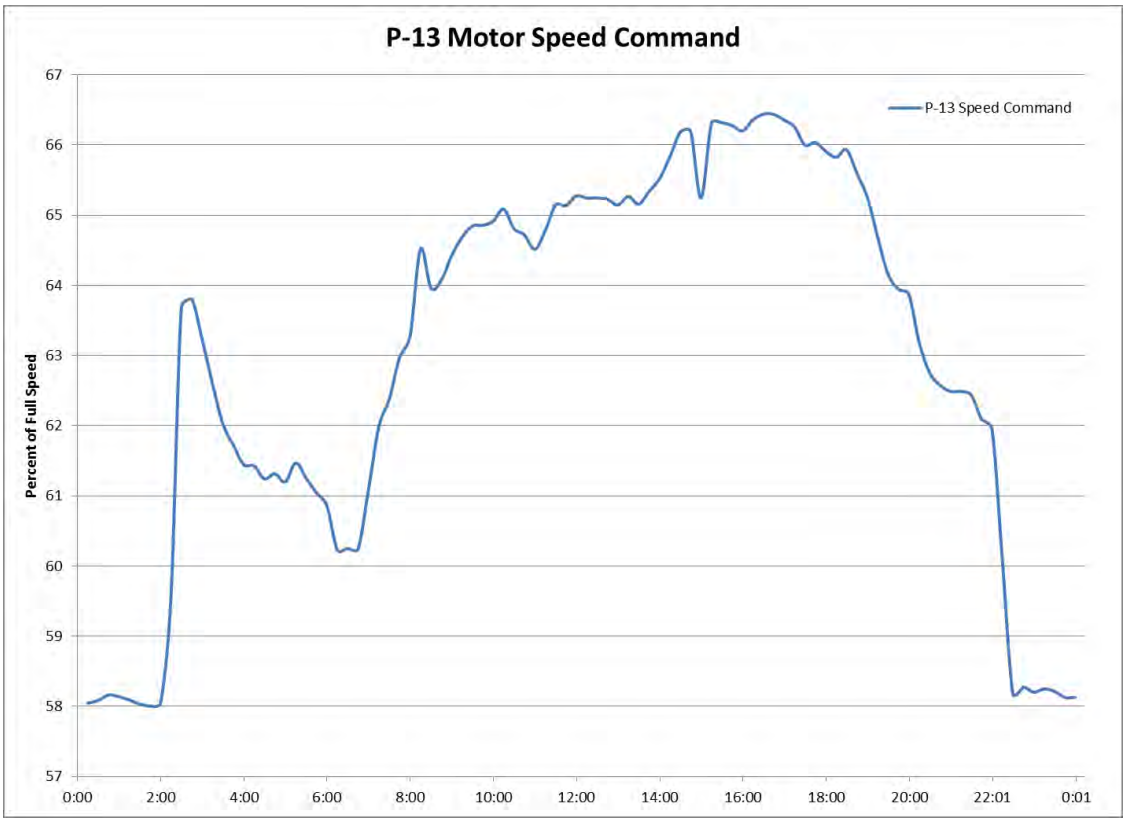

Figure 13. Primary Chilled Water Loop Pump

- The Primary Cooling Loop pumps (Pump 13A/B) runs constantly 24/7, per sequence of operations.

TEMPERATURE CONTROL

The chilled water plant temperatures were analyzed to make sure that they are controlled properly and fall within range of their programmed set points. The following list summarizes the trend analysis findings and a graphical example is shown below in Figure 14.

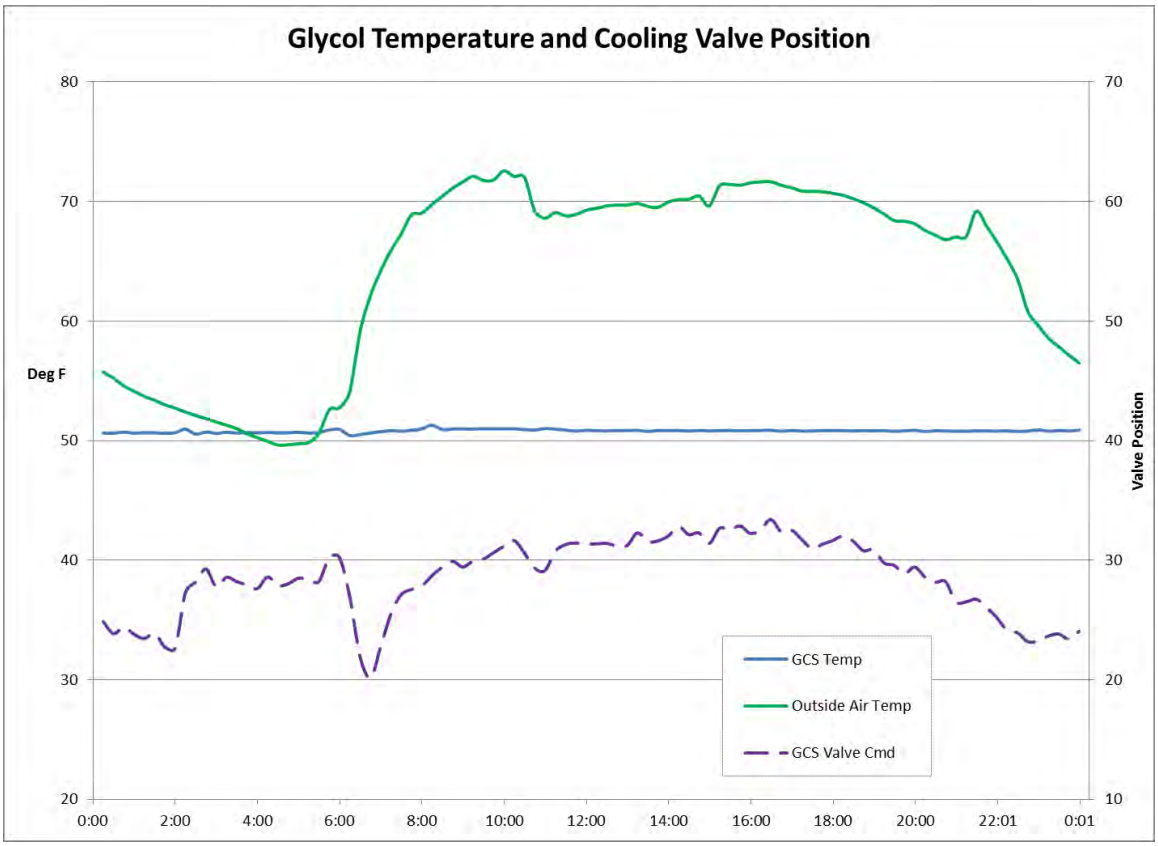

Figure 14. Cooling Glycol Temperature and Valve Position

- Cooling Glycol is maintained at approximately 51 degrees F.
- A Pre-Cooling routine between 2:00 AM and 7:00 AM engages the cooling valve. This is operating correctly per the Sequence of Operations.

HEATING SYSTEM / HEATED GLYCOL SYSTEM

Heating system/plant operation was assessed using diagnostic monitoring data. The data was also used to identify additional issues for repair and potential energy saving measures. Trend data for the programmed hot water supply temperature set points, reset strategies, and system lockouts were observed for most systems. The most frequent issues identified through the monitoring process are presented in the following sections.

SCHEDULE CONTROL

The scheduling of equipment was analyzed to determine if any of the equipment was operating unnecessarily outside of building occupancy. The following list summarizes the trend analysis schedule findings and a graphical example is shown below in Figure 15.

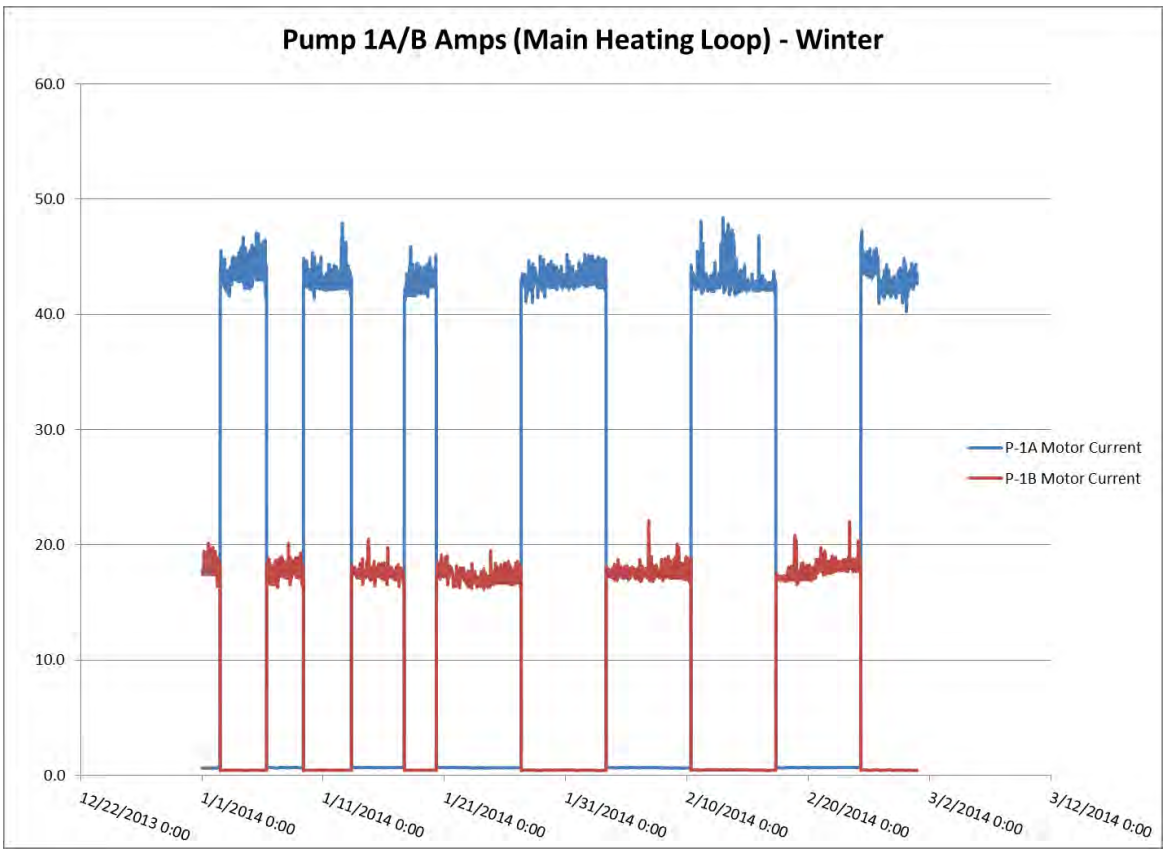

Figure 15. Main Heat Loop Pump (Winter 2014)

- The heating loop is enabled continuously; however pump B appears to run at lower amperage than A. From field inspection both motors are identical.

TEMPERATURE CONTROL

The heating water plant temperatures were analyzed to make sure that they are controlled properly and fall within range of their programmed set points. The following list summarizes the trend analysis findings and a graphical example is shown below in Figure 16.

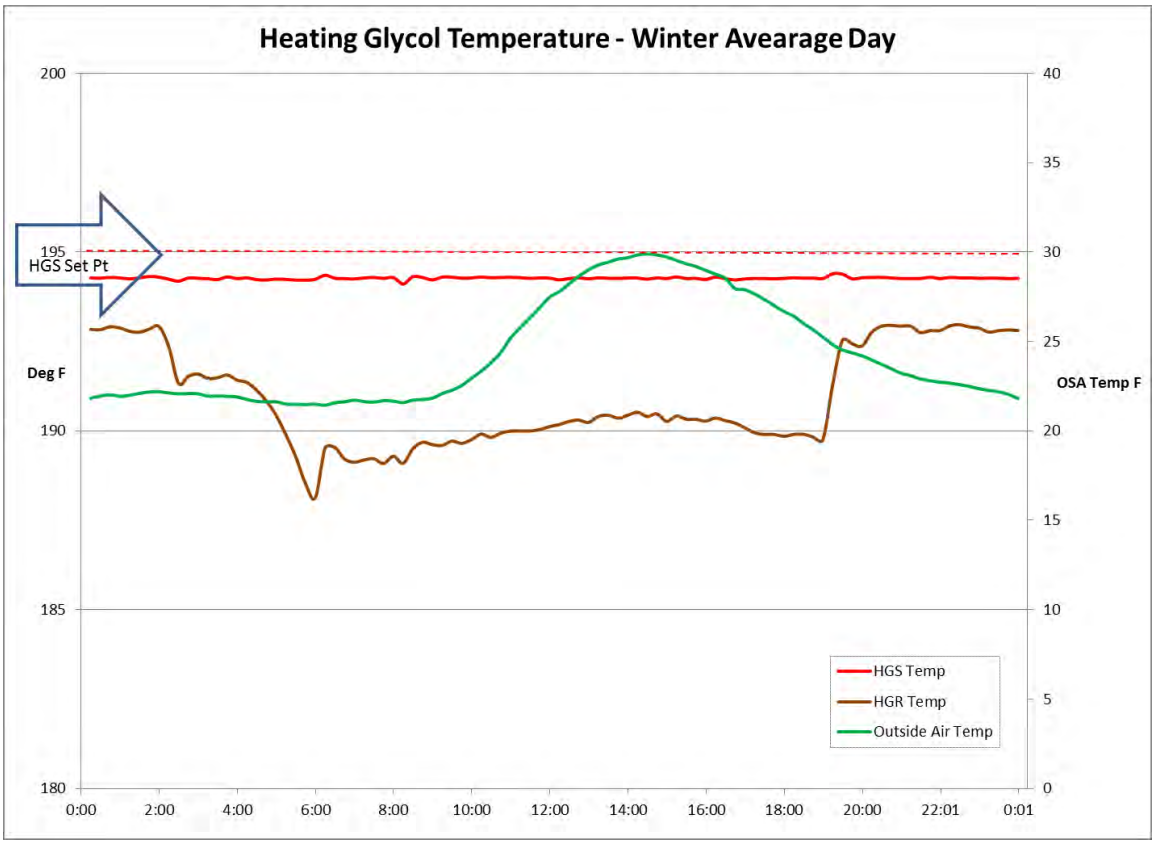

Figure 16. HGS Temperature and Set Point

- The Heating Glycol supply temperature closely matches the set point of 195 degrees F.
- The Heating Glycol return temperature is inverse of the outside air temperature, while the supply temperature remains constant, indicating that the system is able to respond correctly to heat the building

AIRSIDE SYSTEMS

Diagnostic monitoring data was used to assess airside system operation, identify additional issues for repair, and identify potential energy saving measures. There were ten Air Handling Units (AHUs) observed, along with chilled water and hot water supply data, and pump data in winter and summer seasons.

The monitoring process identified several issues, the most frequent of which are shown below by air handler:

AHU 1

SUMMER: Economizer cooling does not appear to be optimized when outside air (OSA) is between 55°F and 70°F; Economizer should be taking full advantage of optimal OSA when it is below return air temperature.

WINTER: There were no apparent issues.

AHU 2

SUMMER: Supply fan operates 24/7, though return fan shuts down each day at 10:00 pm. During occupied hours the supply pressure set point maintains 1” WC.

WINTER: Supply Fan operates 24/7, though return fan shuts down each day at 7:00 pm. Supply pressure set point modulates between 1” to 1.2” WC, while during unoccupied hours it holds steady at 1”.

AHU 3

SUMMER: There is no economizer data. Supply Fan begins operation at 2:00 am, shuts down at 10:00 pm, while the return fan starts at 6:00 am and shuts down at approximately 10:00 pm. The supply fan VFD shows very little modulation vs. OSA except when below 50°F. During occupied hours the Supply pressure set point modulates stays around 1” and modulates up to 1.2” WC; during unoccupied hours it drops to 0” WC, i.e. it shuts down.

WINTER: There is no economizer data. During occupied hours the Supply pressure set point modulates between 1” to 1.4” WC with quite a few hours steady at 1” WC during unoccupied hours it drops to 0” WC, i.e. it shuts down. Supply Fan VFD runs 24/7, though the return fan shuts down each day at 7:00 pm.

AHU 4

SUMMER: There is no economizer data. The supply fan operates in ranges of 76-85% (occupied, most common) and 42-47% (unoccupied) independent of temperature. At occupied it operates 1.4” WC static pressure, while in unoccupied it operates at 1.1” WC. Rather than maintaining 32% humidity (as in winter), it maintains 42% humidity.

WINTER: There is no economizer data. The supply fan operates in ranges of 76-85% (occupied, most common) and 42-47% (unoccupied) independent of temperature. At occupied it operates 1.4” WC static pressure, while in unoccupied it operates at 1.1” WC.

AHU 5

SUMMER: There is a correlation between outside air temperature and fan speed while in cooling mode. The supply and return fan turn on at 2:00 am and run at reduced speeds.

WINTER: There is no available economizer data or return air data. With minor variances, 65-80% operation is being maintained. The supply and return fans are enabled at 1:15 am and disabled at around 10:15 pm. There is no humidity data. Static pressure hovers between 0.7” and 1.1” WC.

AHU 6

SUMMER: There appear to be no apparent issues.

WINTER: The supply fan does not appear to modulate based on outside air, which is appropriate during winter. Supply fan and return fan turn on at 6:00 am and turn off at 8:00 pm. There is roughly 70% fan speed being maintained during occupied hours. There are no apparent issues.

AHU 7

SUMMER: There is no return fan; this unit operates at 100% outside air, which is normal. The fans are running from 2:00 am to 10:00 pm, with the fans ramping up at 2:00 pm till close.

WINTER: There is no return fan; this unit operates at 100% outside air, which is normal. During occupied hours this maintains slightly above 70% of full speed. The supply fan maintains 71% of full speed at occupied hours between 6:00 am and 6:45 pm. From about 7:00 pm till 1:00 am, the air handler shut down but shows a feedback of 10% fan speeds per the data. At 1:00 am until 6:00 am it ramps up in a linear fashion to the 6:00

am occupied 71% condition, most likely to maintain static. From 1:00 am till 7:00 pm, the unit is maintaining a minimum 0.9” WC, a standard occupied set point.

AHU 8

SUMMER: The fan runs from 6:15 am to 10:15 pm. The supply fan maintains around 90% speed with minor modulations.

WINTER: There is no return fan, thus it uses 100% OSA; the supply fan appears to be running from 2:30 am to 7:00 pm maintaining roughly full speed Monday through Friday. The unit is not meeting its humidity set point.

AHU 9

SUMMER: Supply fan runs at 100% full time and there is no return fan. The unit is maintaining just under 40% space humidity regardless of outside air. Supply pressure is maintaining a constant air flow.

WINTER: Supply fan runs at 100% full time and there is no return fan. The unit is maintaining just under 30% space humidity regardless of outside air. Supply pressure is maintaining a constant air flow.

AHU 10

AHU-10 is the make-up air unit for the emergency generator. It is only used when the generator is running and therefore no trend data was collected.

AHU 11

SUMMER: Economizer operates between 15% and 30% when OSA is between 50F and 90F. No supply fan speed data provided, however the return fan operates at a reduced static during unoccupied hours from 10:30 pm to 6:00 am. Supply fan static pressure reduces to zero during unoccupied hours and maintains 0.15” when occupied.

WINTER: From the data collected it is apparent that the supply fan runs daily from 6:00 am to 7:00 pm. A constant 20% outside air is used, the economizer does not appear to modulate based on conditions. Supply pressure is maintained at approximately 1.3” during occupied hours only.

TERMINAL UNITS

Diagnostic monitoring data was used to assess terminal unit operation, identify additional issues for repair, and identify potential energy saving measures. The majority of the terminal units analyzed are maintaining set points for space temperature control, with a few exceptions in the terminals outlined below:

- **VAV 1-221, VAV 3-215, VAV 4-216, VAV 5-220:** Temperature consistently above set point. A graphical example is shown in Figure 17 below.
- **VAV 8-106:** Not holding humidity set point.
- **VAV 9-102:** Low CFM.

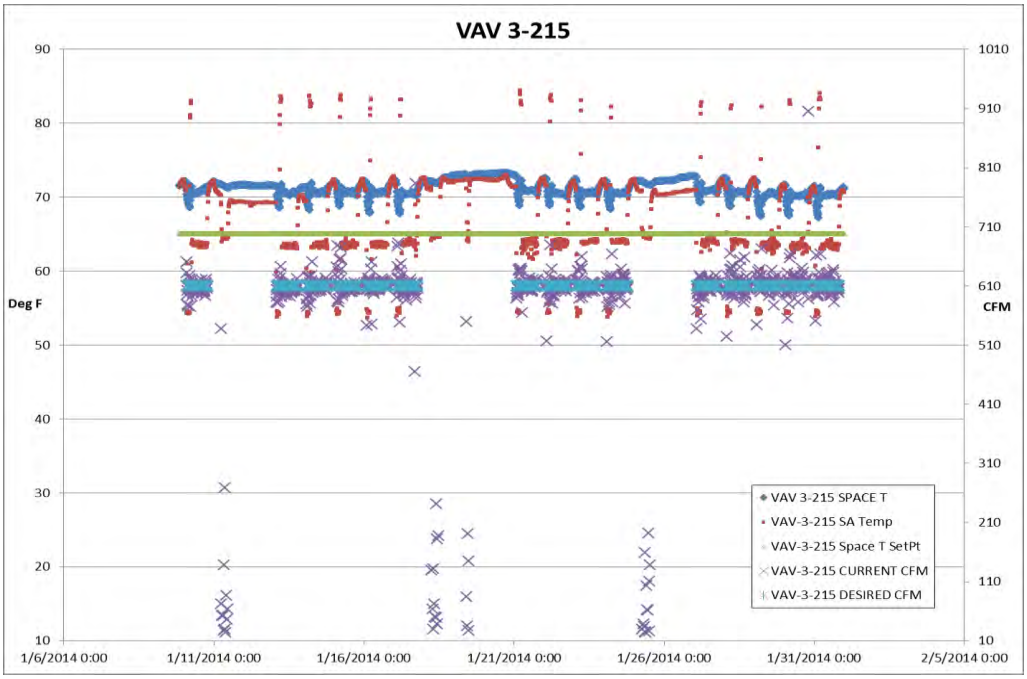

Figure 17. Parameters for VAV 3-215

Please note that the Space Temperature is consistently above the set point, indicating that the thermostat is likely in the wrong area, is blocked by furniture, or that the supply air short-cycles from the supply to the return duct. The CFM matches the CFM set point, which is typical of the VAV boxes analyzed.

8.0 SYSTEMS TEST PROCEDURES, TESTING PLAN AND TESTING RESULTS

The objectives of the system testing included the following:

- Identify sensors whose values do not correspond to operating conditions, indicating a need for calibration or replacement.
- Assess equipment condition to identify deferred maintenance issues.
- Verify the current operating conditions and the operating sequence of control to assess system performance.
- Identify system components that do not correspond to commands and are in need of repair or replacement.
- Identify systems that do not respond to control set points or cannot maintain set points.
- Identify operating set points for temperatures, pressures, humidity, speeds, and flow rates where available.
- Identify potential energy savings measures such as incidents of simultaneous heating and cooling, inadequate or faulty economizer operation, excessive VFD speeds, and other operating parameters that indicate non-optimal operating conditions.

8.1 SYSTEM TESTING PLAN

The objectives of the system testing were accomplished in accordance with the *System Test Procedures* and *Testing Plan* (see **Appendix G**). The plan was used as a model for future testing work conducted at the campus. It includes the following key features:

- System testing objectives.
- Roles and responsibilities for all parties involved in the testing.
- Listing of systems included in the testing plan and which systems will be tested using a sampling methodology.
- Applicable system test procedures and sensor calibration plans.
- Blank copy of the issues log which is used to document issues identified during testing.
- Testing schedule.

System test procedures were developed based on documented and ideal sequences of operation, manufacturer data and O&M instructions, and established testing procedures from the commissioning industry. The system test procedures include controls point-to-point testing, controls functional testing, sensor calibration checks, TAB measurements and system condition assessments. Section 5.0 in the *System Test Procedures and*

Testing Plan describes the components of the system test procedures. Table 9, below, shows the Testing Schedule.

Table 9: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 through 1/10/2014 April 2014	Yes	Functional Testing was Completed in January of 2014 with potential wrap up testing in March to investigate items found during trend analysis
Onsite TAB Measurements	April 2014	Yes	Anticipate bringing in TAB contractor in March of 2014 to take selected measurements.
Prepare Deficiencies Log	1/6/2014 through 5/12/2014	Partial	Ongoing during functional testing and completed in the office after testing is finished.
Prepare Systems Testing Report and Deliver to VA for approval	4/9/2014	No	This report summarizes the findings from the testing.

8.2 SYSTEM TESTING REPORT SUMMARY

The *Systems Testing Report* (see **Appendix G**) documents the test results and the issues identified during the testing process. The Issues Log is presented in **Appendix C**.

IDENTIFIED ISSUES SUMMARY

Overall there were very few issues to be noted throughout the building. After a thorough investigation the systems were found to be in excellent condition which is unusual in RCx studies. One issue was identified through testing. The following list summarizes the identified issue, including the locations and equipment affected, are also summarized in the Issues Log found in Appendix B.

- During testing is was discovered that the PHC control valve on AHU #8 may not be able to fully close.
    - Sensors Passed point to point testing within one degree.
    - Additional investigation by a TAB specialist is warranted; therefore we have brought in a subcontractor to make the investigation by measurement of the delta pressure across the PHC with the valve commanded closed.

- A likely cause of this issue is deposits inside the Griswold valve cartridge preventing it from fully seating in the closed position. The corrective action for this likely cause is replacement of the Griswold valve cartridge.
- This issue effects AHU #8 only.

COOLING SYSTEM / CHILLED WATER PLANT

The condition and operation of the cooling plant was assessed using observations, point to point testing and functional testing. Testing activities indicated that the programmed chilled water supply temperature set points and cooling system lockouts were being observed for the majority of the systems. In some instances, there are opportunities to further automate system control and improve the energy efficiency of the building operation. The most frequent issues identified through the testing process are presented in the following sections.

Point to point testing was used to check the calibration of DDC sensors, valves, VFDs, set-points, etc. associated with chilled water plant control. The following list summarizes the testing results. A detailed list of each point checked and the test associated is available in the *Systems Testing Report (***Appendix G**). There were no failures or issues discovered in this system.

Per VA request, the pumps could be point-to-point tested, but not functionally tested since changing the fluid delta pressure would set off alarms at the Elmendorf side of the system. Point to Point testing procedure used on CHGP-13 is as follows:

- Pump 13A was commanded to 60%
  - **Drive display indicated 62% which is within acceptable limits**
- Pump 13A was commanded to 80%
  - **Drive display indicated 82% which is within acceptable limits**
- Pump 13B was commanded to 60%
  - **Drive display indicated 60%**
- The CHG bypass valve was commanded to close
  - **The valve was visually observed to fully close within 5 minutes**

SNOWMELT SYSTEM

The following parameters were tested for the snowmelt system:

- Point to Point Testing:
  - East Slab surface Temp
    - **Pass: within +/- 3 degrees using handheld IR thermometer**
  - East Slab Moisture Detection
    - **Pass: visual observation by pouring water on sensor**

- West Slab Surface Temp
    - **Pass: within +/- 3 degrees using handheld IR thermometer**
- West Slab Moisture Detection
    - **Pass: visual observation by pouring water on sensor**
- Snowmelt HX Valve Closes Fully
    - **Pass: visual observation**

- Functional Testing:
    - Snowmelt HX Loop Idle temperature
        - **Pass: Measurement within +/- 3 degrees using handheld IR thermometer**
    - Adjust the HGS set-point Up
        - **Bypass valve visually observed - Modulates to maintain set-point**
    - Adjust the HGS set-point Down
        - **Bypass valve visually observed - Modulates to maintain set-point**
    - Override the slab temp below set-point
        - **As slab temp rises, HGS valve observed to adjust to maintain slab rate of temperature increase below 0.2 Deg F per minute**

RE-CIRCULATING AHU TESTING PROCEDURES & RESULTS

The following procedure was performed where applicable to functionally test the Air Handling Units.

- **Simulate a Call for heating**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running
        - **In all cases this was found to be true**
    - Visually check that the OA & RA Dampers are set for minimum OSA
        - **In all cases this was found to be true**
    - Visually observe the heating coil valve modulates to maintain SAT
        - **In all cases the heating valve was found to be functioning normally**
    - Visually check that the Cooling Coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for no heating**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running

        - **In all cases this was found to be true**
    - Visually check that the OA & RA Dampers are set for minimum OSA
        - **In all cases this was found to be true**
    - Visually check that the heating coil valve is fully closed within 5 minutes
        - **In all cases the heating valve was found to be functioning normally and able to fully close**
    - Visually check that the Cooling Coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when both the Airside Economizer and Mechanical Cooling are enabled**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to maintain the SAT set-point
        - **In all cases the dampers were visually observed to modulate fully and correctly**
    - Once the OA & RA & EA dampers are 100% open, mechanical cooling should modulate to maintain the SAT set-point.
        - **Due to winter conditions the unit's freeze alarm would be triggered and the SAT would be far too low for occupied conditions long before the OA damper is fully opened.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the Cooling Coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when the Airside Economizer is disabled and Mechanical Cooling is enabled**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to the minimum airflow position
        - **In all cases the dampers were visually observed to operate correctly**
    - Visually observe the heating coil valve is fully closed

        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the Cooling Coil valve modulates to maintain SAT set-point
        - **In all cases the cooling valve was found to be operating normally**

- **Simulate conditions when there is no call for cooling**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to the minimum airflow position
        - **In all cases the dampers were visually observed to operate correctly**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the cooling coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Test Supply Fan Functionality**
    - Override the duct static pressure set-point to 1.2" W.C.
        - **In all cases the fan was found to be able to maintain 1.2" W.C**
    - Override the duct static pressure set-point to 1.9" W.C.
        - **In all cases EXCEPT AHU #6 Supply Fan, the fan was able to maintain this pressure.**
        - **AHU #6 Supply Fan only able to maintain a maximum of 1.3" W.C.**
    - Override the duct static pressure set-point to 1.5" W.C.
        - **In all cases EXCEPT AHU #6 Supply Fan, the fan was able to maintain this pressure.**
        - **AHU #6 Supply Fan only able to maintain a maximum of 1.3" W.C.**

- **Test Humidification System Functionality**
    - Simulate a call for humidity by overriding the set-point
        - **In all cases the humidification system was visually observed to start and modulate normally to maintain the set point**
    - Simulate the conditions when there is no call for humidity
        - **In all cases the humidification system was visually observed to stop completely**

- **Test SAT Reset Functionality**
    - Override the number of zones requesting DAT decrease
        - **In all cases the SAT was observed to decrease to the minimum set-point**

- Override the number of zones requesting DAT increase
  - **In all cases the SAT was observed to increase to the maximum set point**
- Override the number of zones requesting DAT decrease to 6 and the number of zones requesting DAT increase to 6
  - **In all cases the SAT was observed to increase to the maximum set point**

- **Test Duct SP Reset Functionality**
  - Override the number of zones requesting duct static pressure decrease
    - **In all cases the DSP was observed to decrease to the minimum set point**
  - Override the number of zones requesting duct static pressure increase
    - **In all cases the DSP was observed to increase to the maximum set point**

SINGLE-PASS AHU TESTING PROCEDURES & RESULTS

The following procedure was testing was performed where applicable to functionally test the Air Handling Units.

- **Simulate a Call for heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Check that the Humidity Valve is running in Auto
    - **In all cases this was found to be true**
  - Visually check that the PHC valve modulates to maintain SAT
    - **In all cases this was found to be true**
  - Visually observe the heating coil valve modulates to maintain SAT once the PHC valve is 100% open
    - **In all cases the heating valve was found to be functioning normally**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for no heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Check that the Humidity Valve is running in Auto
    - **In all cases this was found to be true**
  - Visually check that the PHC valve closes fully
    - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**

        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually check that the Cooling Coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when both the Airside Economizer and Mechanical Cooling are enabled**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running
        - **In all cases this was found to be true**
    - Visually check that the PHC valve closes fully
        - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**
        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually observe the Cooling Coil valve is modulate to maintain SAT set point
        - **In all cases the cooling valve was observed to modulate normally**

- **Simulate conditions when there is no call for cooling**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running
        - **In all cases this was found to be true**
    - Visually check that the PHC valve closes fully
        - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**
        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the cooling coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Test Supply Fan Functionality**
    - Override the duct static pressure set point to 1.2” W.C.
        - **In all cases the fan was found to be able to maintain 1.2” W.C**
    - Override the duct static pressure set-point to 1.9” W.C.
        - **In all cases the fan was found to be able to maintain 1.9” W.C**
    - Override the duct static pressure set point to 1.5” W.C.

        - **In all cases the fan was found to be able to maintain 1.5" W.C**

- **Test Humidification System Functionality**
    - Simulate a call for humidity by overriding the set-point
        - **In all cases the humidification system was visually observed to start and modulate normally to maintain the set point**
    - Simulate the conditions when there is no call for humidity
        - **In all cases the humidification system was visually observed to stop completely**

- **Test SAT Reset Functionality**
    - Override the number of zones requesting DAT decrease
        - **In all cases the SAT was observed to decrease to the minimum set point**
    - Override the number of zones requesting DAT increase
        - **In all cases the SAT was observed to increase to the maximum set point**
    - Override the number of zones requesting DAT decrease to 6 and the number of zones requesting DAT increase to 6
        - **In all cases the SAT was observed to increase to the maximum set point**

- **Test Duct SP Reset Functionality**
    - Override the number of zones requesting duct static pressure decrease
        - **In all cases the DSP was observed to decrease to the minimum set point**
    - Override the number of zones requesting duct static pressure increase
        - **In all cases the DSP was observed to increase to the maximum set point**

VAV TERMINAL BOX FUNCTIONAL TEST

The following procedure was used to functional test the VAV boxes:

- The space temp set point is adjusted above the current space temp
    - Zone is expected to go into heating mode to compensate.
        - **VAV box is visually observed to open HGS valve within 5 minutes.**
        - **VAV box is visually observed to modulate the air damper to the heating position (if not already in heat mode) within 5 minutes.**
        - **Discharge air temperature is measured with IR thermometer to increase by 2 degrees or more**.
- The space temp set point is adjusted below the current space temp
    - zone is expected to go into cooling mode to compensate
        - **VAV box is visually observed to fully close HGS valve within 5 minutes.**
        - **VAV box is visually observed to modulate the air damper to the fully open position within 5 minutes.**
        - **Discharge air temperature is measured with IR thermometer to decrease by 2 degrees or more.**

All VAV boxes functionally tested were found to be within parameters, and responded normally to the tests which are designed to test both the control routine and the physical equipment functionality. No Issues discovered in the VAV boxed through functional testing.

8.3 SYSTEM TESTING DEVIATIONS

Fewer VAV Terminal Units were tested – no major issues were discovered in the functional testing nor during trend analysis.

8.4 TAB MEASUREMENTS

Airflow measurements were performed on select mechanical equipment (AHU-7, AHU-8, AHU-9). Fluid flow measurements were performed on select mechanical equipment (AHU-8 Pre-Heat Coil, AHU-9 Cooling Coil). These measurements were used to evaluate operational issues, identify system issues, and recommend possible energy saving improvements. The list of buildings and systems included in the TAB measurement process and additional findings obtained from the TAB process are presented in Section 3.4 of the *System Testing Report.* The 2014 TAB Report can be found in **Appendix H.**

9.0 RECOMMENDED CORRECTIVE ACTIONS SIMPLE REPAIRS

The RCx team will provide simple repairs and set point adjustments as required to correct identified issues and achieve project goals. The objective of simple repairs is to improve the operation of the facility by eliminating issues that can be repaired quickly. Please see **Appendix I** for Deliverable 10, Simple Repairs Report. There is only one Simple Repair, which will be covered by the maintenance contractor (FSI) under their normal duties. Recommended Simple Repair is as follows:

- Change the units shown on the BAS for EF-13 from “Hz” to “%”.
    - There is no operational impact.

10.0 RECOMMENDED CORRECTIVE ACTIONS

Please see **Appendix J** for Deliverable 11, Minor & Major Recommendations Report.

ECM-1: Locate & Stop Compressed Air Leaks

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- Compressed Air System (Non-Medical)

AS-FOUND CONDITIONS

Hypothesis: Suspected Air Leaks. 1. Because the load was not satisfied by original compressors 1 & 2 (20hp). VA installed 60hp comp. 2. The System was data-logged found to have an average load of 28.4 kW, which is equivalent to 38.1 bhp. We expect to see at least 4 CFM/HP @ 100 psig. Therefore, the 60hp compressor would produce about 160 CFM @ 100 psig, where the Clinic only needs approximately 40 CFM @ 100 psig per the humidification system design. HP = 0.030*P*(R0.145-1) 3. Therefore, a substantial air leak(s) is present or the original system design is incorrect.

PROPOSED MODIFICATIONS

We propose that an in-depth investigation be made into sources of air leaks in the system. Leaks should be stopped. This work could be done by an outside specialist contractor or by the in-house HVAC maintenance contractor FSI as determined by contractual obligations.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 10: Estimated Energy and Cost savings

ECM 1: Locate and Stop Compressed Air Leaks											
#	Equipment	HP	Baseline Avg kW	Baseline kWh	Max. Req'd Airflow (ACFM)	Avg. kW (post)	kWh (post)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AC-1 Curtis: OL101HTID20-A4	10	0.0	-	-	0.0	-	-	$ -	see below	
2	AC-2 Curtis: OL101HTID20-A4	10	0.0	-	-	0.0	-	-	$ -	see below	
3	AC-3 Curtis: AF-280	60	28.4	96,101	41.1	7.7	25,908	70,192	$ 7,370	see below	
TOTAL				**96,101**	**41.1**	**7.7**	**25,908**	**70,192**	**$ 7,370**	**$ 2,000**	**0.3**

Notes:

1. Baseline kWh from data logging.
2. Blended electric rated used for financial savings. No Demand Savings shown.
3. Based upon theoretical equations the CFM per brake horsepower is approximately 6.4 CFM per Hp.
4. To be conservative 4.0 CFM per Hp is used in calculations.
5. Required Max Flow Rate is from Provided Design Drawings

ECM-2: Schedule AHU-1 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-1 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-1 starts 4 hours before the return fan. The fans should start at 6:00 am, which is one hour before building occupancy schedule begins. AHU-1 Supply fan was also observed to be running on the weekend. The supply fan for AHU-1 has a 50 hp motor and runs on a VFD at an average speed of 45 Hz during occupied periods and 31.2 Hz during unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing a reduced schedule for the Supply Fan that starts one hour before occupancy or at 6:00 am Monday thru Friday. Weekend runtime will be eliminated.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 11: Estimated Energy and Cost savings

ECM 2: Schedule AHU-1 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-1 Supply Fan	50	31.2	8.2	1,560	12,750	$ 1,339	no cost	immediate
TOTAL						**12,750**	**$ 1,339**	**$ -**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed from 2:00 am to 6:00 am (≈ 31.2Hz)

ECM-3: Schedule AHU-2 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-2 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-2 does not shut down at night, i.e. 24/7 operation. Static pressure of 1" is maintained during off hours, when occupied static pressure of 1.05" to 1.37" is maintained. The Supply Fan for AHU-2 was also observed to be running on the weekend. The supply fan for AHU-2 has a 50 hp motor and runs on a VFD at an average occupied/unoccupied speed of 30.6 Hz.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be eliminated.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 12: Estimated Energy and Cost savings

ECM 3: Schedule AHU-2 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-2 Supply Fan	50	30.6	7.8	5,380	41,970	$ 4,407	no cost	immediate
TOTAL						**41,970**	**$ 4,407**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

ECM-4: Schedule AHU-2 Return Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-2 Return Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Return Fan for AHU-2 runs at a different schedule in the summer and the winter. During the winter the fans shuts down at 7:15 pm as expected, however last summer the fan was being shut down at 10:15 pm, presumably to cool the building. The Supply Fan for AHU-2 was also observed to be running on the weekend but the return fan does not, schedules for supply and return fans should match. The Return Fan for AHU-2 has a 20 hp motor and runs on a VFD at an average speed of 20 Hz.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Return Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 13: Estimated Energy and Cost savings

ECM 4: Schedule AHU-2 Return Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-2 Return Fan	20	20.4	1.2	390	460	$ 48	no cost	immediate
TOTAL						**460**	**$ 48**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

ECM-5: Schedule AHU-3 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-3 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-3 operates longer hours than the return fan. The Supply fan starts 4 hours early, it should start at 6:00 am but it is starting at 2:00 am. The Supply Fan for AHU-3 was also observed to be running on Saturdays. The supply fan for AHU-3 has a 50 hp motor and runs on a VFD at an average speed of approximately 44.4 Hz during occupied and 35.4 Hz during unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be curtailed.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 14: Estimated Energy and Cost savings

ECM 5: Schedule AHU-3 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-3 Supply Fan	50	38.4	13.5	1,872	25,184	$ 2,644	no cost	immediate
TOTAL						**25,184**	**$ 2,644**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

ECM-6: Schedule AHU-4 Supply & Return Fans to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-4 Supply Fan
- AHU-4 Return Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan and the Return Fan for AHU-4 do not shut down at night, i.e. 24/7 operation. The fans run at a lower static pressure when unoccupied, but fans are running 24/7. A higher static is maintained for longer hours in the summer than in the winter. Both fans were observed to be running on weekends. The supply fan for AHU-4 has a 60 hp motor and runs on a VFD at an average speed of 38 Hz during occupied periods and 33.6 Hz during Unoccupied periods. The return fan for AHU-4 has a 25 hp motor and runs on a VFD at an average speed of 29.4 Hz during Unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be curtailed.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 15: Estimated Energy and Cost savings

ECM 6: Schedule AHU-4 Supply & Return Fans to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-4 Supply Fan	60	33.6	11.7	5,380	63,038	$ 6,619	no cost	immediate
1	AHU-4 Return Fan	25	29.4	3.7	5,380	19,902	$ 2,090	no cost	immediate
TOTAL						**82,939**	**$ 8,709**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

ECM-7: Install Ambient Lighting Controls on Lobby Lighting.

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- 400-watt Metal Halide Lighting Fixtures in Lobby
- 350-watt Metal Halide Lighting Fixtures in Lobby

AS-FOUND CONDITIONS

Although not a HVAC deficiency, the lobby lighting was observed to be operating when daylight was much more than sufficient. To save energy, an ambient lighting sensor should be used to secure the lobby lighting when ambient light levels are sufficient due to the large amount of windows and skylights. The lighting fixtures are metal halide of 350 to 400-watts each, and are currently controlled by a time-schedule.

PROPOSED MODIFICATIONS

We recommend installation of an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights. The existing BAS can accommodate this change.

A controls contractor would be responsible for programming the strategy and performing functional testing of the strategy for the lighting system. The strategy parameters would be approved by the VA site team prior to implementation. The conservation strategy can be implemented with minimal impact on overall lighting system operation, and no system outages need to be scheduled.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 16: Estimated Energy and Cost savings

ECM 7: Install Ambient Lighting Controls on Lobby Lighting									
#	Fixture Description	Qty.	Fixt. Watts	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	MH 400-watt Lobby Lighting Fixtures "HA/500"	20	458	9.16	2,190	20,060	$ 2,106	see below	see below
2	MH 350-watt Lobby Lighting Fixtures "HB/400"	8	395	3.16	2,190	6,920	$ 727	see below	see below
TOTAL		**28**		**12.3**		**26,981**	**$ 2,833**	**$ 2,500**	**0.9**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.

OTHER FACILITY IMPROVEMENT OPPORTUNITIES

Several facility improvement measures (FIMs) were identified through the retro-commissioning process. A summary of each recommended measure is given below. These measures were not evaluated to the same level of detail as the EEMs. Costs estimates are included for select measures where appropriate. The following high level information can be used by the VA staff for capital budgeting and long range planning.

FIM-1: Change BAS units shown for EF-13 speed

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- BAS speed value for EF-13

AS-FOUND CONDITIONS

The BAS displays the units for the speed of EF-13 as Hz; however units should be changed to % of full speed because the values displayed are above 60 making it obvious that the speed is actually being reported as a percent. Units are only thing that is not correct, there is no operational impact.

PROPOSED MODIFICATIONS

As part of the “Simple Repair” scope of the RCx project the units displayed on the BAS can be changed from “Hz” to “%” for EF-13 speed. There would be no additional cost to the VA to make this change.

FIM-2: Install RO Water Filtration Equipment for Humidification System

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- All Humidification water supplies to Humidifiers in AHUs. Service to each Penthouse would be required.

AS-FOUND CONDITIONS

The water contains a high level of minerals and the AHU chilled water coils get coated with mineral deposits when the humidification is running. The mineral deposits result in an increase in static pressure with a reduction in airflow distributed to the spaces. FSI cleans the coils, and are testing different cleaners, but we are concerned about the longevity of the coils. In addition, when the OSA temperature drops below a threshold, the humidification dispersion units in AHU-8 and 9 freeze up. This results in staff having to remove the dispersion units to let them defrost.

PROPOSED MODIFICATIONS

Install Reverse Osmosis filtration equipment to serve the humidification systems in all penthouses. If TAB contactor determines actual coil capacities are significantly below submitted coil capacity then coils should also be replaced on an as-needed basis if AHU cannot meet load. Installing RO filtration will significantly reduce the rate of scale build up but will not repair any impact already suffered.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $75,000 not including any coil replacements.

FIM-3: Replace Pre-Heat Coil on AHU-8 or Reduce Load when OSA Conditions are Extremely Cold

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-8

AS-FOUND CONDITIONS

Stratification in the mixing box can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in AHU-8.

PROPOSED MODIFICATIONS
Chang the preheat coil to increase capacity or possibly try to reduce airflow to certain downstream zones determined to be non-critical, if able to, in an effort to reduce load on the AHU during severe weather conditions. After testing, the TAB contractor agreed that the coil was undersized and should be replaced.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $25,000.

FIM-4: Install Baffles in front of Heating Coil on AHU-3

APPLICABLE BUILDINGS AND SYSTEMS
This measure is recommended for the following buildings and systems:

- AHU-3

AS-FOUND CONDITIONS
Stratification in the mixing box can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the Heating coil in AHU-3. Building staff remedies this with some cardboard placed over part of the heating coil in the unit, blocking the portion that gets hit with the most outside air to prevent it from freezing up.

PROPOSED MODIFICATIONS
The amount of OSA contacting a small area of the heating coil is too cold when conditions are severe. Recommended action is to use baffles inside the AHU to direct the OSA towards the center of the mixed air space, rather than allowing it to impact directly onto the nearest edge of the heating coil. If the OSA were dispersed more evenly it would not cause the coil to freeze in one area.

This measure would be implemented by a mechanical contractor or the equipment OEM as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $25,000.

FIM-5: Retrofit IT Equipment Cooling to DX Units

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- IT Equipment / Server Closet Cooling FCUs

AS-FOUND CONDITIONS

While not strictly a deficiency since the existing CHG loop FCUs were found to be functioning well to remove heat from IT equipment spaces, they could be removed from the CHG loop to reduce load on the loop.

Due to the reduced capacity of the chilled glycol system due to increased well water temperatures and flow rate restrictions placed on the clinic by Elmendorf's central plant, every means to reduce load on the CHG loop should be considered.

PROPOSED MODIFICATIONS

To reduce load on the CHG loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs with CHG coils be augmented with DX evaporator units served by rooftop mini-split system type air conditioning units with air cooled condenser and premium efficiency compressors. Each space would be served by a separate unit. This would allow redundant cooling options for the IT spaces, and reduce load on the chilled glycol loop allowing more to be used by the AHUs. Temperature control and unit start/stop control should be added to the BAS for the IT spaces in order to allow the operator to implement a primary/secondary cooling source routine.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $100,000.

FIM-6: Create Controls Interlock to Always Operate EF-11 if the Medical Gas Room Exhaust Fan is Operating

The medical gas exhaust fan is ducted into exhaust for EF-11. Should EF-11 be off and the medical gas exhaust fan be on, medical gas would go back into the building. A controls interlock should be implemented to prevent this from occurring.

OCM-1: Connect ACU-15 Return Air Register to Stairwell Space

The return air duct to the SE stairwell FCU was never finished. The duct should be connected the remaining 6 inches through the wall into the stairwell area. Please see photo at right showing where the duct should penetrate the wall and have a register installed.

Stairwell #2 is enclosed on one side by glass windows and acts like a greenhouse in the summer, trapping heat and making the stairwell quite uncomfortable in the summer. Currently, there is no return duct connecting FCU-15 to the space. Supply air is delivered at the top of the stairwell near the second floor landing. If the return plenum were connected at the bottom of the stairwell better circulation would allow the FCU to effectively remove the heat as designed. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.

The benefits of this recommended corrective action include the following:

- Improved air circulation and optimized cooling in the stairwell

This measure would be implemented by a mechanical contractor as part of a minor project. The estimated installation cost of this project is approximately $2,500.

OCM-2: Re-Position Return Air Registers in Lab

AHU-9 serves the Lab. The Lab space was not designed to accommodate the refrigeration units used. As a result the refrigeration units produce additional heat and the space becomes uncomfortably warm. Return air ductwork should be extended by 2 to 4 feet closer to the high cooling load equipment with registers directly above refrigeration equipment in an effort to better capture the heat produced and remove it from the Lab as quickly as possible. See photo at right. Additional airflow should also be sought through a balancing of the VAV box serving the space. Supply airflow measurements were taken as part

of the functional testing phase; however they showed that the system is operating as designed. An additional cost-effective action can be taken to remedy the temperature issues in the lab, and has already been researched by the VA. This is to install a 4 ton split-system Air Conditioner to serve the lab 1C147.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort in the Lab
- Ability to reliably control the space temperature in the Lab

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project to reposition the ductwork and registers is approximately $9,000. If the split system AC is installed the bid from a local mechanical company was given as $28,838.

OCM-3: Use Multiple Thermostats to Balance Temperature Command to Optimize Baseboard Radiant Heaters

In areas with higher than average occupant comfort complaints such as AHU-4 serving the second floor, we recommend using multiple thermostats and logic to average the values in order to determine if the baseboard radiant heat should be enabled. Most occupant comfort complaints come from areas where the thermostat controlling the VAV zone is located in an adjacent office or further. Also, some areas have been converted to open office cubical areas and are conditioned from multiple zones. Combined with a thermostat in an office with a closed door or a bookshelf in front of the thermostat, and we have a recipe for poorly controlled spaces. With the control routines in place, it is possible to be simultaneously heating and cooling the same space if there are more than one VAV box and baseboard radiant heaters serving an open office area.

This corrective action is recommended for the following systems:

- All areas with above average occupant comfort complaints that have been used as open office areas.
- Spaces served by AHU-4 on the second floor are noted to display this issue.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort
- Energy and savings from reducing simultaneous heating and cooling

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed

to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is approximately $50,000.

OCM-4: Increase Airflow to the Learning Lab 2D116

The learning lab is set up similar to a classroom with 12 computers. Occupants complain that the space is too warm when fully occupied for training sessions, etc. This space was not designed to contain 12 computers and support a dense occupant load such as during a training session. In order to improve occupant comfort we recommend increasing the airflow to the VAV box serving the space.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort

This measure would be implemented by a mechanical contractor as part of a TAB project. The estimated installation cost of this project is approximately $900.

OCM-5: Reduce Load on Chilled Glycol Loop

Because of the limited chilled water flow and temperature from the Elmendorf chilled water system the Clinic experiences a higher Chilled Glycol Cooling supply temperature as a result of the chilled water flow that is below design and entering chilled water temperature above the original design. This issue will only become worse over time.

Potential remedies include removing load from the Chilled Glycol loop wherever possible. For example, running the DX system unit for AHU-8, placing the IT closet cooling on DX split systems and using auxiliary DX units for other AHUs similar to AHU-8. A chiller plant would be an expensive option, but is probably a long term eventuality for the clinic, unless an alternative to the lack of chilled well water is found, such as additional wells.

CHG temp should be much lower (46°F per design documents). The AHUs typically have a 22°F coil per design drawings; however AHU-5 was being provided 53°F glycol. This is just one example; Chilled Glycol loop temperature was above design and will therefore affect all AHUs. This issue will only become worse over time.

In general, the supplied chilled water temperature to the Elmendorf side of the heat exchanger is too high. The clinic was designed for specific supply temperature and flow if the supply temperature and flow rate deviate from design the hospital cannot meet its cooling loads. In order to reduce the Chilled Glycol temperature, the well water flow rate must be increased and the entering well water temperature must be lowered on the primary side of the heat exchangers.

The benefits of this recommended corrective action include the following:

- Improved Occupant Comfort
- Above a certain temperature, the clinic will not be able to serve patients.

- If Elmendorf hospital is unable to cool their own hospital and also provide chilled well water to the Clinic, then they will cease serving the clinic since they must provide 24 hour care to their patients. This is an emergency situation, but it could potentially occur and contingencies should be planned for.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is approximately $3,000 per ton of additional supplementary cooling.

PMM-1: Institute a Preventative Maintenance Program Replace VAV Box Griswold Valve Cartridges

A few VAV box Griswold valves have become clogged with metallic debris over time. A preventative maintenance program should be instituted to check and replace valve cartridges periodically. Focus should be placed on spaces which exhibit above average heating time, or complaints of too cold. Evidence of a valve clogged with metallic debris was shown to the team, however all VAV box functional tests were passed. First Floor VAV boxes are more likely be clogged. The facilities maintenance service provider (FSI) brought this issue to the RCx team's attention.

This corrective action is recommended for the following systems and buildings:

- All VAV Terminal Units, especially the first floor units.

The benefits of this recommended corrective action include the following:

- Restore heating performance

This measure would be implemented by the existing HVAC maintenance service contractor. During unoccupied hours the contractor would check and replace VAV box heating Griswold valve cartridges. This is not a time critical issue and could be done in a slow methodical process. This measure would be added to the existing scheduled PM work. The estimated implementation cost of this project is $0.00, with an ongoing cost increase that depends on the rate at which the valves are checked.

EMM-1: Install BTU Metering to Measure District Heating and Cooling Water Loops

District Provided Heating Water and Chilled Well Water Loops currently do not have working flow measurement devices in place. To properly benchmark the energy use at the Clinic building, the energy sources obtained from Elmendorf should be metered. BTU metering involves measurement of the flow as well as the entering and leaving fluid temperatures as provided to the Clinic building.

This corrective action is recommended for the following systems and buildings:

- Chilled Well Water Loop from Elmendorf.
- Heating Hot Water Loop from Elmendorf.

The benefits of this recommended corrective action include the following:

- Improved benchmarking capabilities

This measure would be implemented by a mechanical contractor. The estimated installation cost of this project is approximately $9,000 for both loops.

10.1 HVAC SYSTEM MAINTENANCE SUMMARY

In general, the current maintenance of the HVAC systems across the campus is exceptional. HVAC systems were observed to be in very good order with the exception of the issues noted in the Issues Log in **Appendix C** and this report. While the maintenance of the HVAC systems is exceptional, there are operational and maintenance enhancements in building systems that may result in improvements in energy efficiency, occupant comfort, and indoor air quality. These enhancements are captured in the Issues Log in **Appendix C.**

HVAC system condition assessments were completed during the Investigation Phase. The issues documented in **Appendix C** present the current condition of the HVAC systems. Observations were not documented for systems where operation was acceptable based on the provided sequences of operation and system operation data gathered from site surveys and facility personnel interviews. Lack of a negative mark can be taken to mean a passed test. The following approach was applied in the condition assessment of the HVAC systems:

- Airside Equipment Inspection, to assess whether:
    - Outside and return air damper linkages are connected and functioning properly.
    - Control sensors are not located near cooling or heating coils.
    - Control sensors are calibrated.

    - Belts are in good working condition with adequate tension.
    - Coils and filters are clean and free of debris.
    - Routine preventative maintenance has been performed.
- Chilled / Hot Water System Inspection, to assess whether:
    - Routine preventative maintenance has been performed.
    - Control sensors are calibrated.
    - Control sensor locations are appropriate.
    - Control valve actuators are functioning properly.
- Terminal Unit Inspection, to assess whether:
    - Routine preventative maintenance has been performed.
    - Control sensors are calibrated.
    - Control sensor locations are appropriate.
    - Control valve and damper actuators are functioning properly (if installed).
- BAS Inspection to:
    - Analyze BAS capabilities and available control points.
    - Evaluate equipment control through the BAS.
    - Assess whether BAS includes required control points for additional energy conservation opportunities.
    - Evaluate whether the existing BAS provides significant capability for ensuring sustainability of energy savings.

11.0 CARBON DIOXIDE (CO_2) MONITORING

DAV Energy solutions did not determine the necessity of CO_2 monitoring due to continuous monitoring already in place; no stand-alone CO_2 monitoring was performed.

12.0 UPDATED CURRENT FACILITY REQUIREMENTS (CFR)

A Current Facility Requirements (CFR) document details the functional requirements for the various spaces in a facility. It includes measurable performance criteria such as: desired heating and cooling temperatures; relative humidity minimums and maximums; and required air changes per hour. The CFR also includes the type(s) of equipment serving the space, filter requirements, and heating/cooling source(s).

The Anchorage Alaska Outpatient Clinic did not have a CFR. DAV Energy Solutions created a summary of the functional requirements for the various space types in a hospital campus from the *VA Design Guide*. This summary is included in **Appendix K** of this report for reference purposes only and is applicable to new construction projects. Existing spaces at the facility may not be able to meet the functional requirements for new construction. Adjustments to the existing HVAC system and equipment should

include input from a planning/design consultant/engineer to confirm their suitability and safety.

During the course of the RCx process, a major update and revision of the *VA Design Guide* was underway. Updates will be incremental; completed guides should be posted by VA on the website http://www.cfm.va.gov/til/dGuide.asp and noted as current. As such, the VA Design Guide Summary in the appendix was supplied to the Site COTR in the form of an editable Excel spreadsheet (.xls).

13.0 OUT-BRIEFING ADDRESSING INVESTIGATION FINDINGS AND IMPLEMENTATION OPTIONS

The out briefing process provided VA staff with an opportunity to discuss the project findings in the report with the RCx Team. The out briefing process was held via telephone with RCx Team members and VA staff on May 15, 2014. During the out briefing, the major RCx Investigation discoveries, improvement measures, and recommendations were discussed. The objective of this briefing was to answer questions and provide further explanations concerning elements of the project that remain unclear to VA staff after review of the project final report.

DAV Energy Solutions discussed a variety of recommendations resulting from the RCx process which included:

- Energy efficiency improvement measures.
- Equipment performance improvement measures.
- Operational and maintenance improvement measures.
- Equipment repair and/or change-out opportunities.

Key items discussed in this meeting included:

- To be finalized after meeting.

The Out-Briefing Meeting Minutes are included as **Appendix L**.

14.0 EQUIPMENT LIST

The equipment list prepared for the RCx Project is shown in **Appendix M**.

Appendix-A

For Final RCx Report

Retro-Commissioning Plan

VISN 20 Alaska
VA Healthcare System

Anchorage, AK

Retro-Commissioning Plan

NOVEMBER 26, 2013

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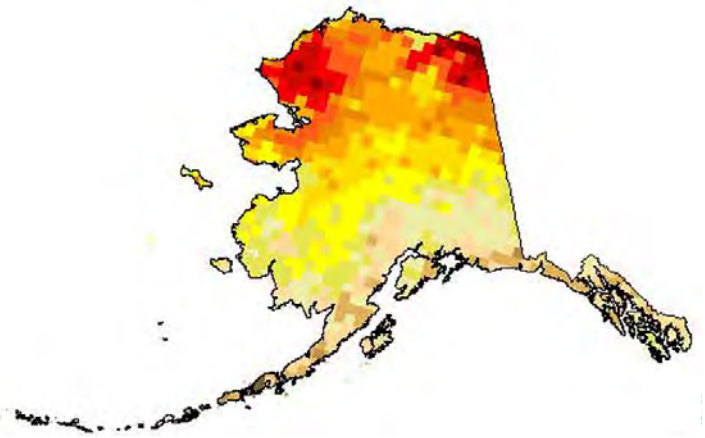

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1.0 Executive Summary

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants. Building system optimization offered as part of an RCx program should fulfill the following goals:

- Reduce electrical and heating energy and demand costs.
- Bring equipment to its proper operational state.
- Reduce occupant complaints.
- Improve indoor environmental quality.
- Maintain or improve infection control.
- Reduce premature equipment failures.
- Improve facility operation and maintenance procedures.
- Reduce staff time spent on emergency or complaint calls.

1.1 REPORT OVERVIEW

This RCx Planning Report is comprised of the following main sections:

1.0: Executive Summary

An introduction to the RCx project and outlines the remaining sections of the report.

2.0: Project Objectives

Outlines the objectives for the project, providing details for the flow and sequence of project events.

3.0: Descriptions of Buildings and Systems

An overview of the building included in the RCx scope of work. It summarizes operational schedules, general building characteristics, and major mechanical equipment & systems.

4.0: Retro-Commissioning Process and Scope

Provides a detailed outline of the activities that will take place during the Planning and Investigation phases of the RCx project.

5.0: RCx Team Members Roles and Responsibilities

Outlines the roles and responsibilities of each team member. Team members are comprised of Anchorage VA staff and the RCx professionals.

6.0: Project Schedule

Outlines the project's major tasks and deliverables, providing target start and completion dates.

7.0: Available Documentation

Outlines the documentation requirements for the project, providing comments and confirming receipt or availability of required data.

8.0: Planning Phase Activities

Provides information about planning phase activities that have occurred.

9.0: Investigation Scope and Methods

Outlines the scope of activities that will take place during the investigation phase of the project.

10.0: Out-Briefing & Implementation Options

Outlines Out-Briefing activities and the scope options available to the facility to implement energy or operational improvement measures recommended as part of the Final RCx Report.

2.0 Project Objectives

Retro-commissioning (RCx) is the systematic, documented process by which owners ensure that their buildings and their systems are optimized to perform interactively to meet the Current Facility Requirements (CFR) as closely as possible. The goal of this RCx project is to provide a thorough understanding of the operating characteristics and current condition of the HVAC and Control systems found in the building. Efforts will then be made to identify and evaluate opportunities for improvements to equipment operation, control and maintenance and to address any deficiencies in design or operation. These opportunities will be presented in the RCx Report. Following are tasks included in this study:

- Prepare an RCx Plan for investigating and analyzing all relevant building systems to verify that they are optimized to perform interactively to meet the current operational needs as closely as possible.
- Compile facility documentation including an equipment list, and existing control sequences where available. Develop a master sequence of control by system type and create plant and AHU schematics where needed.
- Carry out the investigation and analysis, compile building data, conduct interviews, and utilize trend logs from building automation controls, portable data logging, and functional testing as appropriate.
- Benchmark current energy consumption where data is available so that future energy needs can be realistically assessed and then documented.
- Optimize control systems through implementation of simple repairs (less than 30 minutes and $60 in cost) possibly including calibration of sensors, correction of minor programming issues and repair of other mechanical issues.
- Identify options and cost estimates for energy savings throughout the building including both low cost and capital improvement measures.
- Identify the Operations and Maintenance (O&M) personnel training needs to improve the skills/abilities to respond effectively to changing needs of the facility and/or occupants.

3.0 Description of Building and Systems

The Alaska VA Healthcare System Building is located in Anchorage, Alaska. The health care center offers primary, specialty and mental health care services to all eligible Veterans, active duty and their dependents residing within a 586,400 square mile primary service area.

Figure 3-1 below displays the building and its layout:

Figure 3-1: Satellite Image of Site

3.1 BUILDING OVERVIEW

The building is a two story building that was originally constructed in 2010. The building is an outpatient clinic with primary care, dental care, pharmacy, laboratory, operating rooms, physical therapy, orthopedics, prosthetics, mental care, a canteen and supportive administrative offices. Air handling units are located in penthouses. The total conditioned area of the building is approximately 191,000 sq. ft.

The building is currently occupied from 7 am to 7 pm by patients and staff. Air handling units serving the lobby and the laboratory operate 24/7. All other air handling units operate to match the building occupancy.

Table 3-1: Building Characteristics

CHARACTERISTIC	DESCRIPTION
Original construction	2010
Conditioned area	191,000 sq. ft.
Number of stories	2 stories and mechanical penthouses
Building use	General hospital outpatient clinic
Weekly hours of operation by major space type	Monday through Friday 7am to 7pm
Brief renovation history	Minor revisions from original design where a few open office spaces were converted to single offices, a locker room was moved and a clean utility room expanded.
Brief description of building improvements planned	The single offices along the west wall of 1st floor A-wing will be converted to open office space.

3.1.1 General Equipment Overview

Table 3-2 provides a general description of the mechanical equipment serving the building. The building utilizes heating and cooling water served via heat exchangers from a central plant with natural gas boilers and ground water cooling wells located on nearby Elmendorf Air Force Base. In the VA Clinic, duplex 100% capacity base mounted pumps are used to provide circulation through heat exchangers and distribution loops.

Ten air handling units provide ventilation and conditioning to the spaces. Air is distributed to zone VAV boxes with hot water heating coils. Perimeter zones have additional hot water baseboard to meet heating loads. Relative Humidity (RH) is maintained in all building spaces with humidification modules within the AHUs utilizing air atomization. Two central compressors provide 100psig compressed air for the humidification system. Spaces that require greater RH levels utilize air

atomization in local ductwork serving the respective space. An additional air handling unit serves the generator room.

A snowmelt system consisting of a heat exchanger and pumps provides snow melting for four zones.

Central mechanical equipment is located in the first floor mechanical room. Air handlers as well as pumps serving AHU heating coils, perimeter heat and VAV heating coils are located in the penthouses. The table below provides a general description of the mechanical equipment.

Table 3-2: Building Equipment General Description

EQUIPMENT	DESCRIPTION
Type of Cooling System	Campus chilled water to building; (2) Heat exchangers; (2) CHW pumps with VFDs
HVAC Distribution Systems	(10) AHUs; AHU-1, 2,3,4 & 5 –Economizer, HW heating coil, humidification, CHW cooling coil, VFD Supply Fan, VFD Return Air Fan, - serves general clinic space VAV boxes. The pharmacy is served by general AHU with additional local HEPA filter for supply air; AHU-6 –Economizer, HW heating coil, humidification, CHW cooling coil, VFD Supply Fan, VFD Return Air Fan, - serves lobby diffusers; AHU-7 & 9 –100% outside air, HW Pre heating coil, HW heating coil, humidification, CHW cooling coil, VFD Supply Fan, - serves dental and laboratory suite VAV boxes. Fully ducted VFD exhaust fans for each system; AHU-8 –100% outside air, HW Pre heating coil, HW heating coil, humidification, CHW cooling coil, DX cooling coil for dehumidification with associated condensing unit on roof, VFD Supply Fan, - serves surgery. VAV boxes. Fully ducted VFD exhaust fans for each system; AHU-10 – 100% outside air, HW heating coil – serves generator room cooling and combustion air; AHU-11 –Economizer, HW heating coil, CHW cooling coil, CV Supply Fan, CV Return air Fan - serves link diffusers; Zone terminal equipment – VAV boxes with HW heating coil, phoenix air valves in specialty areas; Miscellaneous building exhausts (toilet rooms, janitor's closet, etc.) will be connected to a central general exhaust systems. Two TB isolation rooms utilize a dedicated exhaust fan with HEPA filter to provide negative pressure.
Age of Systems	2010
Heating System Type	Campus hot water to building; (2) Heat exchangers; (2) Primary HW pumps with VFDs; (5x2) Secondary HW pumps with VFDs serving AHU heating coils; (3x2) Secondary HW pumps with VFDs serving VAV reheat and perimeter heating

3.2 BUILDING AUTOMATION SYSTEM

The mechanical equipment is controlled by an Alerton control system version 2.6. This includes AHU's, chilled water pumps, hot water pumps, baseboard heaters, VAV terminal units, zone thermostats and radiant snowmelt. In addition, there are locally controlled unit heaters and cabinet unit heaters throughout the building, typically in penthouses and above exit doors.

The Alerton central computer workstation is located in room 2C-191. This user interface includes graphics for building floor plans and equipment schematics. The control system allows for viewing equipment operation in real time, modifying set-points and control logic, and conducting trending.

4.0 Retro-Commissioning Process and Scope

Retro-commissioning (RCx) is the systematic, documented process by which owners ensure that their buildings and systems are optimized to perform interactively to meet the current operational needs as effectively and as efficiently as possible.

A senior engineer or energy professional will be assigned the role of Site Project Manager for all work at the site. That professional will be the single point of contact at the building to coordinate with VA managers and staff, to communicate progress, to coordinate access for the DAV Energy staff working in the building and performing the RCx, and to prepare reports and deliverables. During the site visits team members might require VA assistance to access HVAC mechanical rooms, the BAS operator workstations, and any interior areas for testing or monitoring. The DAV Energy team will provide bi-weekly progress reports to keep COTR and involved site staff informed of work completed, project status, activities planned in the next 2 weeks and any potential issues.

The following Scope of Work describes the Planning and Site Investigation Phases of the RCx process.

Table 4-1: Task 1 – Planning Phase

TASK 1 - PLANNING PHASE	
The objectives of the Planning Phase are (1) to develop/confirm the needs and requirements for the building, (2) to collect building and equipment information and (3) to develop an RCx Plan for each building. The items in the table below provide a high level outline of the tasks included in this phase of the project.	
TASK	**ACTIVITY**
0	General Deliverables – The general deliverables consist of project schedules, deliverable pricing schedule, required certificates, proof of insurance, an environmental plan, and a site specific safety plan.
1	Key Deliverable 1 – Retro-Commissioning Plan – DAV Energy will develop the RCx Plan based on VISN 20's goals for the project and findings from the initial site visit and information gathering. The RCx Plan will include information on the planned tasks and a project schedule.
2	Key Deliverable 2 – Conduct a Scoping Meeting and Issue Minutes – After submitting the RCx Plan, the DAV Energy will facilitate a meeting to review the Plan, obtain VA comments, discuss, and agree to the RCx Plan. Minutes from the meeting will be prepared and submitted.

Table 3-2: Task 2 – Investigation Phase

TASK 2- INVESTIGATION PHASE (cont')	
The main objectives of the Investigation Phase are (1) to compare the actual building conditions and system performance with the VA's current operational needs and requirements defined by CFR, (2) to identify HVAC system deficiencies through diagnostics testing, (3) improve system performance by completing 30 minute HVAC system repairs, and (4) to compile system operation information. The items in the table below provide a high level outline of the tasks included in this phase of the project. More detail on the work included in the Investigation Phase can be found in Section 7.	
TASK	**ACTIVITY**
3	Key Deliverable 3- Site Condition Assessment and Facility Information Documents - DAV Energy will conduct a thorough site reconnaissance, complete and provide the following to develop the sie condition assessment: Review revelvant HVAC systemd esign drawings, BAS information and equipment data and walk the building to evaluate whether current conditions such as occupancy and sace utilization have changed from the original design; Identify HVAC systems to be monitored and tested and logistical issues affecting access to equipment; Obtain relevant BAS equipment information and determine current sequences of operation; Review components and sensors of existing HVAC equipment; Assess current control for systems not on a BAS. DAV Energy will complete and provide the following as part of the facility information documents: Create an HVAC equipment list with key information available from nameplates and drawings for major HVAC equipment; Review sequences of operation for major HVAC equipment available in documentation and on the Building Automation System (BAS) and compile the available sequences in one document prior to testing; Create plant and AHU schematics where needed.
4	Key Deliverable 4 – Building Occupant Interviews – DAV Energy will conduct in person interviews with facilities maintenance staff and email survey with select occupants to understand the current needs and issues related to system operations and maintenance, indoor air and environmental quality, and occupant comfort/satisfaction. The information will be used to uncover potential improvement opportunities, confirm the CFR and to develop consensus on the RCx goals.
5	Key Deliverable 5 – Facility Performance Analysis, Performance Baseline – The performance of the facility will be assessed in a variety of ways throughout the project. The tasks within this deliverable include assessing the energy performance at the meter level and evaluating the current requirements of the facility. This includes the following: DAV Energy will collect and analyze available building level utility meter data to establish baseline benchmark for facility performance. This benchmarking can help uncover potential opportunities and can be used as a baseline to measure future performance improvements during the RCx process; Energy use for the building will be disaggregated by end use categories; Review occupant survey results, BAS trend data, the current CFR, work orders and comfort complaint logs to establish a performance baseline.
6	Key Deliverable 6 – Systems Diagnostic Monitoring Plan – DAV Energy will develop a diagnostic monitoring plan to provide the VA with information on the HVAC systems and points that will be monitored using the BAS or portable data loggers. Smaller equipment and terminal devices will have a representative sample trended or logged. Monitoring will be prioritized for larger system or those systems and equipment with known operational issues.

Table 4-2: Task 2 – Investigation Phase (continued)

TASK 2- INVESTIGATION PHASE (cont')	
TASK	**ACTIVITY**
7	Key Deliverable 7 – Systems Diagnostic Monitoring Report – Trend data will be analyzed to identify issues and improvement opportunities and to highlight problems that may require more rigorous and focused investigation. Analyzing the diagnostic monitoring data will assist in evaluating the system operation. This work will be documented in the Systems Diagnostic Monitoring Report.
8	Key Deliverable 8 – Systems Test Procedures and Testing Plan – DAV Energy will prepare system test procedures and plans to provide the VA with detailed information on the HVAC equipment to be tested and how testing will be performed. Testing will be conducted for all systems and equipment in the building that are tied to a BAS and all other major pieces of equipment. Locally controlled terminal devices and small locally controlled equipment will be tested with a representative sample. Select airflow and water flow measurements for major systems will be performed as deemed necessary.
9	Key Deliverable 9 – Systems Test Procedures Report – System testing will be conducted to evaluate system performance, including equipment condition, current operating conditions, sequence of operations, and deferred maintenance issues. This work will be documented in the Systems Test Procedures Report that will include a summary of deficiencies, issues and recommended improvements. DAV Energy will install several portable CO2 Monitors, relative humidity and differential air pressure monitors at select air handling units and/or in areas with indoor air quality concerns. The monitoring data will be assessed against ventilation standards to verify that air quality is being maintained and a report summarizing the process and findings will be provided.
10	Key Deliverable 10 – Repair Report Summary & Recommended Corrective Action - DAV Energy will provide simple repairs and set point adjustments as required to correct identified issues and achieve project goals. The objective of these simple repairs is to improve the operation of the facility by eliminating issues that can be repaired quickly. DAV Energy will provide documentation of any simple repairs performed, savings achieved and a prioritized list of larger corrective actions needed.
11	Key Deliverable 11 –Final RCx Report – DAV Energy will summarize all the Task 1 and 2 deliverables described above into a final report.
12	Key Deliverable 12 - Out Briefing – Upon completion of the services described above and submittal of the Final RCx Report, the Site Project Managers will provide an out briefing to VA personnel who have been involved in the project and/or will be involved in implementation (e.g., the COTR, building and/or energy managers, maintenance managers).

Table 4-3: Task 3 – Equipment List

TASK 3 - EQUIPMENT LIST
Through the RCx survey, develop a detailed Equipment List featuring all equipment at the facility.

5.0 Retro-Commissioning Team Members' Roles and Responsibilities

The RCx team includes the Alaska VA and VISN 20 staff and DAV Energy professionals. Within these teams, individual roles and responsibilities will be integrated to deliver on all of the project requirements and services detailed within the scope of work. Outlined below is a list of primary responsibilities of each team member on this project:

5.1 ALASKA VA AND VISN 20 STAFF

Table 5-1: Alaska VA and VISN 20 Staff

Contracting Officer	Brenda Parks	Brenda.Parks@va.gov	TBD
Contract Specialist	Gary Danelishen	Gary.Danelishen@va.gov	(216) 447-6300 ext.3550
VISN COTR, Energy Manager	Steven Juhasz	Steven.Juhasz@va.gov	(360) 567-4689
Site COTR, Energy Manager	Steve Matthes	Stephen.matthes@va.gov	(206) 764-2035
Chief, Facilities Management Services	Gerald Xavier, PMP	gerald.xavier@va.gov	(907) 257-7463
HVAC Contact:	Mark Biehm	mark.biehm2@va.gov	(907) 257-5488
BAS Contact:	Michael Kief	Mike.Kief@va.gov	(907) 257-4900
Safety Manager	Chad	TBD	(907) 538-1347

According to our understanding, VA personnel will:

- Authorize changes
- Provide all drawings and associated documentation
- Assist with the overall coordination of the project
- Complete the review and approval of deliverables
- Respond to RFIs
- Provide clarifications to the documentation

Medical Center operations and support staff will:

- Provide coordination and access to areas of the facility
- Communicate local hospital guidelines related to on-site activities
- Provide internal communication to specific hospital groups of upcoming facility testing
- Provide occupancy and hospital operational schedules that will impact the RCx diagnostic monitoring and testing procedures

- Provide access to the building automation system used to operate the building systems

5.2 DAV ENERGY STAFF

Table 5-2: DAV Energy Staff

Principal/QA:	James Sinclair	James.Sinclair@davenergy.com	(619) 663-7007
Program Manager:	Darren Ito	Darren.Ito@davenergy.com	(858) 880-7004
Site Project Manager:	Michael Rogers, PE, CEM	Michael.Rogers@davenergy.com	(760) 908-6321
Support Engineer:	James Bottomley	James.Bottomley@davenergy.com	(415) 738-9097
Support Engineer:	Agneta Kupilik, PE	Agneta.Kupilik@davenergy.com	(907) 538-9044
Support Engineer:	Jase Zappel	Jase.Zappel@davenergy.com	(408) 655-6172
Support Engineer:	Clayde Barkley	Clayde.Barkley@davenergy.com	(805) 547-2050
Support Engineer:	Mike King	MIke.King@davenergy.com	(760) 505-6930

The Principal/QA will:

- Manage contract related aspects of the work with the VA and VISN COTR and DAV Energy.
- Manage and communicate any issues that arise to the VA.
- Manage the overall project schedule.
- Communicate directives or changes in the project.
- Submit RFIs.
- Provide quality assurance review of final deliverables.

The DAV Energy Program Manager will:

- Coordinate all work and schedule with the VA.
- Provide quality control for all deliverables.

The DAV Energy Site Project Manager will:

- Provide communication regarding the RCx project and coordinate on-site activities with the Alaska VA operations and support staff.
- Manage activities associated with the RCx process.
- Prepare, review, and submit all project deliverables.
- Meet all project deliverable dates, as outlined in the project schedule.
- Manage and execute RCx field work activities specific to each site, including on-site surveys, functional testing, and data acquisition.
- Ensure quality control in the performance of all team members.

The DAV Energy Support team will:

- Execute RCx field work activities specific to each site including on-site surveys, functional testing, and data acquisition.
- Meet all project deliverable dates as outlined in the project schedule.

6.0 Schedule

Table 6-1: Project Schedule

GENERAL		
Following is the schedule of Tasks and Deliverables that represent milestones in the project. Projected Deliverable due dates are based upon the project schedule listed in the Scope of Work. As the project proceeds, dates will be adjusted as required and presented to VA Energy Managers for approval.		
Task	**Tasks and Deliverables**	**Date**
TASK 1 – PLANNING PHASE		
1.1	Key Deliverable 1 – Retro-Commissioning Plan	12/26/2013
1.2	Key Deliverable 2 – Scoping Meeting and Issue Minutes	12/20/2013
TASK 2 – SITE INVESTIGATION PHASE		
2	Retro-Commissioning Coordination	Continuous
2.1	Key Deliverable 3 – Facility Information Documentation (Site Condition Assessment, Facility Information Documents, & Equipment Inventory)	1/28/2014
2.2	Key Deliverable 4 – Building Occupant Interviews and Goals	1/28/2014
2.3	Key Deliverable 5 – Facility Performance Analysis and Performance Baseline	2/25/2014
2.4	Key Deliverable 6 – Systems Diagnostic Monitoring Plan	1/28/2014
2.5	Key Deliverable 7 – Systems Diagnostic Monitoring Report	3/26/2014
2.6	Key Deliverable 8 – Systems Test Procedures Plan	1/28/2014
2.7	Key Deliverable 9 – Systems Test Procedures Report	4/9/2014
2.1	Key Deliverable 10 – Repair Report Summary	4/16/2014
2.11	Key Deliverable 11 – Submit Certified Final RCx Report	5/14/2014
2.12	Key Deliverable 12 – Out Briefing	5/14/2014

7.0 Available Documentation

The quality of the RCx project is dependent upon gaining a thorough understanding of building HVAC systems. Existing building studies, sequence of operation documents and drawings help to improve this understanding. It is critical that these documents are collected during the planning and investigation phases. This allows for better system test procedures and diagnostic monitoring plans to be developed.

The following table outlines the information and data requested to date, and the status of receipt for each item.

Table 7-1: Items Requested

Item Requested	Description	Requested?	Status
Systems Operations & Maintenance	O&M Manuals for mechanicall, electrical and controls	Yes	Received
Current Facilities Requirements (CFR) Report	Defines the current operational needs and requirements for a building. Typically includes temp/humidity set points, operating hours, filtration, sound and/or specialty needs, etc.	Yes	Received- CFR criteria were submitted as part of the construction narrative in 2010
Basis of Design Documents	Basis of Design Documents for previous mechanical and electrical construction projects.	Yes	Received
Preventative Maintenance Program	PMP Reports, Emergency Orders and listing of routine PM tasks and schedule	Yes	Preventative maintenance procedures were discussed during the Kickoff Meeting. Additional information will be requested when needed.
Site Specific Health and Safety Requirements	A document that describes Health and Safety Requirements	Yes	Site specific safety requirements were discussed during the Kickoff Meeting. Information will be documented in the Safety Plan.
Mechanical Equipment Schedule	Equipment Data Sheets that include Name Plate information.	Yes	Received - Hard copies of drawings available for original construction and includes mechanical equipment schedules.
Mechanical Drawings	Drawings of each of the buildings that show equipment schedules; equipment room layouts, duct and piping layouts; steam and chilled water piping schematics, riser diagrams. (Ideally a full set of HVAC drawings, including any known changes, such as renovation drawings and updated as-builts.)	Yes	Received

Table 7-1: Items Requested (continued)

Item Requested	Description	Requested?	Status
Previous Studies and/or Evaluations Performed	Any energy studies, commissioning reports, TAB Reports or similar reports	Yes	Received TAB and commissioning report from original construction.
Utility Bills	Electric, water and sewer bills.	Yes	Received - Building utility information for electric and heating water was provided.
Electric Demand Data	15 or 30 minute electrical interval demand data.	Yes	Electrical demand data is not available
Control System Drawings	Schematics of the control systems with the various controller layouts and design sequences (including any known deviations or updates, if available.)	Yes	Received
Control System Hardware As-Built Data	Submittal data for control components, software versions, etc.	Yes	None Available
Control System Points List	Preferably exported from the control system to assure points are actually on the system.	Yes	Points list is available on the Allerton system. These will be obtained during the Investigation Phase Site Visit.
Sequences of Operation	Written sequences of operation (and any deviations from these written sequences); taken from design drawings, documented in other formats, and/or exported from the control system.	Yes	Received
System Interface and Capabilities Data	Data for system trending capabilities.	Yes	Received

8.0 Planning Phase Activities

The objectives of the Planning Phase are to develop/confirm the needs and requirements for the building, to collect building and equipment information and to develop an RCx Plan for each building. The following section describes the tasks that are included under Key Deliverable 1 – Retro-Commissioning Plan and Key Deliverable 2 – Scoping Meeting and Issue Minutes.

- DAV Energy conducted a kickoff meeting with the COTR and relevant VA personnel on November 20, 2013 at the Alaska VA Hospital. The project scope, planning site visit objectives, safety procedures and general building information was discussed.
- DAV Energy staff will use temporary day visiting passes for contractors as they work in the building.
- Available building documentation, utility data, TAB, previous trend data and commissioning reports were reviewed and collected.
- A walkthrough of the building was conducted and general building information such as space use, operational hours, permissions required, security, and any safety requirements were gathered. The Alerton Control system for the building was evaluated to gain an understanding of the current control points, control sequences, and data trending capability.
- Interviews were conducted with key building facility operations staff to gain an understanding of current needs and issues related to the HVAC systems.
- As previous trend data is already available, point-to-point testing was conducted on select HVAC equipment and a few portable data loggers were placed on equipment where facility staff mentioned issues.
- An out-briefing meeting was held with key facility staff to review the work done during the site visit.

9.0 Investigation Scope and Methods

The Investigation Phase will focus on evaluating the current condition and operation of the existing mechanical equipment and generating recommendations for optimizing systems to meet the needs of facility occupants.

The general approach includes the following steps:

- Evaluate existing control sequences, drawings and other available documentation. Submit Facility Information Documents and Diagnostic Monitoring Plan.
- Perform diagnostic monitoring utilizing the building automation controls or portable data logging. Analyze trend data to verify historical system operation. Submit Diagnostic Monitoring Report.
- Perform diagnostic testing and specialty monitoring in select areas to evaluate system performance and identify deficiencies. Submit Diagnostic Testing Report.
- Implement simple repairs (30 minutes or less and $60 or less in materials) to optimize system performance, possibly including the calibration of sensors, correction of minor programming issues and repair of other mechanical issues. Submit Simple Repairs Report.
- Identify options and cost estimates for energy savings throughout the healthcare facility including both low cost and capital improvement measures. Report the findings.
- Submit Final RCx Report.

The following sections provide more detailed information on the major milestones in the Investigation Phase.

9.1 FACILITY INFORMATION DOCUMENTS & INTERVIEWS

DAV Energy will compile and prepare facility documents to assist in understanding the facility requirements and mechanical system operation. The RCx team will conduct the following tasks under Key Deliverable 3 – Facility Information Documents (Site Condition Assessment, Facility Information Documents, & Equipment Inventory) and Key Deliverable 4 – Building Occupant Interviews and Goals:

- Control sequences of operation, point lists, schematics and zoning plans for major mechanical equipment will be compiled and reviewed. Sequences of operation available in documentation and on the BAS will

be reviewed and compiled in one document prior to testing. The system testing report will include both deficiencies and control sequence improvement opportunities. A final sequence of control document will be prepared for the building summarizing the ideal sequences as part of the System Testing Report. Where needed, plant and AHU schematics will be created for typical equipment. This may include hydronic central plant schematics and AHU schematics for typical AHUs showing flow paths. Screen shots from BAS may be used for these schematics. General AHU zoning maps will be created for major equipment based on drawings and interviews where needed.

- A mechanical equipment inventory will be compiled for ongoing use by the building and as the basis for calculating the energy benefits of potential improvements. It will list key information available from nameplates and drawings for major HVAC equipment. The Equipment Inventory will be provided as a separate MS Excel formatted document and include the following information:
    - Location, such as building, floor, wing, room number and description, room type and area reference (where room number is not available)
    - Area served
    - Manufacturer and model number
    - Serial number
    - Energy input ratings (volts, amps, phases, kW, and/or Btu/hour)
    - Output capacity ratings (HP, cooling tons, heating MBH, CFM/static pressure, GPM/head, etc.)
    - Coil ratings (where present and available)
    - Rated efficiency
    - Date of manufacture and/or installation
- A site condition assessment will be performed based on the existing CFR document. Any drawings, TAB reports, previous studies that are available will be reviewed, facility staff will be interviewed, and the facilities will be walked to identify changes from the original design criteria such as occupancy and space utilization. Assessments will be focused on system level changes, not room by room discrepancies. If it is clear that there is a new space use and systems that were not changed, DAV Energy will document this finding.
- DAV Energy will conduct in person interviews with key facilities operation staff to understand the current needs and issues related to system operations and maintenance, known design and space deficiencies, facility staff training and occupant education needs, indoor air and

environmental quality, and occupant comfort/satisfaction. Interview forms and responses will be summarized and submitted to the VA. A sample interview form is included in Appendix C.

9.2 FACILITY PERFORMANCE ANALYSIS, PERFORMANCE BASELINE & UPDATED CFR

DAV Energy will collect and analyze available building level utility meter data to establish baseline benchmarks for facility performance. The DAV Energy team will conduct the following tasks under Key Deliverable 5 – Facility Performance Analysis and Performance Baseline.

- The building utility use will be evaluated and estimates will be used to determine the percentage of the total that is included in the systems evaluated with this project. Utility data and building level meter data available will be analyzed. This may include hydronic Btuh meter data or any BAS sub-meter data. The data will be used to determine annual energy use and the building will be benchmarked against other facilities using tools such as Energy Star or Commercial Buildings Energy Consumption Survey (CBECS). A table of annual building level energy use and kBtu/sq-ft will be presented.
- Building level energy use will be disaggregated by end use category for typical building types. Categories may include fans, cooling, heating, lighting, kitchen/process, pumps, plug loads, etc. This will primarily be conducted from CBECS and engineering estimates with additional input from surveys. Collected nameplate and equipment information may be used where available.
- The requirements in the CFR will guide the RCx effort. The existing CFR document will be updated based on the Site Condition Assessment under Key Deliverable 3 where it is clear that there is a new space use and mechanical systems were not changed. Additional facility requirements identified during the subsequent work will be updated as necessary, and the final CFR will be submitted with the Final RCx Report.
- It is still to be determined what modeling will be necessary. Most likely, if an energy savings measure involves an HVAC weather related analysis, typically a model based on historical TMY3 weather data would be used, and in turn it would utilize any and all available trend data.

9.3 SYSTEM DIAGNOSTIC MONITORING

DAV Energy will develop a diagnostic monitoring plan, perform monitoring activities and analyze data to conduct comprehensive system diagnostic monitoring. The intent is to identify issues, confirm compliance with CFR, identify improvement opportunities and highlight problems that may require more rigorous and focused investigation. The team will conduct the following tasks under Key Deliverable 6 – Systems Diagnostic Monitoring Plan and Key Deliverable 7 – Systems Diagnostic Monitoring Report:

- A diagnostic monitoring plan will be developed and submitted for approval. The Plan will be based on information collected from building plans, control system documentation, and staff interviews. The plan will list the central plant equipment, air handlers, and terminal devices that will be trended. Smaller equipment and terminal devices will have a representative sample trended or logged. Monitoring will be prioritized for larger systems or those systems and equipment with known operational problems. A sample monitoring plan can be found in Appendix A.
- Trending of system operations will be conducted for two weeks for the equipment identified in the plan. The existing BAS will be utilized to the extent feasible. Where BAS trends are not available, portable data logging will be used to obtain operating data from a representative sample of systems and equipment. In order to identify and account for interactions between variables, logging of each system shall be as comprehensive as possible, giving priority to comprehensive logging of a smaller sample of systems over partial logging of a larger sample of systems. Spot measurements may supplement, or in some cases, be carried out in place of trending or logging. For example, for constant load devices identified by facilities staff as operating continuously, a spot measurement of power consumption or flow may be all that is required to verify operating parameters and quantify energy use. Variables measured with spot measurements may include power, current, temperature, airflow, liquid flow, humidity, or pressure. If it is determined that any motors are oversized, spot measurements will typically be taken for these as well.
- The collected trend data will be analyzed using spreadsheet tools to evaluate system operation and identify potential issues or energy savings opportunities. Trend data will be utilized to determine correlations between various occupancies, outdoor conditions and equipment performance. The analysis and a summary of findings will be presented in the System Monitoring Report.

9.4 SYSTEM TESTING

DAV Energy will prepare system test procedures, conduct system functional testing, and complete system point to point testing. The intent is to evaluate system performance, including equipment condition, current operating conditions, sequence of operations, and deferred maintenance issues. The RCx team will conduct the following tasks under Key Deliverable 8 – Systems Test Procedures Plan and Key Deliverable 9 – Systems Test Procedures Report:

- The System Test Procedure Plan will be developed and submitted for approval. Test procedures will be developed based on documented and ideal sequences of operation, manufacturer data and O&M instructions, and established testing procedures from the Commissioning industry and VA guidance documents. Diagnostic testing will include all major AHUs, pumps and all zone level equipment on the BAS. Major equipment includes chillers, boilers, fans, pumps, and air handling units with supply fans 5HP or greater. Small locally controlled equipment, zone level terminal units, exhaust fans and small AHUs will be tested with a selective sampling and limited testing procedures. Sample Diagnostic Testing Forms are included in Appendix A.
- Diagnostic testing will be conducted to test equipment operation versus the ideal sequence of control. This will include steps to verify the full sequence of operation for the equipment including scheduling, outside air control, economizer operation, control interlocks, space temperature and humidity control, heating and cooling modes, fan control, etc.
- Point to point testing will be conducted to verify the calibration of equipment primary sensors. Sensors will be calibrated during this process or during the 30-minute repairs. Damper linkages and control valves will be inspected and operated through their full range to verify smooth operation. A deficiency log will be created to track the deficiencies found during diagnostic testing.
- DAV Energy will install several portable CO2 monitors, relative humidity and differential air pressure monitors at select air handling units and/or in areas with indoor air quality concerns. The monitoring data will be assessed against ventilation standards to verify that air quality is being maintained. Post monitoring will be provided in locations where outside air adjustments were made with low cost repairs.
- In areas with known air quality issues, select airflow and water flow measurements will be performed as necessary. DAV Energy will engage an independent TAB firm. All TAB work shall adhere to the following:

    - Follow the current industry standards and procedures when performing the TAB work.
    - Communicate on a regular basis, through proper channels, items relating to design, installation, or function that prevent the TAB Firm from achieving completion of the TAB work in accordance with the current edition of the NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems or other as approved by CO.
    - Perform the specified commissioning support requirements, in conformance with the approved System Test Procedure Plan.
    - Measurements taken will be summarized in a report and where changes are made, a TAB Report of final conditions will be submitted.
- Operations and maintenance procedures will be reviewed and recommendations to enhance current procedures will be presented in the Systems Test Procedures Report.
- The Systems Test Procedures Report will include a summary of key findings and deficiencies, issues and recommended improvements.

9.5 SIMPLE REPAIRS

DAV Energy will provide simple repairs and set-point adjustments as required to correct identified issues and achieve project goals. The following tasks will be conducted under Key Deliverable 10 – Repair Report Summary:

- The objective of these simple repairs is to improve the operation of the facility by eliminating issues that can be repaired quickly. Simple repairs are improvements requiring less than 30 minutes to complete with a material/equipment COTS catalogue cost of less than $60. Post monitoring will be conducted where simple repairs have been executed and pre-monitoring was done to confirm proper equipment operation. Simple repairs and set-point adjustments may include the following:
    - Calibrating temperature sensors
    - Lubrication of damper linkages
    - Tightening of set screws on damper actuators
    - Loosening of stuck dampers
    - Correction of minor programming issues
    - Re-Connection of actuators to dampers
    - Re-Connection of pneumatic control tubing to actuators

    - Restoration of automatic control to devices that have been deemed functional based on results of point to point and functional testing
    - Adjustment of set-points or schedules
    - Clearing alarms and resetting tripped devices
    - Removing blockages from dampers or ductwork
    - Adjusting v-belt pulleys
    - Adding or adjusting filters to provide full coverage of airstream
    - Adjusting throttled valves or balancing valves that are out of adjustment
    - Calibration of sensors and pneumatic controllers
    - Adjustment of minimum flow settings
- A Repair Report Summary will document simple repairs performed, the locations of the repairs, the dates and times, the reasons for the repairs and persons performing and authorizing the repairs and repairs not completed. The report will present savings achieved and will provide priorities for a list of larger corrective actions needed.
- Energy savings and cost estimates will be prepared for both repairs completed and future recommended action items (future repairs not completed and energy conservation measures (ECMs)). Utility rebates will be incorporated where possible. Energy savings calculations will be based on spreadsheet calculations using engineering estimates. Savings and costs will be grouped by repair and ECM type (such as damper repairs, VFD installation, programming changes, etc.); savings will not be prepared for every recommendation at the equipment level.

9.6 FINAL RETRO-COMMISSIONING REPORT

All deliverables in Tasks 1 & 2 (planning and site investigation) shall be included in the final RCx report, as follows:

- RCx Process and Plan
- Site Condition Assessment and Facility information Documents
- Equipment Inventory
- Utility Evaluation and Benchmarking
- Diagnostic Monitoring Plan and Analysis Report
- Diagnostic Testing Plan and Testing Report
- Simple Repairs Report with TAB and CO2 monitoring
- Findings and Recommendations with Energy Savings and Costs

A draft RCx report will be submitted for discussion purposes and a teleconference meeting will be scheduled to discuss the content of the RCx Report, to record changes and editions if any, and to finalize the report content, previous to publishing and submitting the final RCx report.

10.0 Out-Briefing and Implementation

The Out-Briefing process is specifically designed to provide VA staff with an opportunity to discuss the project with the RCx Team responsible for completion of the project. The Out-Briefing process can be held by teleconference for individual RCx Team members unable to attend in person. During the Out Briefing the major RCx Investigation discoveries, improvement measures and recommendations will be discussed. The objective of this briefing is to answer questions and provide further explanations concerning elements of the project that remain unclear to VA staff after review of the project final report.

The implementation of facility improvement measures that are recommended as a result of this RCx project, and implementation planning, are excluded from the scope of work. However, it is the intent to provide sufficient information concerning implementation options during the Out-Briefing process in order to support the site's desire to effectively act upon the recommendations outlined in the RCx final report. Typically an RCx Investigation will yield a variety of recommendations. These will generally include:

- Energy Efficiency improvement measures
- Equipment Performance improvement measures
- Operational and Maintenance improvement measures
- Equipment Repair and/or change-out opportunities

During the Out-Briefing process, DAV Energy will discuss the results of the RCx Investigation, providing explanations and guidance pertaining to implementation of facility improvement measures. This discussion is meant to examine the important components that an RCx Implementation Plan should include, and to provide guidance to the facility in choosing cost effective measures that are consistent with available funding. An effective RCx Implementation Plan includes specific considerations for Facility Improvement Measure persistence, and should include:

- A plan for operational sustainability and ongoing commissioning developed as a result of the commissioning process to support the goal of continuously improving facility performance
- Benchmarking the building energy use to compare to similar buildings and to the original building prior to implementing the RCx process
- Tracking of energy use to monitor changes on an ongoing basis. Utility tracking records a building's energy use over time and helps operating personnel understand the building's consumption patterns

- Establishing specific energy type (i.e. electricity, natural gas, etc.) and system level performance targets to help improve energy performance on a continuous basis.
- Monitoring and tracking non-energy building performance metrics such as comfort calls, occupant satisfaction, indoor air quality parameters, etc. to assess building performance as compared to pre-established benchmarks
- Trending key system parameters in the BAS to detect problems early and assess system performance. Trending is an important tool to ensure that the implemented facility improvement measures continue to perform according to improvements
- Utilizing an operator's log to keep a record of significant events such as equipment replacement, maintenance or testing, and problems and their resolution - If possible, the log should be kept electronically within a Computerized Maintenance Management System to allow for easy access.
- A personnel training plan that promotes skill improvements capable of improving maintenance outcomes, equipment performance and energy efficiency
- An evaluation of sub-contractor agreements to ensure tasking activities are consistent with the intent of the facility's measure sustainability and ongoing commissioning plans
- A plan for completing RCx for the facility on a regular schedule (3 to 5 years is a frequently cited time frame), or when building performance degrades, or when building occupancy or usage changes significantly

The value of the RCx process can only be fully realized through the implementation of the measures recommended as a result of the RCx Investigation and the ongoing management of persistence activities associated with those implemented measures. Approaching the RCx implementation and management in a professionally planned, systematic and coordinated fashion will help to ensure that the Department of Veterans Affairs receives the full benefit from its investment in its RCx program.

11.0 Appendix A: System Monitoring Plan

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: _____

Prepared By: _____ *Date:* _____

Notes: _____

AHU Name: _____

Instructions: Columns b. and c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.
#	**Data Point Common Name**	**Data Point DDC Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed		%	15 min		
2	RF VFD Speed		%	15 min		
3	OAD Position		%	15 min		
4	RAD Position		%	15 min		
5	Hum. Vlv. Pos.		%	15 min		
6	Hum. Set-Pt.		%	15 min		
7	OSA Temp.		°F	15 min		Calibrate main OSA-T Sensor
8	Ret Air Temp.		°F	15 min		
9	Mixed Air. Temp.		°F	15 min		
10	MAT Set-Pt.		°F	15 min		
11	Supply Air Temp.		°F	15 min		
12	SAT Set-Pt.		°F	15 min		
13	Supply Air Vel.		FPM	15 min		
14	Pre-Heat GHST		°F	15 min		
15	Pre-Heat GHRT		°F	15 min		
16	Pre-Heat Vlv. Pos.		%	15 min		
17	Heating GHST		°F	15 min		
18	Heating GHRT		°F	15 min		
19	Heating Vlv. Pos.		%	15 min		
20	Cooling CHGST		°F	15 min		
21	Cooling CHGRT		°F	15 min		
22	Cooling Vlv. Pos.		%	15 min		

System Monitoring Plan (100% OSA AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: _____

Prepared By: _____ *Date:* _____

Notes: _____

AHU Name: _____

Instructions: Columns b. and c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.
#	Data Point Common Name	Data Point DDC Name	Units	Sampling Frequency	Trend Start Date	Notes
1	SF VFD Speed		%	15 min		
2	EF VFD Speed		%	15 min		
3	OAD Position		%	15 min		
4	Hum. Vlv. Pos.		%	15 min		
5	Hum. Set-Pt.		%	15 min		
6	OSA Temp.		°F	15 min		Calibrate main OSA-T Sensor
7	Supply Air Temp.		°F	15 min		
8	SAT Set-Pt.		°F	15 min		
9	Supply Air Vel.		FPM	15 min		
10	Pre-Heat GHST		°F	15 min		
11	Pre-Heat GHRT		°F	15 min		
12	Pre-Heat Vlv. Pos.		%	15 min		
13	Heating GHST		°F	15 min		
14	Heating GHRT		°F	15 min		
15	Heating Vlv. Pos.		%	15 min		
16	Cooling CHGST		°F	15 min		
17	Cooling CHGRT		°F	15 min		
18	Cooling Vlv. Pos.		%	15 min		
19	DX Coil Status		on/off	15 min		
20						
21						
22						

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 1

Prepared By: *Date:*

Notes:

Central Plant Equipment

Instructions: Columns b. thru d. describe an existing DDC data point. Columns e. and f. give the units and sample frequency. Column g. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.	h.
#	Data Point Common Name	Equipment Tag #	Data Point DDC Name	Units	Sampling Frequency	Trend Start Date	Notes
1	Heated Glycol Pump 1A (VFD Spd)	P-1A		%	15 min		Clinic Primary Heating Loop
2	Heated Glycol Pump 1B (VFD Spd)	P-1B		%	15 min		Clinic Primary Heating Loop
3	Heated Glycol Pump 2A (VFD Spd)	P-2A		%	15 min		AHU-1, 2 & 7 Heating Coils
4	Heated Glycol Pump 2B (VFD Spd)	P-2B		%	15 min		AHU-1, 2 & 7 Heating Coils
5	Heated Glycol Pump 3A (VFD Spd)	P-3A		%	15 min		AHU-1, 2 & 7 Re-Heat & Perim Heat
6	Heated Glycol Pump 3B (VFD Spd)	P-3B		%	15 min		AHU-1, 2 & 7 Re-Heat & Perim Heat
7	Heated Glycol Pump 4A (VFD Spd)	P-4A		%	15 min		AHU-3, 4 & 8 Re-Heat & Perim Heat
8	Heated Glycol Pump 4B (VFD Spd)	P-4B		%	15 min		AHU-3, 4 & 8 Re-Heat & Perim Heat
9	Heated Glycol Pump 5A (VFD Spd)	P-5A		%	15 min		AHU-3, & 8 Heating Coils
10	Heated Glycol Pump 5B (VFD Spd)	P-5B		%	15 min		AHU-3, & 8 Heating Coils
11	Heated Glycol Pump 6A (VFD Spd)	P-6A		%	15 min		AHU-5, & 9 Heating Coils
12	Heated Glycol Pump 6B (VFD Spd)	P-6B		%	15 min		AHU-5, & 9 Heating Coils
13	Heated Glycol Pump 7A (VFD Spd)	P-7A		%	15 min		AHU-4, 5 & 9 Re-Heat & Perim Heat
14	Heated Glycol Pump 7B (VFD Spd)	P-7B		%	15 min		AHU-4, 5 & 9 Re-Heat & Perim Heat
15	Heated Glycol Pump 8A (VFD Spd)	P-8A		%	15 min		AHU-4, & 6 Heating Coils
16	Heated Glycol Pump 8B (VFD Spd)	P-8B		%	15 min		AHU-4, & 6 Heating Coils
17	Heated Glycol Pump 9A (Status)	P-9A		on/off	15 min		Radient Floor Tertiary Loop
18	Heated Glycol Pump 9B (Status)	P-9B		on/off	15 min		Radient Floor Tertiary Loop
19	Heated Glycol Pump 10A (VFD Spd)	P-10A		%	15 min		AHU-11 Heat, Re-Heat & Perim Heat
20	Heated Glycol Pump 10B (VFD Spd)	P-10B		%	15 min		AHU-11 Heat, Re-Heat & Perim Heat
21	Heated Glycol Pump 11A (Status)	P-11A		on/off	15 min		Entrance Snowmelt Tertiary Loop
22	Heated Glycol Pump 11B (Status)	P-11B		on/off	15 min		Entrance Snowmelt Tertiary Loop

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 2

Prepared By: *Date:*

Notes:

Central Plant Equipment

Instructions: Columns b. thru d. describe an existing DDC data point. Columns e. and f. give the units and sample frequency. Column g. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.	h.
#	Data Point Common Name	Equipment Tag #	Data Point DDC Name	Units	Sampling Frequency	Trend Start Date	Notes
23	Heated Glycol Pump 12A (Status)	P-12A		on/off	15 min		Patio Snowmelt Tertiary Loop
24	Heated Glycol Pump 12B (Status)	P-12B		on/off	15 min		Patio Snowmelt Tertiary Loop
25	Chilled Glycol Pump 13A (VFD Spd)	P-13A		%	15 min		Primary Cooling Loop
26	Chilled Glycol Pump 13B (VFD Spd)	P-13B		%	15 min		Primary Cooling Loop
27	Heated Glycol Pump 14A (VFD Spd)	P-14A		%	15 min		Central Plant Pri Ht Loop
28	Heated Glycol Pump 14B (VFD Spd)	P-14B		%	15 min		Central Plant Pri Ht Loop
29	Chilled Glycol Pump 15A (VFD Spd)	P-15A		%	15 min		Charge Air Cooler Loop
30	Chilled Glycol Pump 15B (VFD Spd)	P-15B		%	15 min		Charge Air Cooler Loop
31	Air Compressor #1 (Status)	AC-1		on/off	15 min		
32	Air Compressor #2 (Status)	AC-2		on/off	15 min		
33	Air Compressor #3 (Status)	AC-3		on/off	15 min		
34	Air Compressor #3 (PSI Actual)	AC-3		psi	15 min		
35	Air Compressor #3 (PSI Set-Pt.)	AC-3		psi	15 min		
36	Air Compressor #3 (Amps)	AC-3		Amps	15 min		
37	Compressed Air Tank/System (PSI)	AT-1		psi	15 min		
38	Well Water Temperature (EWT)	WW		°F	15 min		
39	Well Water Temperature (LWT)	WW		°F	15 min		
40	Heating Heat Exchanger 1A (Vlv. Pos.)	HX-1A		%	15 min		
41	Heating Heat Exchanger 1A Pri EGT	HX-1A		°F	15 min		
42	Heating Heat Exchanger 1A Pri LGT	HX-1A		°F	15 min		
43	Heating Heat Exchanger 1A Sec EGT	HX-1A		°F	15 min		
44	Heating Heat Exchanger 1A Sec LGT	HX-1A		°F	15 min		

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 3

Prepared By: *Date:*

Notes:

Central Plant Equipment

Instructions: Columns b. thru d. describe an existing DDC data point. Columns e. and f. give the units and sample frequency. Column g. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.	h.
#	Data Point Common Name	Equipment Tag #	Data Point DDC Name	Units	Sampling Frequency	Trend Start Date	Notes
45	Heating Heat Exchanger 1B (Vlv. Pos.)	HX-1B		%	15 min		
46	Heating Heat Exchanger 1B Pri EGT	HX-1B		°F	15 min		
47	Heating Heat Exchanger 1B Pri LGT	HX-1B		°F	15 min		
48	Heating Heat Exchanger 1B Sec EGT	HX-1B		°F	15 min		
49	Heating Heat Exchanger 1B Sec LGT	HX-1B		°F	15 min		
50	Cooling Heat Exchanger 2A (Vlv. Pos.)	HX-2A		%	15 min		
51	Cooling Heat Exchanger 2A Pri EGT	HX-2A		°F	15 min		
52	Cooling Heat Exchanger 2A Pri LGT	HX-2A		°F	15 min		
53	Cooling Heat Exchanger 2A Sec EGT	HX-2A		°F	15 min		
54	Cooling Heat Exchanger 2A Sec LGT	HX-2A		°F	15 min		
55	Cooling Heat Exchanger 2B (Vlv. Pos.)	HX-2B		%	15 min		
56	Cooling Heat Exchanger 2B Pri EGT	HX-2B		°F	15 min		
57	Cooling Heat Exchanger 2B Pri LGT	HX-2B		°F	15 min		
58	Cooling Heat Exchanger 2B Sec EGT	HX-2B		°F	15 min		
59	Cooling Heat Exchanger 2B Sec LGT	HX-2B		°F	15 min		
60	Snow Melt Heat Exchanger 3 (Vlv. Pos.)	HX-1B		YF	15 min		
61	Snow Melt Heat Exchanger 3 Pri EGT	HX-1B		YF	15 min		
62	Snow Melt Heat Exchanger 3 Pri LGT	HX-1B		%	15 min		
63	Snow Melt Heat Exchanger 3 Sec EGT	HX-1B		°F	15 min		
64	Snow Melt Heat Exchanger 3 Sec LGT	HX-1B		°F	15 min		
65	Condensing Unit (Amps)	CU-1		amps	15 min		
66	Outside Air Temperature Sensor	OSA-T		°F	15 min		

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number:

Prepared By: *Date:*

Notes: Complete for 5% of zones, to include a representative sample of all zone types, and each AHU. Including: OR, Offices/Administrative, IT, Lab, Clinic, Pharmacy, etc.

Space Temperature Trending

Instructions: Column b. and c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.
#	**Data Point Common Name**	**Data Point DDC Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Zone C-123 Set-Pt.		°F	15 min		
2	Zone C-123 Space Temp		°F	15 min		
3	Zone C-123 Set-Pt.		°F	15 min		
4	Zone C-123 Space Temp		°F	15 min		
5	Zone C-123 Set-Pt.		°F	15 min		
6	Zone C-123 Space Temp		%	15 min		
7	Zone C-123 Set-Pt.		°F	15 min		
8	Zone C-123 Space Temp		°F	15 min		
9	Zone C-123 Set-Pt.		°F	15 min		
10	Zone C-123 Space Temp		°F	15 min		
11	Zone C-123 Set-Pt.		%	15 min		
12	Zone C-123 Space Temp		°F	15 min		
13	Zone C-123 Set-Pt.		°F	15 min		
14	Zone C-123 Space Temp		°F	15 min		
15	Zone C-123 Set-Pt.		°F	15 min		
16	Zone C-123 Space Temp		°F	15 min		
17	Zone C-123 Set-Pt.		°F	15 min		
18	Zone C-123 Space Temp		%	15 min		
19	Zone C-123 Set-Pt.		°F	15 min		
20	Zone C-123 Space Temp		°F	15 min		
21	Zone C-123 Set-Pt.		°F	15 min		
22	Zone C-123 Space Temp		°F	15 min		
23	Zone C-123 Set-Pt.		°F	15 min		
24	Zone C-123 Space Temp		°F	15 min		
25	Zone C-123 Set-Pt.		°F	15 min		
26	Zone C-123 Space Temp		°F	15 min		
27	Zone C-123 Set-Pt.		°F	15 min		
28	Zone C-123 Space Temp		°F	15 min		
29	Zone C-123 Set-Pt.		°F	15 min		
30	Zone C-123 Space Temp		°F	15 min		
31	Zone C-123 Set-Pt.		°F	15 min		
32	Zone C-123 Space Temp		°F	15 min		

12.0 Appendix B: Testing Plan Forms

System Point-to-Point Testing Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number:

Prepared By: *Date:*

Notes:

AHU Name:

#	Data Point Common Name	Data Point DDC Name	Input Command	DDC Observation	Output Observation	Pass / Fail	Initials	Notes
1	SF VFD Speed Min							
2	SF VFD Speed Max							
3	SF VFD Speed Auto							
4	RF VFD Speed Min							
5	RF VFD Speed Max							
6	RF VFD Speed Auto							
7	OAD Position Min							
8	OAD Position Max							
9	OAD Position Auto							
10	RAD Position Min							
11	RAD Position Max							
12	RAD Position Auto							
13	Humidity Cmd Full							
14	Humidity Cmd OFF							
15	Humidity Cmd Auto							
16	Pre-Heat Vlv. Pos. Min							
17	Pre-Heat Vlv. Pos. Max							
18	Pre-Heat Vlv. Pos. Auto							
19	Heat Vlv. Pos. Min							
20	Heat Vlv. Pos. Max							
21	Heat Vlv. Pos. Auto							
22	Cool Vlv. Pos. Min							
23	Cool Vlv. Pos. Max							
24	Cool Vlv. Pos. Auto							
25	Heating Glycol Sup Temp							
26	Heating Glycol Ret Temp							
27	Cooling Glycol Sup Temp							
28	Cooling Glycol Ret Temp							
29	Return Air Temp							
30	Mixed Air Temp							
31	Supply Air Temp							
32	Supply Air Set-Pt							
33								
34								
35								

System Functional Testing Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number:

Prepared By: Date:

Notes:

AHU Name:

OCCUPIED HEATING MODE

a.	b	d.	f	g.	h	i
#	Test Description	DDC Observation	Output Observation	Pass / Fail	Initials	Notes
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
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System Point-to-Point Testing Plan (100% OSA AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number:

Prepared By: *Date:*

Notes:

AHU Name:

a	b	c	d	e	f	g	h	i
#	Data Point Common Name	Data Point DDC Name	Input Command	DDC Observation	Output Observation	Pass / Fail	Initials	Notes
1	SF VFD Speed Min							
2	SF VFD Speed Max							
3	SF VFD Speed Auto							
4	EF VFD Speed Min							
5	EF VFD Speed Max							
6	EF VFD Speed Auto							
7	OAD Position Min							
8	OAD Position Max							
9	OAD Position Auto							
10	Humidity Cmd Full							
11	Humidity Cmd OFF							
12	Humidity Cmd Auto							
13	Pre-Heat Vlv. Pos. Min							
14	Pre-Heat Vlv. Pos. Max							
15	Pre-Heat Vlv. Pos. Auto							
16	Heat Vlv. Pos. Min							
17	Heat Vlv. Pos. Max							
18	Heat Vlv. Pos. Auto							
19	Cool Vlv. Pos. Min							
20	Cool Vlv. Pos. Max							
21	Cool Vlv. Pos. Auto							
22	DX Coil Engage							
23	DX Coil Dis-Engage							
24	Heating Glycol Sup Temp							
25	Heating Glycol Ret Temp							
26	Cooling Glycol Sup Temp							
27	Cooling Glycol Ret Temp							
28	Supply Air Temp							
29	Supply Air Set-Pt							
30								
31								
32								
33								
34								
35								

System Functional Testing Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 1

Prepared By: _____ *Date:* _____

Notes: _____

Central Plant Equipment

CENTRAL PLANT

a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n	o.	p.
#	Data Point Common Name	Equip. Tag #	Data Point DDC Name	Input Command			DDC Observation			Output Observation			Pass / Fail	Initials	Notes
				HI	LOW	Auto	HI	LOW	Auto	HI	LOW	Auto			
1	Heated Glycol Pump 1A (VFD Spd)	P-1A													Clinic Primary Heating Loop
2	Heated Glycol Pump 1B (VFD Spd)	P-1B													Clinic Primary Heating Loop
3	Heated Glycol Pump 2A (VFD Spd)	P-2A													AHU-1, 2 & 7 Heating Coils
4	Heated Glycol Pump 2B (VFD Spd)	P-2B													AHU-1, 2 & 7 Heating Coils
5	Heated Glycol Pump 3A (VFD Spd)	P-3A													AHU-1, 2 & 7 Re-Heat & Perim Heat
6	Heated Glycol Pump 3B (VFD Spd)	P-3B													AHU-1, 2 & 7 Re-Heat & Perim Heat
7	Heated Glycol Pump 4A (VFD Spd)	P-4A													AHU-3, 4 & 8 Re-Heat & Perim Heat
8	Heated Glycol Pump 4B (VFD Spd)	P-4B													AHU-3, 4 & 8 Re-Heat & Perim Heat
9	Heated Glycol Pump 5A (VFD Spd)	P-5A													AHU-3, & 8 Heating Coils
10	Heated Glycol Pump 5B (VFD Spd)	P-5B													AHU-3, & 8 Heating Coils
11	Heated Glycol Pump 6A (VFD Spd)	P-6A													AHU-5, & 9 Heating Coils
12	Heated Glycol Pump 6B (VFD Spd)	P-6B													AHU-5, & 9 Heating Coils
13	Heated Glycol Pump 7A (VFD Spd)	P-7A													AHU-4, 5 & 9 Re-Heat & Perim Heat
14	Heated Glycol Pump 7B (VFD Spd)	P-7B													AHU-4, 5 & 9 Re-Heat & Perim Heat
15	Heated Glycol Pump 8A (VFD Spd)	P-8A													AHU-4, & 6 Heating Coils
16	Heated Glycol Pump 8B (VFD Spd)	P-8B													AHU-4, & 6 Heating Coils
17	Heated Glycol Pump 9A (Start/Stop)	P-9A													Radient Floor Tertiary Loop
18	Heated Glycol Pump 9B (Start/Stop)	P-9B													Radient Floor Tertiary Loop
19	Heated Glycol Pump 10A (VFD Spd)	P-10A													AHU-11 Heat, Re-Heat & Perim Heat
20	Heated Glycol Pump 10B (VFD Spd)	P-10B													AHU-11 Heat, Re-Heat & Perim Heat
21	Heated Glycol Pump 11A (Status)	P-11A													Entrance Snowmelt Tertiary Loop
22	Heated Glycol Pump 11B (Status)	P-11B													Entrance Snowmelt Tertiary Loop

System Functional Testing Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 2

Prepared By: _____ *Date:* _____

Notes: _____

Central Plant Equipment

CENTRAL PLANT

a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n	o.	p.
#	Data Point Common Name	Equip. Tag #	Data Point DDC Name	Input Command			DDC Observation			Output Observation			Pass / Fail	Initials	Notes
				HI	LOW	Auto	HI	LOW	Auto	HI	LOW	Auto			
23	Heated Glycol Pump 12A (Start/Stop)	P-12A													Ratio Snowmelt Tertiary Loop
24	Heated Glycol Pump 12B (Start/Stop)	P-12B													Ratio Snowmelt Tertiary Loop
25	Chilled Glycol Pump 13A (VFD Spd)	P-13A													Primary Cooling Loop
26	Chilled Glycol Pump 13B (VFD Spd)	P-13B													Primary Cooling Loop
27	Heated Glycol Pump 14A (VFD Spd)	P-14A													Central Plant Prim Loop
28	Heated Glycol Pump 14B (VFD Spd)	P-14B													Central Plant Prim Loop
29	Chilled Glycol Pump 15A (VFD Spd)	P-15A													Charge Air Cooler Loop
30	Chilled Glycol Pump 15B (VFD Spd)	P-15B													Charge Air Cooler Loop
31	Air Compressor #1 (Start/Stop)	AC-1													
32	Air Compressor #2 (Start/Stop)	AC-2													
33	Air Compressor #3 (Start/Stop)	AC-3													
34	Heating Heat Exchanger 1A (Viv. Pos.)	HX-1A													
35	Heating Heat Exchanger 1B (Viv. Pos.)	HX-1B													
36	Cooling Heat Exchanger 2A (Viv. Pos.)	HX-2A													
37	Cooling Heat Exchanger 2B (Viv. Pos.)	HX-2B													
38	Snow Melt Heat Exchanger 3 (Viv. Pos.)	HX-1B													
39	Condensing Unit (Start/Stop)	CU-1													
40															
41															
42															
43															
44															

System Point-to-Point Testing Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 3

Prepared By: *Date:*

Notes:

Central Plant Equipment

CENTRAL PLANT

a.	b.	c.	e.	f.	g.	h.	
#	Data Point Common Name	Data Point DDC Name	DDC Observation	Output Observation	Pass / Fail	Initials	Notes
1	Air Compressor #3 (PSI Actual)						
2	Air Compressor #3 (PSI Set-Pt.)						
3	Compressed Air Tank/System (PSI)						
4	Well Water Temperature (EWT)						
5	Well Water Temperature (LWT)						
6	Heating Heat Exchanger 1A Pri EGT						
7	Heating Heat Exchanger 1A Pri LGT						
8	Heating Heat Exchanger 1A Sec EGT						
9	Heating Heat Exchanger 1A Sec LGT						
10	Heating Heat Exchanger 1B Pri EGT						
11	Heating Heat Exchanger 1B Pri LGT						
12	Heating Heat Exchanger 1B Sec EGT						
13	Heating Heat Exchanger 1B Sec LGT						
14	Cooling Heat Exchanger 2A Pri EGT						
15	Cooling Heat Exchanger 2A Pri LGT						
16	Cooling Heat Exchanger 2A Sec EGT						
17	Cooling Heat Exchanger 2A Sec LGT						
18	Cooling Heat Exchanger 2B Pri EGT						
19	Cooling Heat Exchanger 2B Pri LGT						
20	Cooling Heat Exchanger 2B Sec EGT						
21	Cooling Heat Exchanger 2B Sec LGT						
22	Snow Melt Heat Exchanger 3 Pri EGT						
23	Snow Melt Heat Exchanger 3 Pri LGT						
24	Snow Melt Heat Exchanger 3 Sec EGT						
25	Snow Melt Heat Exchanger 3 Sec LGT						
26	Outside Air Temperature Sensor						
27							
28							
29							
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System Point-to-Point Testing Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number:

Prepared By: *Date:*

Notes: Complete for 5% of zones, to include a representative sample of all zone types, and each AHU. Including: OR, Offices/Administrative, IT, Lab, Clinic, Pharmacy, etc.

Terminal Air Equipment

a	b	c	d	e	g	f	
#	Data Point Common Name	Data Point DDC Name	DDC Observation	Output Observation	Pass / Fail	Initials	Notes
1	Zone C-123 Space Temp						
2	Zone C-123 Discharge Air Temp						
3	Zone C-124 Space Temp						
4	Zone C-124 Discharge Air Temp						
5	Zone A-255...						
6	etc.						
7							
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13.0 Appendix C: Sample Interview Form

VISN 20 RCx Alaska

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

In order to understand the current needs and issues related to the mechanical systems in the building DAV Energy is conducting interviews with a few building occupants. Please take a moment to answer the questions in the table below and feel free to enlist the opinions of your co-workers. We sincerely appreciate your time and involvement. Please contact Mike Rogers with DAV Energy or XXX with the Anchorage VA for any questions you may have regarding the project. See contact information below.

Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

Project Name: VISN 20 RCx Alaska	**Name of Interviewee** xx
Point of Contact at the VA:	**Interviewee Contact Phone** xx
Survey Date:	**Interviewee Contact E-Mail** xx
Survey By:	**Interviewee Room Number**

Are there conference rooms, computer rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	
Are there rooms in your area that are un occupied? List Room Names	

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	
Are there spaces where fans are used for additional cooling? List Room Names	
Are there spaces where portable unit heaters are used for additional heat? List Room Names	
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	
Are there zones with air quality issues and what are the typical complaints?	
Are there zones with infection control issues? Please, describe the issues in detail.	
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	
What would you describe as your worst building problem and how do you deal with that?	

Other Observations & Comments

OCCUPANT INTERVIEW FORM – MAINTENANCE STAFF

Project Name: xx	**Site Contact Name(s) xx**
Survey By	**Site Contact Phone xx**
Survey Date	**Site Contact E-Mail xx**

Briefly describe the Renovation, Retrofit and Equipment Replacement history for this site:	
Briefly describe site Control Systems – Make, Age, Capabilities:	
Is the Control System capable of providing Trending Data? Is it set up to do so? How much memory is available?	
What control system upgrades would you like to see implemented?	
From which areas in the building do you receive the greatest number of complaints for heating, cooling or other comfort problems?	
Are there zones with air quality issues and what are the typical complaints?	
Are there zones with infection control issues? Please, describe the issues in detail	
What would you describe as your worst building problem and how do you deal with that?	
Briefly describe site HVAC Systems - Equipment Age,	

1

Make, Capacities, and Configuration:	
Has Heating System always met Load? Under what conditions has your heating system not met load? What was the solution to this problem?	
Has Cooling System always met Load? Under what conditions has your cooling system not met load? What was the solution to this problem?	
How are the HVAC systems scheduled?	
What HVAC adjustments do you make to unoccupied areas or spaces (turn off HVAC, adjust thermostat to minimum heating and cooling, close off damper, etc.)?	
Do you feel you have any undersized or oversized HVAC equipment?	
In your opinion, is the building HVAC system well balanced? If no, explain:	
Do you maintain and utilize a Computerized Maintenance Management System? Describe:	

2

What are some recent energy conservation measures that have been implemented? How well do you think they were implemented? Are there any other energy conservation measures that you think should be implemented?	

Other Observations & Comments

Appendix-B

For Final RCx Report

Scoping Meeting Minutes

MEETING AGENDA | VISN20 RCX - ALASKA SCOPING MEETING

MTG. #
SM-1

RETRO-COMMISSIONING
VISN 20: ALASKA
CONTRACT #: VA701-13-Q-0257

03:00PM, TUESDAY JANUARY 7, 2014
Dial In Number: 267.507.0240
Access Code: 198438

	Attendees:					
	Name	Initials	Organization		Phone	email
	Steve Juhasz	SJ	VA		360.567.4689	Steven.juhasz@va.gov
	Steve Mathis	SM	VA			Stephen.matthes@va.gov
X	Mark Blem	MB	VA - Alaska		907.257.5488	Mark.blehm2@va.gov
X	James Sinclair	JS	DAV Energy		619.663.7007	James.sinclair@davenergy.com
X	Agneta Kupilik	AK	DAV Energy			Agneta.Kupilik@davenery.com
X	Mike Rogers	MBR	DAV Energy		760.908.6321	Michael.Rogers@davenergy.com
X	James Bottomley	JB	DAV Energy			James.Bottomley@davenergy.com
	Jason Perez	JP	DAV Energy		770.508.3088	Jason.Perez@davenergy.com
	Darren Ito	DI	DAV Energy		323.547.6475	Darren.ito@davenergy.com

Open Items:

Item	Description	Doc Ref	RESP.	Due Date
1.1	Present RCx Plan Executive Summary a) Report Overview			
1.2	Summarize Project Objectives			
1.3	Brief Discussion of Buildings and Systems a) Building Overview b) Building Automation System			
1.4	Review Retro-Commissioning Process and Scope			
1.5	Review Retro-Commissioning Team Members' Roles and Responsibilities			
1.6	Review Project Schedule – Asked Mark if he could get responses from Deliverable 4: Occupant Interview forms.		MB (VA)	
1.7	Discuss Available Documentation			
1.8	Summarize Planning Phase Activities			
1.9	Present Investigation Scope and Methods a) Facility Information Documents & Interviews b) Facility Performance Analysis, Performance Baseline & Updated CFR c) System Diagnostic Monitoring d) System Testing			

ITEM NUMBERING KEY
2.3
ITEM IDENTIFICATION
MEETING NUMBER

MTG. #
SM-1

RETRO-COMMISSIONING
VISN 20: ALASKA
CONTRACT #: VA701-13-Q-0257

03:00PM, TUESDAY JANUARY 7, 2014

	e) System Simple Repairs f) Final Retro-Commissioning Report			
1.10	Present Out briefing and Implementation			
1.11	Brief Presentation of RCx Plan Appendices			
1.12	General Comments			

New Items:

Item #	Description	Doc Ref	RESP.	Due Date

RECORDED AND SUBMITTED BY:

DARREN ITO
PROJECT MANAGER

DAV ENERGY

ITEM NUMBERING KEY
2.3
ITEM IDENTIFICATION
MEETING NUMBER

Appendix-C

For Final RCx Report

Issues Log, Energy Savings, AHU Zone Plans

&

Sequence of Operations

#	MECH EQUIPMENT NAME	BUILDING AREA	ISSUE DESCRIPTION	COMMENTS	RECOMMENDED CORRECTIVE ACTION
1	ACU-15	Stairs 2, SE Corner A-wing	The stair located in the south east corner of the A-wing gets extremely hot with the solar load. There seems to be no circulation of air, the RA and SA is located next to each other and the RA opening of the fan coil unit is not ducted to the RA plenum	See Tab "Issue 1" for drawings & photos	Install RA plenum duct remaining 6 inches through wall and install a register. On other side of wall is intended RA plenum location, which is under stairs. This will allow cooling system to function more effectively by supplying the air at the top of the stairs and returning it to the FCU at the bottom. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.
2	EF-13		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	SIMPLE REPAIR ITEM	Change units on BAS.
3	AHU-9	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	Issue: Not able to cool space. Installed Coil is 51.7 MBH (per 2008 submittals). Hypotheses: Cooling CHW coil is undersized. & Ductwork not configured properly for new space usage (refrig equipment installed) Observations: CHG temperature is above design temp, Primary Chilled Well Water Flow rate well Below design. Mike Kief (FSI) agrees with this assessment. There are 3 Lab Refrigerators, and 1 Freezer in Lab 1C147. These have been added.	1. Reposition terminal ductwork and registers (or add an additional register) in lab space to better capture warm exhaust air from the refrigeration equipment condensers. 2. Install 4 ton split system cooling unit to serve Lab 1C147.
4	AHU-4	2nd FL	Most comfort complaints are due to the thermostat located in another person's office. Areas where open offices were converted to individual offices are hard to control. Some of them will experience simultaneous heating and cooling as they have baseboard from one system while the air is supplied from different system, being the VAV. Part of the remodel included long runs of flex duct which reduces the airflow.	Mike Kief (FSI) brought this problem to our attention.	Use multiple thermostats and balance using logic to determine if the baseboard should be enabled.

#	MECH EQUIPMENT NAME	BUILDING AREA	ISSUE DESCRIPTION	COMMENTS	RECOMMENDED CORRECTIVE ACTION
5	EF-14		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Mike Kief (FSI) brought this problem to our attention. This VAV box was functionally tested, and works as intended. VAV box probably not designed to absorb the load in this space.	The airflow to the space terminal box should be increased if possible.
6	AHU-10	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature	0	0
7	AHU-8 and 9	0	The water contains a high level of minerals and the AHU chilled water coils get coated with mineral deposits when the humidification is running. The mineral deposits result in an increase in static pressure with a reduction in airflow distributed to the spaces. FSI cleans the coils, and are testing different cleaners, but we are concerned about the longevity of the coils. In addition, when the OSA temperature drops below a threshold, the humidification dispersion units in AHU-8 and 9 freeze up. This results in staff having to remove the dispersion units to let them defrost.	Mike Kief (FSI) brought this problem to our attention. Assessment: TAB contractor to test the coil capacity on the three smallest AHUs (#7, #8, #9) to determine if scale build-up has impacted capacity. If it is then all AHUs should be tested. The RCx team determined that per the plans the Penthouse 3D107 is supposed to have a heated water softening system installed. Potentially to serve the humidification system, although this is not clear from available documentation. HWG-3 as installed is an AO Smith model DEL-30-110 standard 30 gallon electric water heater with a 9kW capacity. Although there is an expansion tank also installed marked "Expansion Tank, Softened Hot Water" the RCx team did not observe any water softening equipment installed.	Install Reverse Osmosis filtration equipment to serve the humidification systems in all penthouses. TAB contactor has determied that coil airflow is reduced in AHU 7, 8, & 9 due to scaling, therefore coils immediately next to the humidifier spray bar should be replaced on an as-needed basis if AHU cannot meet load. This is costly and should only be done as a last resort.
8	EF-15		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Mike Kief (FSI) brought this problem to our attention.	Changing the coil capacity and possibly try to reduce airflow to certain zones if able to in effort to reduce load on the AHU during severe weather conditions. TAB test performed in 2014 under RCx scope confirmed Pre-Heat coil is undersized. Recommend: replace Pre-Heat Coil.

#	MECH EQUIPMENT NAME	BUILDING AREA	ISSUE DESCRIPTION	COMMENTS	RECOMMENDED CORRECTIVE ACTION
9	AHU-11	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	Mike Kief (FSI) brought this problem to our attention.	1.) Run the DX unit for AHU #8 when cooling load exceeds threshold 2.) Remove load from the central plant - this could be done on a permanent basis or on a dispatchable basis to get through a tough high load period. This issue is not going to get better only worse. Recommend to look at removing 24/7 load for IT closets, etc. and put in dedicated small DX units for those spaces and/or look into utilizing OSA for free cooling in the winter. 3.) for those critical cooling spaces look at offsetting load with DX such as was done with AHU #8
10	Compressor	0	Hypothesis: Suspected Air Leaks. 1. Because load was not satisfied by original compressors 1&2 (20hp). VA installed 60hp comp. 2. System was data-logged found that average load was 28.4 kW, which is equivalent to 38.1 bhp. We expect to see 4.26 CFM/hp @ 100 psig. Therefore, we are producing about 160 CFM @ 100 psig, and we only should need about 40 CFM @100 psig per drawings. HP = 0.030*P*(R0.145-1) 3. Therefore substantial air leak or the drawing is completely wrong	Substantial Compressed Air leak is suspected. 1. Look at drawing to see the required capacity 2. What is the Available CFM from the small compressors? 3. What is the load the large compressor is running at (data logger)? 4. Using the rule of thumb of 4 CFM per horsepower or actual CFM capacity you will be able to show based upon the air flow of each humidifier there is a leak	Investigate compressed air system for leaks, stop leaks as found.
11	EF-16		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	CHG temp should be much lower (46F per design documents). This is a 22 degree coil per drawings, however we are being provided 53F glycol. Check with Mike Kief if he has noticed that unit has problems meeting load.	Well water temperature is too high, must reduce CHG temperature. In order to reduce the CHG temperature, the well water flow rate must be increased or the well water temperature must be lowered on the primary side of the heat exchangers.
12	AHU-12	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the	Too small to be an issue. MAT not affected, See Tab "Issue #12"	none

#	MECH EQUIPMENT NAME	BUILDING AREA	ISSUE DESCRIPTION	COMMENTS	RECOMMENDED CORRECTIVE ACTION
13	VAV boxes	first floor (mostly)	Griswold balancing valve cartridges are becoming clogged with metallic debris, mostly on first floor.	Mike Kief (FSI) brought this problem to our attention. Although we were shown the remains of a clogged valve replaced recently, functional testing of the VAV boxes did not indicate any stuck heating valves.	Institute a preventative maintenance program to periodically replace valve cartridges, targeting VAV boxes that have trouble meeting load especially in cooling mode.
14	EF-17		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Mike Kief (FSI) brought this problem to our attention. Building staff remedies this with some cardboard in the unit.	Heating coil is too small or the amount of OSA is too large when conditions are severe.
15	AHU-13	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	REMOVED: upon further investigation, no problems detected with the thermostat	none
16	VAV 1-221	0	Space Temperature set-point trend data shows space temperature set-point is 65F.	Most likely the trend data is not correct, because the space is being correctly maintained at a more reasonable temperature.	None, because the space temperature is being correctly maintained.
17	EF-18		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Most likely the trend data is not correct, because the space is being correctly maintained at a more reasonable temperature.	None, because the space temperature is being correctly maintained.
18	AHU-14	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	Most likely the trend data is not correct, because the space is being correctly maintained at a more reasonable temperature.	None, because the space temperature is being correctly maintained.

#	MECH EQUIPMENT NAME	BUILDING AREA	ISSUE DESCRIPTION	COMMENTS	RECOMMENDED CORRECTIVE ACTION
19	VAV 5-220	0	Space Temperature consistently above set-point	Most likely the trend data is not correct, because the space is being correctly maintained at a more reasonable temperature.	None, because the space temperature is being correctly maintained.
20	EF-19		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Investigated, since no set-point provided for the space this is deemed OK.	None
21	AHU-15	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	0	None, because the space temperature is being correctly maintained.
22	AHU-1	0	The Supply fan starts at 2:00 am rather than starting at 6:00 am. This shows that the unit is going into it's pre-occupied mode as intended. NOT AN ISSUE	Supply Fan runs 6 days a week.	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-1 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
23	EF-20		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Not a issue, Potentially this could be an energy savings opportunity, unless the fan is already running at minimum static pressure.	None
24	AHU-16	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	NOT AN ISSUE. Energy Savings Opertunity by scheduling to match occupied schedule w/ override.	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-2 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.

#	MECH EQUIPMENT NAME	BUILDING AREA	ISSUE DESCRIPTION	COMMENTS	RECOMMENDED CORRECTIVE ACTION
25	AHU-2	0	RETURN FAN: Winter Schedule shuts down @ 7:15 pm, Summer Schedule shuts down @ 10:15 pm.	Energy Savings Opportunity	Energy Savings Measure: Schedule AHU-2 Return Fan to match supply fan schedule
26	EF-21		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	Not a issue, Potentially this could be an energy savings opportunity, unless the fan is already running at minimum static pressure.	None
27	AHU-17	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space	Supply Fan runs 6 days a week.	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-3 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
28	AHU-4	0	Supply and Return Fan are 24/7. They run a lower static pressure when unoccupied, but fans are running 24/7. A higher static is maintained for longer hours in the summer than in the winter.	NOT AN ISSUE. Energy Savings Opportunity by scheduling to match occupied schedule w/ override.	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-4 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.
29	EF-22		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	While not a deficiency in the HVAC system, we include other energy savings opportunities in the recommendations where found.	Install an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights
30	AHU-18	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	While not actually a deficiency because the system works properly as designed, we recommend that the server/IT space cooling be removed from the CHG loop. Instead heat removal should be accomplished through the use of split air conditioning units.	To reduce load on the CHG loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs be augmented by rooftop mini-split system type air conditioning units with air cooled condenser and premium efficiency compressor. Each space would be served by a separate unit.
31	CHWWS	0	No Metering exists for chilled well water supply	This is a benchmarking improvement opportunity.	Install BTU metering (temperatures & flow) to measure the BTU delivered via the chilled (well) water loop from Elmendorf.
32	EF-23		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %	This is a benchmarking improvement opportunity.	Install BTU metering (temperatures & flow) to measure the BTU delivered via the hot water loop from Elmendorf.

#	Measure Type	Energy Savings Measure	Occupant Comfort Measure	O&M Enhancement	Other Measure	DATE NOTED	DATE CLOSED	STATUS
1	Minor	No	Yes			11/22/2013		
2	Simple	No	No		Yes, #1	11/22/2013		
3	Major	No	Yes			11/22/2013		
4	Minor	No	Yes			11/22/2013		

#	Measure Type	Energy Savings Measure	Occupant Comfort Measure	O&M Enhancement	Other Measure	DATE NOTED	DATE CLOSED	STATUS
5	Minor	No	Yes			11/22/2013		
6	n/a	0	0		0	11/22/2013		
7	Major	No	No		Yes, #3	11/22/2013		
8	Major	No	No		Yes, #4	11/22/2013		

#	Measure Type	Energy Savings Measure	Occupant Comfort Measure	O&M Enhancement	Other Measure	DATE NOTED	DATE CLOSED	STATUS
9	Major	No	Yes			11/22/2013		
10	Major	Yes, #1	No			11/30/2013		
11	Major	No	Yes			1/9/2014		
12	n/a					1/9/2014		

#	Measure Type	Energy Savings Measure	Occupant Comfort Measure	O&M Enhancement	Other Measure	DATE NOTED	DATE CLOSED	STATUS
13	Minor	No	No	PM Program		1/10/2014		
14	Major	No	No		Yes, #5	1/10/2014		
15	n/a	0	0		0	3/1/2014		
16	n/a					3/1/2014		
17	n/a					3/1/2014		
18	n/a					3/1/2014		

#	Measure Type	Energy Savings Measure	Occupant Comfort Measure	O&M Enhancement	Other Measure	DATE NOTED	DATE CLOSED	STATUS
19	n/a					3/1/2014		
20	n/a					3/1/2014		
21	n/a	0	0			3/1/2014		
22	Minor	Yes, #2	No			3/1/2014		
23	n/a					3/1/2014		
24	Minor	Yes, #3	No			3/1/2014		

#	Measure Type	Energy Savings Measure	Occupant Comfort Measure	O&M Enhancement	Other Measure	DATE NOTED	DATE CLOSED	STATUS
25	Minor	Yes, #4	No			3/1/2014		
26	n/a					3/1/2014		
27	Minor	Yes, #5	No			3/1/2014		
28	Minor	Yes, #6	No			3/1/2014		
29	Minor	Yes, #7	No			3/1/2014		
30	Major	No	No		Yes, #7	3/1/2014		
31	Minor	No	No	Benchmarking		3/1/2014		
32	Minor	No	No	Benchmarking		3/1/2014		

LOG #	MECH EQUIPMENT NAME	RECOMMENDED MEASURE	MEASURE TYPE	ECM #	ENERGY SAVINGS (kWh/yr)	ENERGY $ SAVINGS ($/yr)	EST. MEASURE COST ($)	SIMPLE PAYBACK (yrs)
10	Compressor	Investigate compressed air system for leaks, stop leaks as found.	Major	1	70,192	$ 7,370	$ 2,000	0.3
22	AHU-1	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-1 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	2	12,750	$ 1,339	$ -	0.0
24	AHU-2	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-2 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	3	41,970	$ 4,407	$ -	0.0
25	AHU-2	Energy Savings Measure: Schedule AHU-2 Return Fan to match supply fan schedule	Minor	4	460	$ 48	$ -	0.0
27	AHU-3	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-3 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	5	25,184	$ 2,644	$ -	0.0
28	AHU-4	Energy Savings Measure: Reduce Pre-Occupied Mode to a durration of one hour prior to the start of Occ Mode. Occupied Mode: schedule AHU-4 Supply Fan to start at 6:00 am, Monday thru Friday with Override Mode to be available to satisfy after-hours needs.	Minor	6	82,939	$ 8,709	$ -	0.0
29	Lobby Lighting	Install an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights.	Minor	7	26,981	$ 2,833	$ 2,500	0.9
TOTAL					**260,476**	**$ 27,350**	**$ 4,500**	**0.2**

VISN 20 Alaska VA Healthcare System

Facility & Equipment Information Documents

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Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Introduction

As part of its RCx efforts at VISN 20 Anchorage VA Medical Center, DAV Energy presents the following facility information documentations report.

This is being completed under **Key Deliverable 3- Systems Functional Testing Plan**.

This report provides a summary of the facility information documents collected and prepared for the VA facilities. Many documents were collected including hard copy and electronic drawings, control system documentation, and previous reports. As part of this deliverable, logs were created to document the drawings and information gathered in this process. A preliminary equipment inventory was prepared for the facility. The following sections summarize the project activities and detailed facility information provided in the appendices.

The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	**Facility Information & Equipment Documents**	**Complete**
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	In Progress
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	3/26/2014
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Facility & Equipment Information Documents

The RCx team compiled and prepared facility documents to assist in understanding the facility requirements and mechanical system operation. The following sections summarize the key items included in this process and the detailed data are presented in appendices.

2.1 DRAWING & DOCUMENT SUMMARY

Campus and individual building documents were reviewed to understand original design intent and current operation, and to collect facility and equipment information. Documents included design drawings, control sequences, TAB reports, systems operations and maintenance manuals, current facility requirements, and other applicable reports. A summary of the available documents for the campus is below.

Table 2-1: Document Summary

Building No.	Documentation Available	Description
Clinic	YES	Design Drawings
Clinic	YES	As-Built Drawings
Clinic	YES	2010 TAB Report
Clinic	YES	Sequence of Operations
Clinic	YES	AHU Data Sheets
Clinic	YES	Commissioning Report

2.2 CONTROLS SEQUENCES & SCHEMATICS

Control sequences of operation, points lists, and schematics for major mechanical equipment were compiled and reviewed. As the facility is a new building all of the equipment are included in the available documentation.

The following list provides an overview of the system types included in the control sequence and schematic documentation. These can be found in **Appendix A**.

1. Variable Air Volume Single Pass AHU - Variable air volume (Supply Fan VFD), Glycol pre-heating coil, Glycol Heating coil, Glycol cooling coil

2. Variable Air Volume Single Pass AHU - Variable air volume (Supply Fan VFD), Glycol pre-heating, Glycol Heating, Glycol cooling, DX Cooling

3. Variable Air Volume Re-Circulating AHU - Variable air volume (Supply and Return Fan VFDs), Glycol heating coil, Glycol cooling coil, Air-side Economizer

2.3 AHU ZONING PLANS

General AHU zoning maps were collected and compiled from existing sources, including hand-colored drawings kept in mechanical rooms and interviews. The zoning plan below is an example for a specific area in the building.

Figure 2-1: Zoning Plan

Table 2-2: AHU Zoning Summary

Building No.	AHU Number	Area Served
Clinic	AHU 1	First Floor A Wing, Second Floor A Wing
Clinic	AHU 2	First Floor A Wing, Second Floor A Wing
Clinic	AHU 3	First Floor D Wing, Second Floor D Wing
Clinic	AHU 4	First Floor B Wing, Second Floor B Wing
Clinic	AHU 5	First Floor C Wing, Second Floor C Wing
Clinic	AHU 6	First Floor Entryway, Second Floor Entryway
Clinic	AHU 7	Second Floor A Wing
Clinic	AHU 8	First Floor D Wing
Clinic	AHU 9	First Floor C Wing, Second Floor C Wing
Clinic	AHU 10	Emergency Generator
Clinic	AHU 11	Corridor to Elmendorf

2.4 CURRENT FACILITY REQUIREMENTS (CFR)

Existing Current Facility Requirement (CFR) documents were available for the Anchorage VA Outpatient Clinic. These documents were collected and reviewed to assist with overall understanding of current space use and HVAC system performance requirements. Facilities were walked to identify changes from the original design criteria such as occupancy and space utilization. Assessments were focused on system level changes, not room by room discrepancies.

The information included in existing CFRs will be used to assist with HVAC system diagnostic monitoring analysis and functional performance testing. For this site the VA Design Guide was taken to be equivalent to the Facility Requirements.

Please see Table 2-3 below showing summarized ventilation rates from the VA Design guide.

Table 2-3: Ventilation Requirements Summary

VA Ventilation Summary Table

Space	Air Changes per Hour (AC/HR)*	Pressure^	Cooling Temp (deg F)	Heating Temp (deg F)	Summer RH (%)	Winter RH (%)
Canteen	10	Negative	78	72	50	30
Clean Utility	4	Positive	78	72	50	30
Computer Room	6	Negative	70	70	40 +/- 5	40 +/- 5
Corridor or Hall	4	Positive	78	72	50	30
Dental - Operating	15	Positive	78	72	50	30
Exam or Treatment	6	Neutral	76	78	50	30
Hospital Supplies	4	Positive	78	72	50	30
Laboratory	12	Negative	76	72	50	30
Lobby	6	Positive	78	72	50	30
Locker/ Dressing Room	10	Negative	78	72	50	30
Lounge/Break	6	Negative	78	72	50	30
Mech. or Elec.	10	Negative	-	65	-	-
Office - enclosed	4	Positive	78	72	50	30
Office - open	4	Positive	78	72	50	30
Pharmacy	4	Positive	78	72	50	30
Radiology	6	Negative	78	72	50	30
Reception or Waiting	6	Negative	78	72	50	30
Restroom	10	Negative	78	72	-	-
Soiled Utility	10	Negative	78	72	50	30
Stairs	0	Positive	78	72	-	-
Surgery - GI	10	Negative	76	78	50	30
Surgery - Operating	15	Positive	62	80	45-55	45-55
Surgery - PACU, Stage II	8	Positive	75	75	50	30
Surgery - Pre-Op	8	Positive	75	75	50	30
Steris	4	Positive	78	72	50	30
Vestibule	0	Positive	78	72	-	-

*These ventilation rates are engineering guidelines subject to the specific requirements of a space, such as cooling load, exhaust load, and number of occupants.

^ Overall building pressure to be positive with respect to outdoor ambient condition.

2.5 PRELIMINARY EQUIPMENT INVENTORY

Key equipment information available from drawings, preventative maintenance procedures, and other sources for major HVAC equipment was collected and compiled in MS Excel format. This will provide the basis for the Equipment List deliverable under Task 3.

The preliminary equipment list has been provided as a separate document and is included as a PDF in **Appendix B**. It includes the following information where available:

- Location, such as building, floor, wing, room number and description, room type and area reference (where room number is not available)
- Area served
- Manufacturer and model number
- Serial number
- Energy input ratings (volts, amps, phases, kW, and/or Btu/hour)
- Output capacity ratings (HP, cooling tons, heating MBH, CFM/static pressure, GPM/head, etc.)
- Coil ratings (where present and available)
- Rated efficiency
- Date of manufacture and/or installation

Table 2-4 summarizes the major equipment that has been included in the Equipment Inventory:

Table 2-4: Summary of Equipment Inventory

Building No	Description of Equipment
Clinic	(11) Air Handling Units
Clinic	(30) Pumps (HVAC system only)
Clinic	(452) VAV Terminal Units
Clinic	(1)DX Condensing Unit
Clinic	(3) Air Compressors (HVAC system only)
Clinic	(5) Heat Exchangers
Clinic	(15) Exhaust Fans
Clinic	(10) Terminal Heating Units

3.0 Appendix

3.1 APPENDIX A – CONTROL SEQUENCES & SCHEMATICS

Sequence of Operation

VA CLINIC
SEQUENCE OF OPERATION

includes sequence of operation for:

1. General.
   - DDC general.
   - DDC time clock schedule.
   - Alarms.
   - Outside air reset schedule.

2. Fuel system.
   - Fuel storage tank.
   - Day tank.

3. Hydronic heating.
   - Heat exchangers.
   - Pumps.
   - Finned tube radiation.
   - Radiant ceiling panels.
   - Radiant floors.
   - Unit heaters.
   - Cabinet unit heaters.
   - Reheat coils.
   - Snow melting.
   - Hydronic heating glycol make-up tank.

4. Hydronic cooling.
   - Heat exchangers.
   - Pumps.
   - Computer room cooling units.
   - Hydronic cooling glycol make-up.

5. Ventilation.
   - Air handling units.
   - Typical 100 percent OSA air handling unit.
   - Engine generator air handling unit.
   - Ventilation fans.
   - Exhaust fans.
   - Kitchen exhaust fans.
   - Typical 100 percent OSA exhaust fans.
   - Capture hood exhaust fans.
   - Procedure room exhaust fans.
   - Medical gas cylinder room exhaust fans.
   - Air valves.
   - VAV terminal units.

6. Humidification.
   - Air compressors.
   - Air handling unit humidification method and control.
   - Duct humidification method and control.

7. Plumbing.
   - Hot water generators.
   - Hot circulator water pumps.
   - Elevator sump pump.
   - Stairwell sump pump.

8. Engine Generator
   - Remote Radiator.
   - Charge Air Cooler.

9. Medical Systems.
   - Vacuum Pump.
   - Air Compressor.

10. Dental Systems.
    - Vacuum Pump.
    - Air Compressor.

11. Electrical Systems.
    - Heat tape.
    - Interior lighting.
    - Exterior lighting.

1 GENERAL

A. DDC General

1. All points outlined is addressable through the DDC system. All points are programmed at the host computer and graphics are prepared for all buildings.

B. DDC Time Clock Schedule

1. DDC time clock shall schedule occupied and unoccupied mode. Occupied mode shall begin at 6:00 a.m. and end at 7:00 p.m. Monday through Friday. Unoccupied mode shall begin at 7:00 p.m. and end at 6:00 a.m. Monday through Thursday and shall begin 7:00 p.m. Friday and end 6:00 a.m. Monday

C. Alarms and Monitoring

1. All alarms at local control panels shall be transmitted to the host computer.
2. Provide the following DDC alarm, status, and monitoring points at the control panel.
   a. Refrigerator L8 High Temperature Alarm.
   b. Refrigerator L9 High Temperature Alarm.
   c. Refrigerator L10 High Temperature Alarm.
   d. Refrigerator PC17 High Temperature Alarm.
   e. Refrigerator P2 High Temperature Alarm.

D. Outside Air Reset Schedule

1. Outside air reset for heating glycol shall be according to the following schedule (adjustable), following a linear path between these two points:
   a. 5 °C (40 °F) and above 66 °C (150 °F).
   b. -7 °C (20 °F) and below 88 °C (190 °F).

2 FUEL SYSTEM

A. Fuel Storage Tank (T-1):

1. Level Indicator: Tank monitoring devices and sensors shall be controlled by manufacturer's packaged controller. Tank level shall be input to DDC controller.
2. Leak Detection: The tank leak detection monitor shall interface with the DDC system.
3. Provide the following DDC alarm, status, and monitoring points at the control panel:
   a. Tank low level alarm at 25 percent, adjustable.
   b. Tank high level at 95 percent, adjustable.
   c. Tank level (gallons).
   d. Tank leak detection (alarm).

B. Day Tank (DT-1):

1. Day tank shall be controlled by manufacturer's packaged controller. Whenever the day tank calls for fuel, its respective FOS control valve shall open and its integral fuel pump shall be energized. When the day tank level sensor is satisfied, the pumps shall de-energize and the day tank control valve shall return to its normally closed position. Whenever the main storage tank is less than 10 percent full, the pumps shall not be allowed to start regardless of day tank demand.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
   a. Tank low level alarm at 25 percent, adjustable.
   b. Tank high level alarm at 95 percent, adjustable.
   c. Fuel pump status (on/off)
   d. DT-1 control valve status (open/closed)

3 HYDRONIC HEATING

A. Heat Exchangers

1. Building heat exchangers (HX-1A/1B):
   a. Three-way control valve modulates to maintain a heat exchanger discharge temperature of 87 °C (188 °F). Three-way control valve is normally open and will only operate if pumps P-14A/B VFDs are unable to maintain set point after 10 minutes (adjustable).
2. Snow melt heat exchanger (HX-3):
   a. Two-way control valve modulates to maintain snowmelt glycol heating supply temperature at setpoint when any snowmelt system pump is running.

B. Pumps (P-1A/1B, P-2A/2B, P-3A/3B, P-4A/4B, P-5A/B, P-6A/B, P-7A/B, P-8A/B, P-10A/B)

1. Primary Pumps (P-1A/B):
   a. Shall be variable volume pumps.
   b. While in "Auto" position, pump shall operate continuously and VFD shall modulate to maintain a set system pressure.
   c. Pressure differential sensor is in penthouse B. VFD shall adjust rpm to maintain system differential pressure. Set point shall be determined during testing, adjusting, and balancing.
2. Secondary Pumps (P-2A/2B, P-3A/3B, P-4A/4B, P-5A/B, P-6A/B, P-7A/B, P-8A/B, P-10A/B):
   a. Shall be variable volume pumps.
   b. Pumps operate when associated system calls for heat.
   c. 3-way valve modulates to maintain a temperature setpoint established by an economizer schedule.
   d. The VFD is used for balancing by setting the maximum speed for full flow. The VFD modulates between 20Hz and the maximum set point based on percentage of flow required in relation to number of valves open.
3. Central Plant Pumps (P-14A/B):
   a. Shall be variable volume pumps.
   b. While in "Auto" position, pump operates when VA Clinic calls for heat. The VFD modulates to maintain supply temperature at setpoint to VA Clinic based on an outside air reset schedule. The VFD modulates down to 1/3 of maximum GPM. If the heat exchanger (HX-1A/1B) discharge temperature sensor is not satisfied after 10 minutes (adjustable), the 3-way control valve shall modulate to maintain temperature set point.
4. Pumps alternate as follows:
   a. Timed rotation from lead pump to lag pump on a weekly basis.
   b. Automatic switching from lead pump to lag pump when a run failure occurs.
   c. A 15 sec. time lag between the stoppage of lead pump and the starting of the lag pump.
   d. Pumps are off above 22 °C (72 °F), adjustable.
5. Upon failure of the lead pump a failure alarm activates and the stand-by pump is automatically energized.
6. Pump motor current status is an input to the DDC controller.
7. The following DDC alarm, status and monitoring points is provided at the control panel:
   a. Status (on/off).
   b. Failure alarm.

C. Finned Tube Radiation (FTR-1, FTR-2, FTR-3, FTR-4, FTR-5, FTR-6)

1. DDC Control
   a. The DDC controller modulates a 2-way control valve on the radiation element as required to maintain space temperature at setpoint.
2. Space shall have dual setpoint control. In the occupied mode, the setpoint shall be 22 °C (72 °F) and in the unoccupied mode, the setpoint shall be 16 °C (60 °F), adjustable.
3. 2-way control valve fails open.
4. The following DDC alarm shall be provided at the control panel:
   a. Space low temperature alarm.

D. Radiant Ceiling Panels (RCP-1)

1. DDC Control
   a. The DDC controller modulates a 2-way control valve on the radiation element as required to maintain space temperature at setpoint.
2. Space shall have dual setpoint control. In the occupied mode, the setpoint shall be 22 °C (72 °F) and in the unoccupied mode, the setpoint shall be 16 °C (60 °F), adjustable.
3. 2-way control valve fails open.
4. The following DDC alarm shall be provided at the control panel:
   a. Space low temperature alarm.

E. Radiant Floors (P-9A/B, RFZ A-C, see drawings)

1. Upon call for heat from radiant floor zone, P-9 lead pump is energized.
2. Pumps alternate as follows:
   a. Timed rotation from lead pump to lag pump on a weekly basis.
   b. Automatic switching from lead pump to lag pump when a run failure occurs.
   c. A 15 sec. time lag between the stoppage of lead pump and the starting of the lag pump.
   d. Pumps are off above 22 °C (72 °F), adjustable.
3. Three-way control valve from the header modulates as required to maintain a radiant floor loop discharge temperature setpoint of 95 °F, adjustable.
4. Individual telestat zone control valves on the manifolds cycle as required to maintain adjustable room temperature setpoint. Room space thermostat controls manifold telestat zone valve(s), VAV box air valve and heating coil 2-way control valve.
5. The following DDC alarm shall be provided at the control panel:
   a. Pump Status (on/off)
   b. Failure alarm.

F. Unit Heaters (UH-1, UH-2, UH-3)

1. Thermostatic Control
   a. UH coil flows continuously. Line voltage thermostat cycles fan as required to maintain setpoint temperature.

G. Cabinet Unit Heaters (CUH-1, CUH-2, CUH-3, CUH-4, CUH-5)

1. Thermostatic Control
   a. UH coil flows continuously. Line voltage thermostat cycles fan as required to maintain setpoint temperature.

H. Reheat Coils (RHC X-XXX, see drawings)

1. The DDC controller modulates a 2-way control valve to maintain setpoint temperature.
2. Space shall have dual setpoint control. In the occupied mode, the setpoint shall be 22 °C (72 °F) and in the unoccupied mode, the setpoint shall be 16 °C (60 °F), adjustable.
3. The following DDC alarm is provided at the control panel:
   a. Space low temperature alarm.

I. Snow Melting (P-11 A/B, P-12 A/B, SMZ A-D)

1. The snowmelt system operates in four modes: Warm Weather Cutoff, Idle Mode, Melting Mode, and Cold Weather Cutoff.
   a. Warm Weather Cutoff is enabled when the outside air temperature is above 40°F, adjustable. All pumps are off.
   b. Idle Mode is enable when the outside air temperature is below 35°F, adjustable. Pumps run as needed to maintain the slabs at the slab temperature setpoint of 28°F, adjustable.
   c. Melting mode is enabled when Idle Mode is enabled and moisture is detected at the slab sensor location. Pumps run as needed to maintain the slabs at the slab temperature setpoint of 40°F, adjustable. Melting Mode lasts for a minimum of 4 hours.
   d. Cold Weather Cutoff is enabled when the outside air temperature is below -10°F, adjustable. All pumps are off.
2. Snow melting pumps (P-11A/B, P-12A/B) are energized for their respective slab zones as needed during Idle Mode or Melting Mode to maintain the slabs at their temperature setpoint.
3. Pumps alternate as follows:
   a. Timed rotation from lead pump to lag pump on a weekly basis.
   b. Automatic switching from lead pump to lag pump when a run failure occurs.
   c. A 15 sec. time lag between the stoppage of lead pump and the starting of the lag pump.
   d. Pumps are off above 22 °C (72 °F), adjustable.
4. A two-way modulating valve on "hot" side of heat exchanger modulates as required to maintain the glycol discharge temperature setpoint. The discharge temperature setpoint modulates from 70°F to 130°F as needed to maintain the slabs at their temperature setpoint. If either slab temperature rises faster than 0.2°F per minute, the discharge temperature will be reduced until the slab rate of temperature increase is below 0.2°F per minute to help prevent slab cracking.

Sequence of Operation

I. Hydronic Heating Glycol Make-Up Tank (GMT-1)
1. A pressure sensor in the mechanical room near expansion tank monitors glycol system static pressure.
2. The glycol make-up tank is controlled by manufacturer's packaged controller.
4. The following DDC alarm shall be provided at the control panel:
a. Glycol Supply Low pressure alarm.
b. Glycol system pressure.

K. Hydronic Heating Glycol Make-Up Tank (GMT-3)
1. A pressure sensor in the mechanical room near expansion tank monitors glycol system static pressure.
2. The glycol make-up tank is controlled by manufacturer's packaged controller.
4. The following DDC alarm shall be provided at the control panel:
a. Glycol Supply Low pressure alarm.
b. Glycol system pressure.

L. Hydronic Heating Glycol Make-Up Tank (GMT-4)
1. A pressure sensor in the mechanical room near expansion tank monitors glycol system static pressure.
2. The glycol make-up tank is controlled by manufacturer's packaged controller.
4. The following DDC alarm shall be provided at the control panel:
a. Glycol Supply Low pressure alarm.
b. Glycol system pressure.

4 HYDRONIC COOLING
A. Heat Exchangers (HX-2A/2B)
1 A two-way control valve modulates to maintain 8 °C (46 °F) supply temperature (adjustable).
2 Minimum flow setting for 2-way control valve is 4 gpm, adjustable, to maintain freeze protection in discharge pipe.
3 Two-way valve fails closed.

B. Pumps (P-13A/13B)
1.Shall be variable volume pumps.
2. While in "Auto" position, pump operates when space temperatures in areas controlled by air conditioning units are greater than setpoint or air handling unit cooling coils call for cooling.
3. The VFD modulates to maintain a set system differential pressure as sensed by a differential pressure sensor located in penthouse B.
4. Pumps alternate as follows:
a. Timed rotation from lead pump to lag pump on a weekly basis.
b. Automatic switching from lead pump to lag pump when a run failure occurs.
c. A 15 sec. time lag between the stoppage of lead pump and the starting of the lag pump.
d. Pumps are off when all cooling demand temperature setpoints are satisfied or outside air temperature is below 7 °C (45 °F), adjustable. If any air handling unit cooling coil or ACU-13 thru 16 cooling demand temperature setpoint rises 1 °C (2 °F), adjustable, above its setpoint, activate lead pump. If any ACU-1 thru 12 cooling demand temperature rises 4 °C (7 °F), adjustable, above its setpoint, activate lead pump.
f. Provide a minimum 20 minute pump run time and a 20 minute minimum pump off time, adjustable.
g. Cooling demand temperature setpoints are: air handling unit cooling coil discharge air temperatures and air conditioning unit (ACU) space temperatures.
5. The following DDC alarm, status and monitoring points shall be provided at the control panel:
a. Status (on/off).
b. Failure alarm.
6. When P-13A/B VFD has ramped down to set minimum hertz as a response to the system static pressure and the system static pressure is still above setpoint, the system bypass valve modulates to maintain the set system pressure. While the system bypass valve is open/modulating, P-13A/B VFD shall not modulate above set minimum hertz. Once the system bypass valve is fully closed, P-13A/B VFD shall once again modulate to maintain the set system pressure.

C. Space Cooling Units (ACU-1 through ACU-12)
1 Each space cooling unit shall be controlled by manufacturer's packaged controller to maintain space temperature set point on an adjustable 22 °C (72 °F). Maintain a 1 degree C (2 °F) temperature difference between ACU and VAV box set points
2 Set the space VAV building ventilation system thermostat to 21 °C (70 °F), adjustable.
3 The following DDC alarm shall be provided at the control panel:
a. Space high temperature.

D. Computer Room Cooling Unit (ACU-13/ACU-14)
1. Space cooling unit shall be controlled by manufacturer's packaged controller to maintain space temperature set point of 22 °C (72 °F), adjustable, and 45 percent relative humidity. Maintain a 1 degree C (2 °F) temperature difference between ACU and VAV box set points.
2. Set the space VAV building ventilation system thermostat to 21 °C (70 °F), adjustable.
3. The following DDC alarm shall be provided at the control panel:
a. Space high temperature.
b. ACU fault alarm.

E. Space Cooling Unit (ACU-15/ACU-16)
1.Space cooling unit are energized when the sensed return air temperature rises above setpoint of 72°F, adjustable. Since the return air temperature may not represent space conditions when the fan is not energized, the ACU will be energized for 5 minutes every hour (adjustable) to take air temperature samples.
2. The following DDC alarm shall be provided at the control panel:
a. Space high temperature

F. Hydronic Cooling Glycol Make-Up Tank (GMT-2)
1. A pressure sensor in the mechanical room near expansion tank monitors glycol system static pressure.
2. The glycol make-up tank is controlled by manufacturer's packaged controller.
4. The following DDC alarm shall be provided at the control panel:
a. Glycol Supply Low pressure alarm.
b. Glycol system pressure.

5 VENTILATION
A. Air Handling Units
1. General Clinic Air Handling Units (AHU-1, AHU-2, AHU-3, AHU-4, AHU-5, AHU-6, AHU-11)
a. Air handling unit operates in warm-up, cool-down, occupied, and unoccupied modes of operation. The DDC time clock dictates warm-up, cool-down occupied, and unoccupied modes of operation.
b. Warm-up Mode of Operation
1) The DDC system monitors the number of terminal zones requesting AHU warm-up mode. If the number of terminal zones requesting warm-up exceeds the setpoint, the AHU will be placed into warm-up mode until the occupied time begins. Warm-up mode overrides cool-down mode.
2) The supply fan will be energized and its VFD will modulate to maintain the supply duct static pressure at setpoint.
3) The return fan will be energized if the supply fan is providing 75% of its minimum flowrate.
4) The outside air damper will be closed, the return air damper will be open, the relief air damper will be closed, and the heating coil valve will modulate to achieve the supply air temperature setpoint of 85°F.
c. Cool-Down Mode of Operation
1) The DDC system monitors the number of terminal zones requesting AHU cool-down mode. If the number of terminal zones requesting cool-down exceeds the setpoint, the AHU will be placed into cool-down mode until the occupied time begins. Warm-up mode overrides cool-down mode.
2) The supply fan will be energized and its VFD will modulate to maintain the supply duct static pressure at setpoint.
3) The return fan will be energized if the supply fan is providing 75% of its minimum flowrate.
4) The outside air damper, return air damper, relief air damper, heating coil valve and cooling coil valve will modulate to achieve the supply air temperature setpoint.
d. Occupied Mode of Operation
1) The supply fan will be energized and its VFD will modulate to maintain the supply duct static pressure at setpoint.
2) The return fan will be energized and its VFD will modulate to maintain the return duct flowrate at setpoint. The return duct flowrate setpoint is determined by the following equation:
Return Air = (Supply Air)*90% - (Exhaust Air)
3) The outside air damper, return air damper, relief air damper, heating coil valve and cooling coil valve will modulate to achieve the supply air temperature setpoint. The supply air temperature setpoint is determined by space conditions. The DDC system monitors the number of terminal zones requesting an AHU supply air temperature increase or decrease. If the number of terminal zones requesting a supply air temperature increase or decrease exceeds the setpoint, the supply air temperature setpoint will be increased or decreased accordingly by 1°F every ten minutes between its minimum and maximum setpoints of 55°F and 65°F. A request for temperature increase will override a request for temperature decrease.
4) Minimum outside air damper position is set according to the following schedule:
a) AHU-1 5,800 CFM
b) AHU-2 7,100 CFM
c) AHU-3 5,900 CFM
d) AHU-4 12,500 CFM
e) AHU-5 4,800 CFM
f) AHU-6 2,000 CFM
g) AHU-11 = 750 CFM
3) For AHU-6, the minimum outside air damper position is overridden by Carbon Dioxide Control. A return air CO2 sensor shall initiate modulation of outside air damper from minimum position to open in sequence with return and relief air dampers to maintain less than 700 PPM.
e. Unoccupied Mode of Operation.
1) Outside air damper is closed, return air damper is open, relief air damper is closed, cooling coil valve is closed, and heating coil control valve is open 10% if the outside air temperature is below 35°F, adjustable. All fans are off.
f. Heating Coil
1) Coil supply and return temperatures are input to the DDC controller.
2) The 3-way control valve fails open.
g. Cooling Coil
1) Coil supply and return temperatures are input to the DDC controller.
2) The 2-way control valve fails closed.
h. Fan Shutdown
1) A high duct static pressure switch located in the supply fan discharge duct shuts down the supply fan whenever the duct discharge pressure rises above setpoint pressure of 4.0 i.w.g. Manual reset required.
2) A low-limit temperature switch is on the downstream side of the supply fan. Upon a low-limit condition all fans stop, the outside air damper closes, the return air damper opens, the relief air damper closes, the heating coil valve opens fully, the cooling coil valve closes fully, and an alarm is activated. Initial setpoint low-limit setpoint is 40 °F, adjustable. The low-limit condition can be manually reset by depressing the orange button located on R-9 (leftmost relay) located in the AHU DDC control enclosure. Otherwise, the AHU will automatically attempt to reset the low-limit condition every ten minutes from the initial low-limit condition time.
3) A smoke detector is mounted in the supply air ductwork downstream of the fan. Fan is interlocked with fire alarm system. Upon smoke detection the fire alarm system shuts down the supply fan.
4) For AHU's 1 through 5, a smoke detector is mounted in the return air duct. For AHU's 6 and 11, a smoke detector in the return air stream is not required. Fan is interlocked with fire alarm system. Upon smoke detection the fire alarm system shuts down the return fan.
i. Humidifier
1) For AHU's 1 through 5, two humidity sensors (one on each floor, shown on plans) inputs relative humidity to the DDC controller. The DDC controller averages the two values for a space relative humidity reference.
2) For AHU-6, one humidity sensor in the lobby inputs relative humidity to the DDC controller.
3) The humidifier cycles on/off and modulates to maintain space relative humidity in accordance with the following schedule, following a linear path between these two points:

Outside Air Temperature	Relative Humidity
-7 °C (20 °F)	30 %
5 °C (40 °F) or greater	50 %

j. Filter
1) Differential pressure across the filter is input to the DDC controller.
2) DDC controller initiates a maintenance alarm when the differential pressure across the filter rises above 1.0 i.w.g., adjustable.
3) The following DDC maintenance alarm is provided at the control panel:
a) Filter maintenance alarm.
k. Other features
1) The following DDC alarms, status & monitoring points are at the control panel.
a) Fan Status (on/off).
b) Fan Failure alarm
c) Percent Outside Air.
d) Outside Air CFM.
e) Return Air Temperature
f) Mixed Air Temperature
g) Discharge Air Temperature.
h) Mixed Air Damper Position.
i) Relief Air Damper Position.
j) Low Limit Alarm.
k) High duct static pressure shutdown.
l) Supply Air CFM.
m) Return Air CFM.

2. Typical 100 percent OSA Air Handling Unit (AHU-7, AHU-8, AHU-9)
a. Air handling unit operates in warm-up, cool-down, occupied, and unoccupied modes of operation. The DDC time clock dictates warm-up, cool-down occupied, and unoccupied modes of operation.
b. Warm-up Mode of Operation
1) The DDC system monitors the number of terminal zones requesting AHU warm-up mode. If the number of terminal zones requesting warm-up exceeds the setpoint, the AHU will be placed into warm-up mode until the occupied time begins. Warm-up mode overrides cool-down mode.
2) The supply fan will be energized and its VFD will modulate to maintain the supply duct static pressure at setpoint.
3) The preheating coil valve and the heating coil valve will modulate in series to achieve the supply air temperature setpoint of 85°F.
c. Cool-Down Mode of Operation
1) The DDC system monitors the number of terminal zones requesting AHU cool-down mode. If the number of terminal zones requesting cool-down exceeds the setpoint, the AHU will be placed into cool-down mode until the occupied time begins. Warm-up mode overrides cool-down mode.
2) The supply fan will be energized and its VFD will modulate to maintain the supply duct static pressure at setpoint.
3) The preheating coil valve, heating coil valve and cooling coil valve will modulate to achieve the supply air temperature setpoint.
d. Occupied Mode of Operation
1) The supply fan will be energized and its VFD will modulate to maintain the supply duct static pressure at setpoint.
3) The preheating coil valve, heating coil valve and cooling coil valve will modulate to achieve the supply air temperature setpoint. The supply air temperature setpoint is determined by space conditions. The DDC system monitors the number of terminal zones requesting an AHU supply air temperature increase or decrease. If the number of terminal zones requesting a supply air temperature increase or decrease exceeds the setpoint, the supply air temperature setpoint will be increased or decreased accordingly by 1°F every ten minutes between its minimum and maximum setpoints of 55°F and 65°F. A request for temperature increase will override a request for temperature decrease.
e. Unoccupied Mode of Operation.
1) Preheating valve modulates to maintain casing temperature of 55°F, heating coil valve is closed, and cooling coil valve is closed. Supply fan is off.
f. Preheating Coil
1) The 3-way control valve fails open.
g. Heating Coil
1) The 3-way control valve fails open.
h. Cooling Coil
1) The 2-way control valve fails closed.
i. Fan Shutdown
1) A high duct static pressure switch located in the supply fan discharge duct shuts down the supply fan whenever the duct discharge pressure rises above setpoint pressure of 4.0 i.w.g. Manual reset required.
2) A low-limit temperature switch is on the downstream side of the supply fan. Upon a low-limit condition supply fan stops, the outside air damper closes, the preheating and heating coils valves open fully, the cooling coil closes fully, and an alarm is activated. Initial setpoint low-limit setpoint is 40 °F, adjustable. The low-limit condition can be manually reset by depressing the orange button located on R-9 (leftmost relay) located in the AHU DDC control enclosure. Otherwise, the AHU will automatically attempt to reset the low-limit condition every ten minutes from the initial low-limit condition time.
3) A smoke detector is mounted in the supply air ductwork downstream of the fan. Fan is interlocked with fire alarm system. Upon smoke detection the fire alarm system shuts down the supply fan.
j. Humidifier
1) For each AHU one humidity sensor (shown on plans) inputs relative humidity to the DDC controller.
2) The humidifier cycles on/off and modulates to maintain space relative humidity in accordance with the following schedule, following a linear path between these two points:

Outside Air Temperature	Relative Humidity
-7 °C (20 °F)	30 %
5 °C (40 °F) or greater	50 %

3) The duct humidifiers for O.R. Room 1D222 and Procedure Room 1D218 cycle on/off and modulate to maintain space relative humidity in accordance with the following schedule, following a linear path between these two points:

Outside Air Temperature	Relative Humidity
-29 °C (-20 °F)	40 %
-18 °C (0 °F) or greater	50 %

Sequence of Operation

k. Dehumidifier
1) For AHU-8, condensing unit CU-1 will use the average input from O.R. Room ID222 and Procedure Room ID218 space humidity sensors to cycle on when average space relative humidity reaches 55 percent or higher.
2) The dehumidifier cycles off when space relative humidity reaches 53 percent or lower.
3) Interlock CU-1 with AHU-8 humidifier and Surgery Suite duct humidifiers to prevent CU-1 from running when any of these humidifiers are operating.
4) The following DDC alarm, status, and monitoring points are at the control panel:
a) CU-1 Status (on/off)

l. Filter
1) Differential pressure across each filter is input to the DDC controller.
2) DDC controller initiates a maintenance alarm when the differential pressure across the filter rises above 1.0 i.w.g., adjustable.
3) The following DDC maintenance alarm is provided at the control panel:
a) Filter maintenance alarm.

m. Other features
1) The following DDC alarm, status & monitoring points are at the control panel:
a) Fan Status (on/off).
b) Fan Failure alarm.
c) Discharge Air Temperature.
d) Low Limit Alarm.
e) High duct static pressure shutdown.
f) Supply Air CFM
g) Duct Relative Humidity
h) High Humidity Alarm

2. Engine Generator Air Handling Unit (AHU-10)
a. Air handling unit is interlocked with the generator to operate in On or Off mode of operation. Air handling unit is on when the generator is on and off when the generator is off.
b. On Mode of Operation
1) The fan operates continuously
2) Outside air damper and relief air dampers open
c. Off Mode of Operation
1) The fan is off
2) Outside air damper and relief air dampers close
d. Filter
1) Differential pressure across the filter is input to the DDC controller
2) DDC controller initiates a maintenance alarm when the differential pressure across the filter rises above 1.0 i.w.g., adjustable
3) The following DDC alarm, status & monitoring points are at the control panel:
a) Filter maintenance alarm.
e. Other features
1) The following DDC alarm, status & monitoring points are at the control panel:
a) Fan Status (on/off).
b) Fan Failure alarm.

B. Typical Ventilation Fan, VF-1 through 5
1. Return and outside air dampers modulate to maintain discharge setpoint temperature, 19 °C (65 °F), adjustable.
2. Fan Motor current status is input to DDC controller.
3. Provide the following DDC alarm, status and monitoring points at the control panel:
a. Fan Failure alarm.
b. Low Space temperature alarm

C. Typical General Exhaust Fans, EF-1 through 5
1. General exhaust fans are interlocked with corresponding AHU-1 through 5 respectively.
2. Fan motor current status is input to DDC controller. DDC controller provides runtime totalizer function for maintenance activities.
3. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. Status (on/off).
b. Fan Failure alarm.

D. Kitchen Exhaust Fan, EF-6
1. Kitchen exhaust fan EF-6 is controlled by kitchen grease hood.
2. VAV box 4-228 is a two position box and is interlocked with EF-6. When EF-6 is off, VAV box 4-228 is in minimum position of 310 CFM. When EF-6 is on, VAV box 4-228 opens to maximum position of 1860 CFM.
3. Kitchen thermostat cycles VAV box 4-228 heating coil on/off.

E. Typical 100 percent OSA Exhaust Fans, EF-7, 9, & 11.
1. Interlocked with respective AHU.
a. DDC controller energizes exhaust fan and opens the exhaust air damper when respective AHU is activated.
b. DDC controller modulates the exhaust fan via VFD and maintains exhaust system duct static pressure at setpoint.
c. Fan motor current status is input to DDC controller.
d. Provide the following DDC alarm, status and monitoring points at the control panel:
1) Fan Status (on/off).
2) Fan Failure alarm.
3) Exhaust Air CFM
e. Interlock schedule
1) AHU-7 and EF-7
2) AHU-8 and EF-9
3) AHU-9 and EF-11

F. Capture Hood Exhaust Fans, EF-8, 10
1. Capture hood exhaust fan are controlled by local wall switches. DDC controller energizes fan when the respective wall switch is activated and de-energizes fan when the respective wall switch is deactivated. See floor plans for switch locations.
2. Fan motor current status is input to DDC controller. DDC controller provides runtime totalizer function maintenance activities.
3. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. Status (on/off).
b. Fan Failure alarm.

G. Procedure Room Exhaust Fans, EF-13, 14
1. Interlocked with respective AHU.
a. DDC controller energizes exhaust fan and opens the exhaust air damper when respective AHU is activated.
b. DDC controller modulate the exhaust fan via VFD and maintains exhaust system duct static pressure at setpoint.
c. Fan motor current status is input to DDC controller.
d. Provide the following DDC alarm, status and monitoring points at the control panel:
1) Fan Status (on/off).
2) Fan Failure alarm.
3) Filter Maintenance Alarm
e. Interlock schedule
1) AHU-1 and EF-13
2) AHU-2 and EF-14

H. Medical Gas Cylinder Room Exhaust Fan, EF-15
1. Medical gas cylinder room exhaust fan is controlled by a local wall switch, normally on. DDC controller shall energize the fan when the wall switch is activated and de-energize the fan when the wall switch is deactivated.
2. The DDC controller can override the wall switch for continuous operation if desired.
3. Fan motor current status is input to DDC controller. DDC controller provides runtime totalizer function for maintenance activities.
4. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. status (on/off).
b. Fan Failure alarm.

I. Air Valves
1. DDC controller sets occupied or unoccupied mode of operation based upon DDC time clock. Constant or variable air volume is determined by Duct and Air Valve schedules on drawings.
a. Constant Air Volume Air Valve Occupied Mode of operation
1) Air valve reheat coil control valve (if applicable) opens upon call for heat.
2) Supply or exhaust air flow controlled by factory set mechanical linkages.
b. Variable Air Volume Air Valve Occupied Mode of Operation
1) Air valve modulates between minimum and maximum airflow setpoints to maintain space setpoint, 22 degrees C (72 degrees F), adjustable.
3) If the air valve is at minimum airflow, finned tube control valve (if applicable) opens upon call for heat.
4) If air valve is at minimum airflow and finned tube control valve is open (if applicable), reheat coil control valve opens upon call for heat.
c. Unoccupied Mode of Operation
1) Air valve reheat coil control valve (if applicable) is closed.
2. Provide the following DDC alarms, status and monitoring points at the control panel:
a. Space temperature setpoint, 22 degrees C (72 degrees F), adjustable.
b. Space temperature.
c. Minimum airflow setpoint (for variable air volume type).
d. Maximum airflow setpoint (for variable air volume type).

L. VAV Terminal Units
1. DDC controller sets occupied or unoccupied mode of operation based upon DDC time clock.
a. Occupied Mode of operation
1) VAV damper modulates between minimum and maximum airflow setpoints to maintain space setpoint, 22 °C (72 °F), adjustable.
2) If VAV is at minimum airflow, finned tube control valve (if applicable) opens upon call for heat.
3) If VAV is at minimum airflow and finned tube control valve (if applicable) is open, VAV reheat coil control valve opens upon call for heat.
2. Provide the following DDC alarms, status and monitoring points at the control panel:
a. Space temperature setpoint, 22 °C (72 °F), adjustable.
b. Space temperature.
c. Minimum airflow setpoint.
d. Maximum airflow setpoint.

M. Air Valve After-filters for O.R. ID222 and Procedure Room ID218
a. Differential pressure across the filter is input to the DDC controller.
b. DDC controller initiates a maintenance alarm when the differential pressure across the filter rises above 250 Pa (1.0 i.w.g.), adjustable.
c. The following DDC maintenance alarm shall be provided at the control panel:
a) Filter maintenance alarm.

6 HUMIDIFICATION
A. Air Compressors, AC-1, AC-2.
1. Air compressors are controlled by manufacturer's packaged controller to maintain 100 psi.
2. Compressor motor current status is input to the DDC controller.
5. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. Low pressure alarm.

B. Air Handling Unit Humidification Method and Control
1. On a call for humidity, the DDC system signals a proportional control panel to modulate the water atomizing output to maintain the space at humidity setpoint.
2. Provide the following DDC alarm, status, and monitoring points at the control cabinet:
a. High humidity alarm, initially set at 60 percent relative humidity (adjustable)
b. Low humidity alarm, initially set at 20 percent relative humidity (adjustable).
c. Control cabinet power failure alarm.

C. Duct Humidification Method and Control (Operating and Procedure Room)
1. On a call for humidity, the DDC system signals a proportional control panel to modulate the water atomizing output to maintain the space at humidity setpoint.
2. Provide the following DDC alarm, status, and monitoring points at the control cabinet:
a. High humidity alarm, initially set at 60 percent relative humidity (adjustable).
b. Low humidity alarm, initially set at 20 percent relative humidity (adjustable).
c. Control panel power failure alarm.

7 PLUMBING
A. Hot Water Generators HWG-1 and HWG-2
1. Packaged controller shall provide 55 degrees C (130 degrees F) hot water.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. High temperature alarm.
b. Low temperature alarm.

B. Hot Water Generators HWG-3
1. Packaged controller provides 130°F hot water.

C. Hot Water Generators HWG-4
1. Packaged controller provides 170°F hot water.

D. Domestic Hot Water Pump P-16
1. Domestic hot water pump runs continuously.
2. Provide the following DDC alarm, points at the control panel:
a. Pump failure alarm.

E. Softened Water Hot Water Pump P-17
1. Softened hot water circulator pump runs continuously during the hours between 0600 and 1800. The pump is shut off during the hours between 1800 and 0600.
2. Provide the following DDC alarm, status, and monitoring points at the control panel.
a. Pump failure alarm.

F. Kitchen Hood Hot Water Pump P-18
1. Kitchen hood high temperature hot water pump runs continuously between the hours 1700 and 2000. The pump is shut off between the hours 2000 and 1700.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. Pump failure alarm

G. Elevator Sump Pump P-15 A/B
1. Elevator Sump Pump is controlled by manufacturers packaged controller.
2. Provide the following DDC alarm, status, points at the control panel:
a. High sump level alarm.

H. Stairwell Sump Pump P-19
1. Elevator Sump Pump is controlled by manufacturers packaged controller.
2. Provide the following DDC alarm, status, points at the control panel:
a. High sump level alarm.

8 ENGINE GENERATOR
A. Remote Radiator
1. Upon initiation of engine generator, remote radiator fan is energized.
2. Provide the following DDC alarm, status, and monitoring points.
a. Remote radiator fan status (on/off)
b. Remote radiator fan failure alarm.

B. Charge Air Cooler
1. Upon initiation of engine generator, the charge air cooler primary pump, (P-15A/B) is energized.
2. Pumps alternate as follows:
a. Rotation from lead pump to lag pump after every generator shutdown so that pumps are alternating for every generator run condition.
b. Automatic switching from lead pump to lag pump when a failure occurs.
c. A 15 second time lag between the stoppage of lead pump and the starting of the lag pump can occur.
3. The following DDC alarm, status and monitoring points shall be provided at the control panel:
a. Pump status (on/off)
b. Pump failure alarm.

9 MEDICAL SYSTEMS
A. Vacuum Pump
1. Vacuum pump is controlled by manufacturers packaged controller.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. Low pressure alarm.

B. Air Compressor
1. Air compressor is controlled by manufacturers packaged controller.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
a. Low pressure alarm.

Sequence of Operation

10 DENTAL SYSTEMS

A. Vacuum Pump

1. Vacuum pump is controlled by manufacturers packaged controller.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
   a. Low pressure alarm.

B. Air Compressor

1. Air compressor is controlled by manufacturers packaged controller.
2. Provide the following DDC alarm, status, and monitoring points at the control panel:
   a. Low pressure alarm.

11 ELECTRICAL SYSTEMS

A. Heat tape

1. DDC controller provides enable signal to electrical heat tape system when OSA temperature is below 2 °C (35 °F), adjustable. A line voltage (120V) rated relay is provided for control.

B. Interior lighting

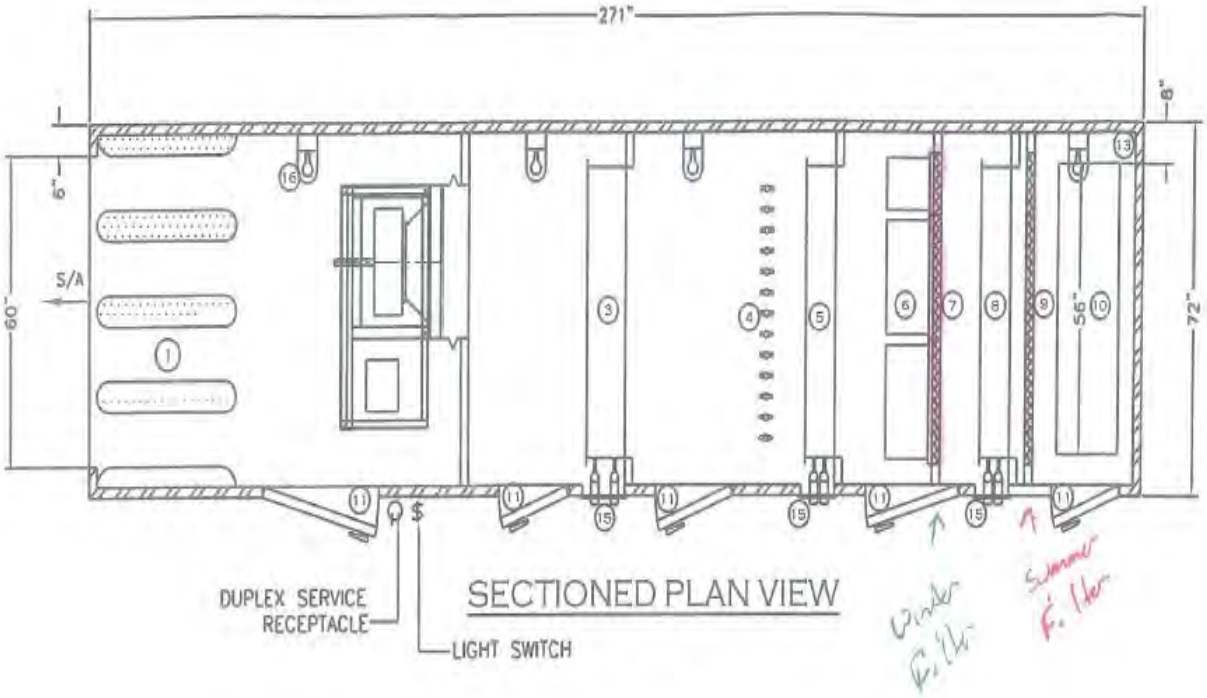
1. For corridor lighting, the DDC time clock schedules occupied (on) and unoccupied (off) modes. Occupied mode begins at 6:01 a.m. and end at 7:00 p.m. Monday through Friday. Unoccupied mode begins at 7:01 p.m. and end at 6:00 a.m. Monday through Thursday and begins 7:01 p.m. Friday and end 6:00 a.m. Monday (Adjustable).
2. Local momentary contact override switches provide on/off manual control of their respective lighting zones.
   a. Placing an override switch in the ON position will enable the corresponding lighting zone for one hour (adjustable) and then resume the normal occupied/unoccupied schedule for that zone.
   b. Placing an override switch in the OFF position will disable the corresponding lighting zone until the occupied schedule for that zone cycles on again unless the override switch is placed in the ON position.

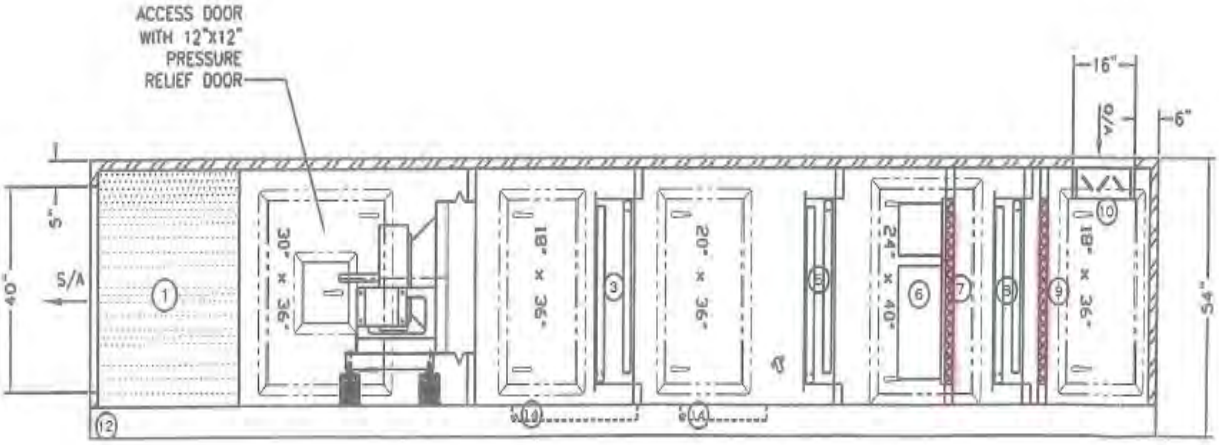
C. Exterior lighting

1. Building photocell provides enable signal for exterior lighting through the DDC controller.
2. Exterior perimeter lighting photocell enable signal shall be capable of manual override through the DDC controller.

AHU Schematics are shown below.

3.1.1 VAV Single-Pass AHU without DX coil: Schematic Drawings

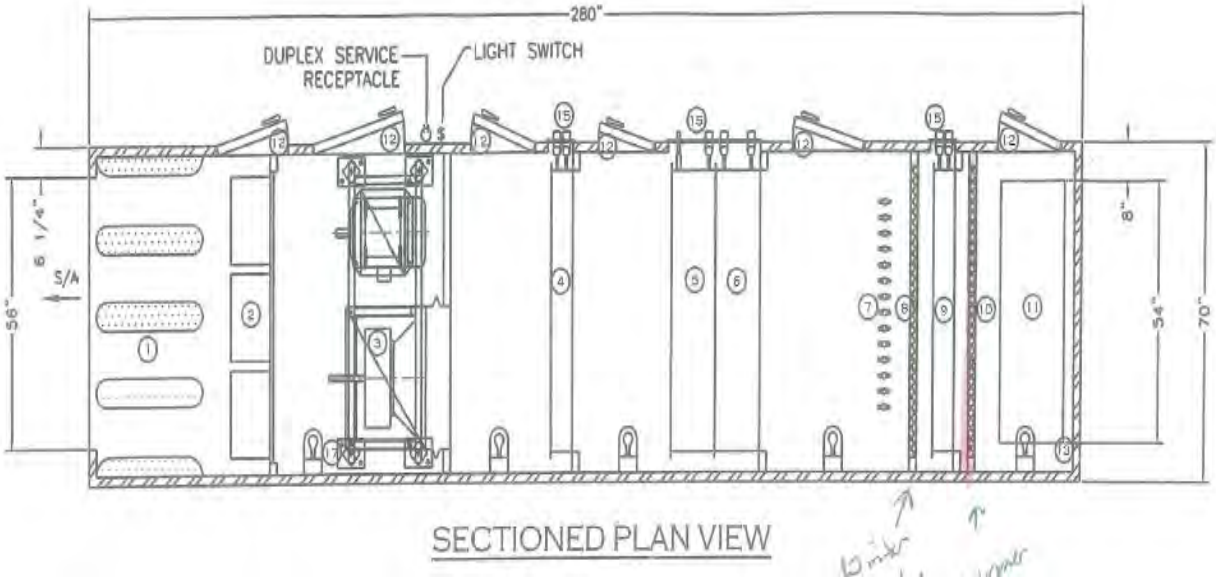


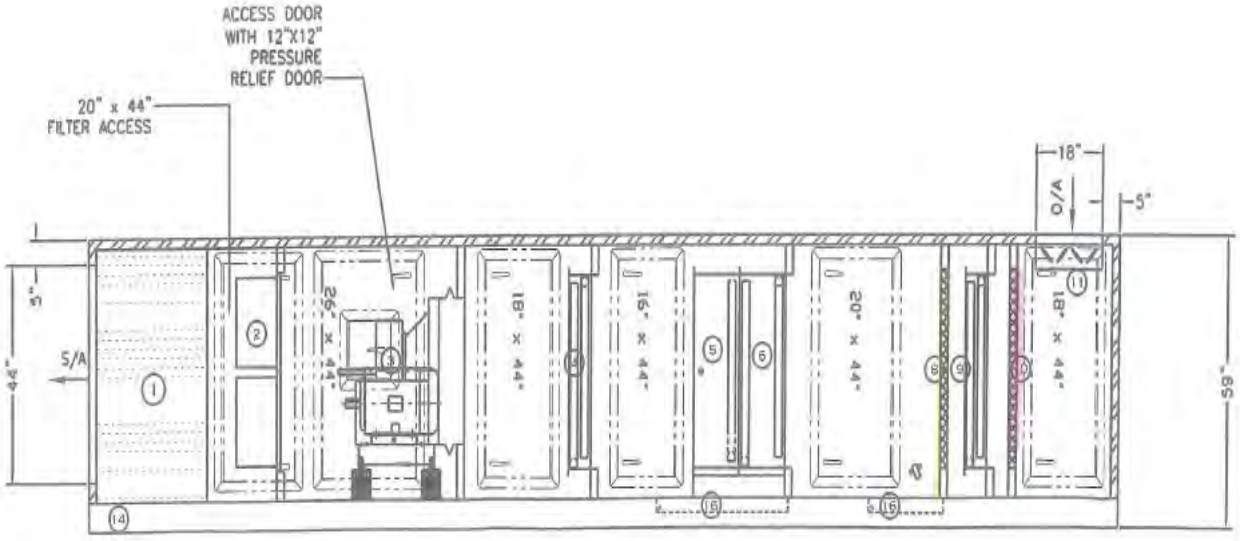


DRAWING LEGEND

1. S/A SILENCER
2. 20" PLENUM SUPPLY FAN C/W 15 HP MOTOR
3. COOLING COIL
4. ATOMIZING HUMIDIFIER
5. HEATING COIL
6. 12" 85% CARTRIDGE FINAL FILTERS
7. 2" 30% PLEATED WINTER PRE-FILTER
8. PRE-HEATING COIL
9. 2" 30% PLEATED SUMMER FILTERS
10. O/A DAMPER 56" W X 16"H
11. ACCESS
12. 6" BASE CHANNEL
13. 2" INSULATED CABINET
14. DRAIN PAN
15. COIL PULL ACCESS
16. MARINE LIGHT (TYP.)

3.1.2 VAV Single-Pass AHU with DX coil: Schematic Drawings

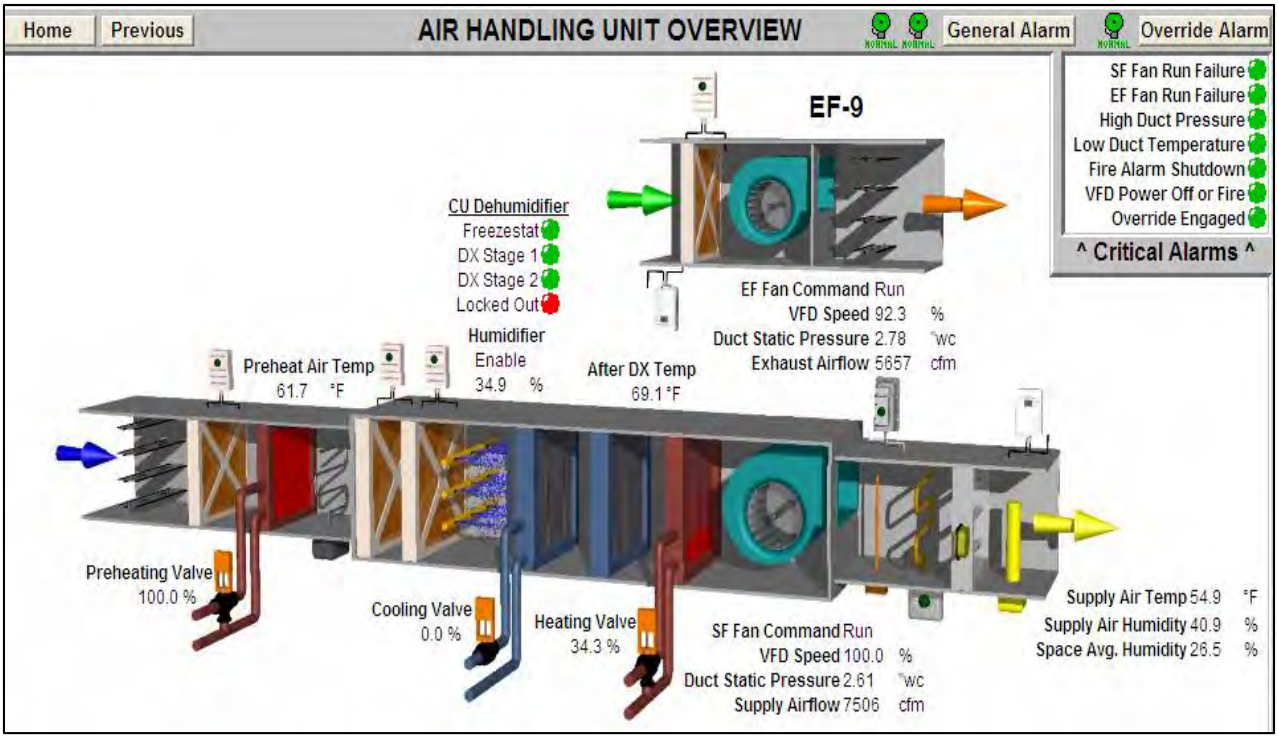




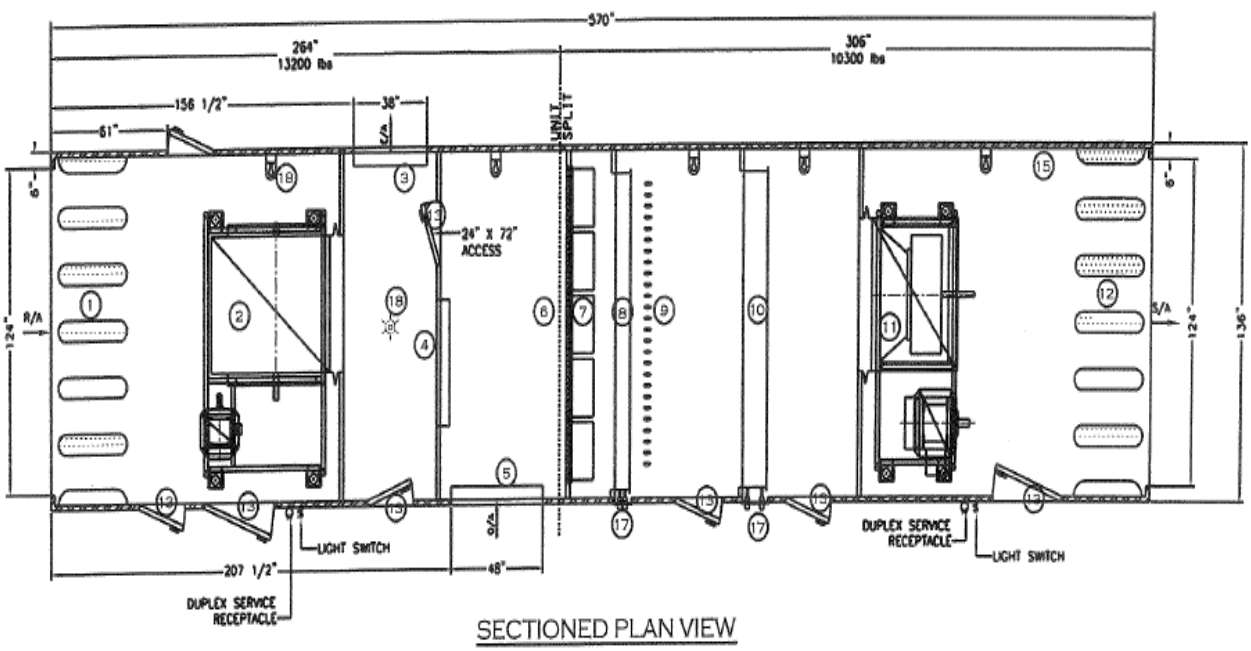
SECTIONED PROFILE VIEW

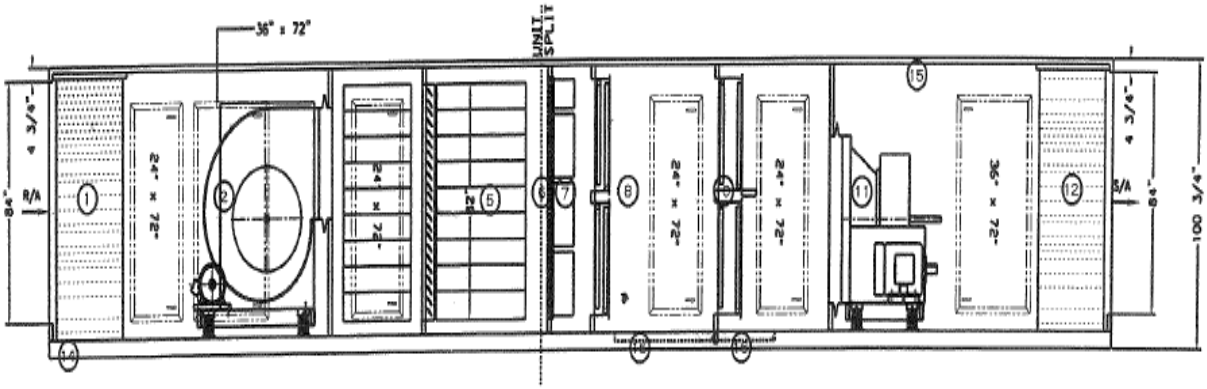
DRAWING LEGEND

1. S/A SILENCER
2. 12" 95% FINAL FILTERS
3. 20" PLENUM SUPPLY FAN C/W 20 HP MOTOR
4. RE-HEAT COIL
5. DX COOLING COIL
6. CHILLED WATER COOLING COIL
7. ATOMIZING HUMIDIFIER
8. 2" 30% PLEATED WINTER PRE-FILTER
9. PRE-HEAT COIL
10. 2" 30% PLEATED SUMMER PRE-FILTER
11. 54"W x 18" H O/A DAMPER
12. ACCESS
13. 2" INSULATED CABINET
14. C6 X 8.2 BASE CHANNEL
15. COIL PULL ACCESS
16. DRAIN PAN
17. MARINE LIGHT (TYP.)



3.1.3 VAV Re-Circulating AHU with Economizer: Schematic Drawings

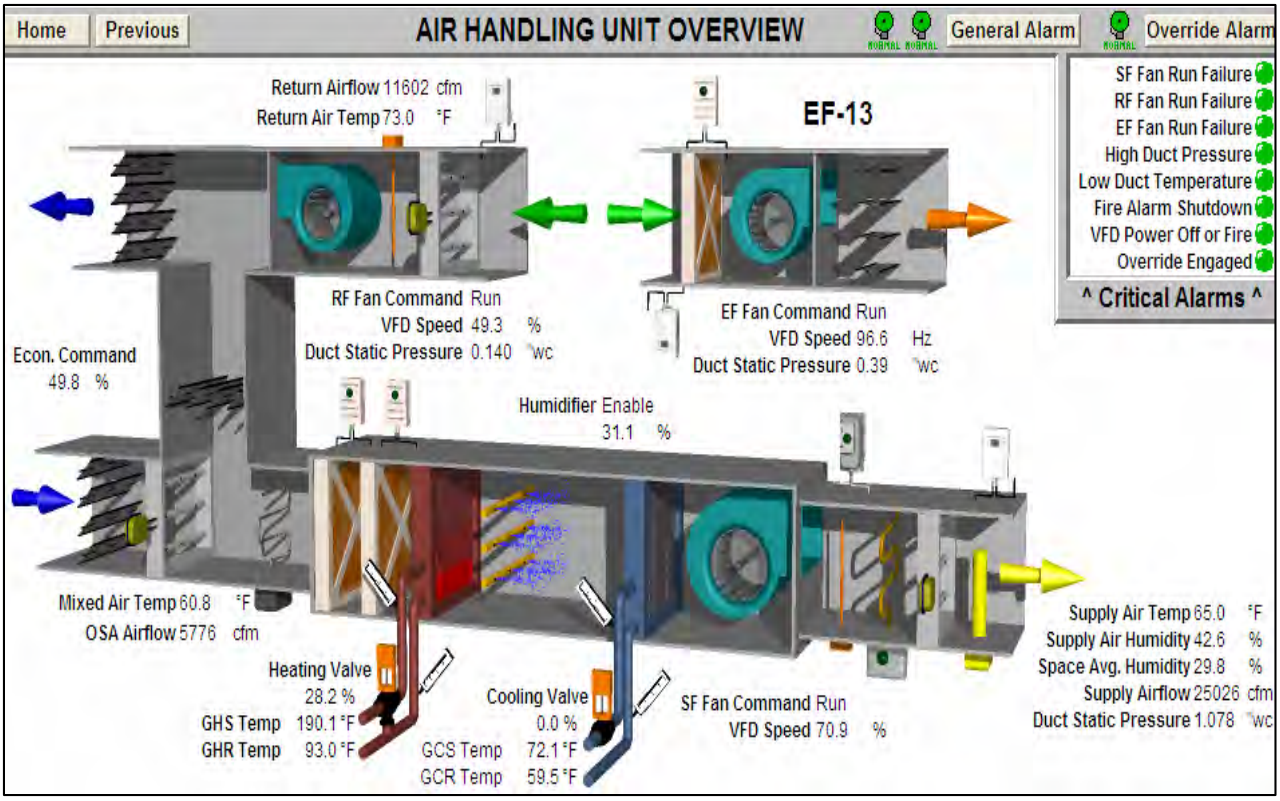




SECTIONED PROFILE VIEW

DRAWING LEGEND

1. SILENCER R/A
2. 36" DWDI RETURN AF FAN 20 HP MOTOR
3. E/A DAMPER 38"W X 82"H
4. MIXING DAMPER 48" W X 82" H
5. O/A DAMPER 48" W X 82"H
6. 2" 30% PLEATED FILTERS
7. 12" 85% CARTRIDGE FINAL FILTERS
8. HEATING COIL
9. ATOMIZING HUMIDIFIER
10. COOLING COIL
11. 44" PLENUM AF SUPPLY FAN 50 HP MOTOR
12. S/A SILENCER
13. ACCESS
14. 6" BASE CHANNEL
15. 2" INSULATED CABINET
16. DRAIN PAN
17. COIL PULL ACCESS
18. MARINE LIGHT (TYP.)


Home
Previous
AIR HANDLING UNIT OVERVIEW
General Alarm
Override Alarm
Return Airflow 11602 cfm
Return Air Temp 73.0 °F
EF-13
SF Fan Run Failure
RF Fan Run Failure
EF Fan Run Failure
High Duct Pressure
Low Duct Temperature
Fire Alarm Shutdown
VFD Power Off or Fire
Override Engaged
^ Critical Alarms ^
RF Fan Command Run
VFD Speed 49.3 %
Duct Static Pressure 0.140 "wc
EF Fan Command Run
VFD Speed 96.6 Hz
Duct Static Pressure 0.39 "wc
Econ. Command
49.8 %
Humidifier Enable
31.1 %
Mixed Air Temp 60.8 °F
OSA Airflow 5776 cfm
Heating Valve
28.2 %
GHS Temp 190.1 °F
GHR Temp 93.0 °F
Cooling Valve
0.0 %
GCS Temp 72.1 °F
GCR Temp 59.5 °F
SF Fan Command Run
VFD Speed 70.9 %
Supply Air Temp 65.0 °F
Supply Air Humidity 42.6 %
Space Avg. Humidity 29.8 %
Supply Airflow 25026 cfm
Duct Static Pressure 1.078 "wc

Appendix-D

For Final RCx Report

Building Occupant Interviews

VISN 20 Alaska VA Healthcare System

Building Occupant Interviews and Goals

JANUARY 28, 2013

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

Prepared by:

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3.0 APPENDIX A 8

ACRONYMS

BOD	Basis of Design
CWP	Condenser Water Pump
CWR	Condenser Water Return
DHRC	Dedicated Heat Recovery Chiller
DHW	Domestic Hot Water
EMS	Energy Management System
GPM	Gallons per Minute
GSHP	Ground Source Heat Pump
hp	Horsepower
SCW	Softened Cold Water
TAB	Testing and Balancing

1.0 Introduction

As part of its RCx efforts at VISN 20 Anchorage VA Medical Center, DAV Energy presents the following results of the Building Occupant Interviews

This is being completed under **Key Deliverable 4-Building Occupant Interview and Goals**.

As part of the RCx process, interviews were conducted to gather information from facility operators and occupants. This report provides an overview of the interview process and the interviewees. It summarizes the opinions of the interviewees regarding comfort, air quality, infection control, energy use and conservation, HVAC system sizing and balance. The potential improvement opportunities revealed through interviews are discussed and how the process goals could be fine-tuned with the feedback gathered.

The following summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	**Building Occupant Interviews & Goals**	**Complete**
5	Facility Performance Analysis & Performance Baseline	In Progress
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	3/26/2014
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Occupant Interviews

Interviews with key facilities staff and occupants are important to understand the current needs and issues related to system operation and maintenance, known design and space deficiencies, facility staff training and occupant education needs, indoor air and environmental quality, and occupant comfort/satisfaction. The intent of interviews is also to help uncover potential improvement opportunities, confirm the Current Facilities Requirements (CFR), and develop consensus on the RCx process goals.

2.1 INTERVIEW PROCESS

The RCx team was on site on 11/22/2013 performing in person interviews with key facility operators. Each interview included the same set of questions in order to find answers to the project goals.

2.1.1 Facility Operators and Maintenance Staff

The facility operators are in charge of the mechanical equipment and work orders regarding occupant comfort at each respective building. They have the most extensive knowledge and familiarity with the buildings, HVAC systems, and related issues. They interact with the occupants and work continually on the mechanical equipment in order to resolve indoor environmental quality issues. In addition, facility operators can answer questions related to design and space deficiencies, and issues related to system operations and maintenance.

The following table lists the facility operators that were interviewed. The completed interview forms are compiled in Appendix A.

Table 2-1: Operator Interview summary

Name	Title / Role
Gerry Xavier, VA	Buildings Operations Chief
Mark Blehm, VA	HVAC Contact
Mike Kief, FSI	Building-Automation System Contact

2.1.2 Building Occupants

Interviews with select hospital staff were conducted to establish occupant comfort/satisfaction and specific space requirements. The following table lists those that were interviewed representing building occupants. The completed interview forms are compiled in **Appendix A**.

Table 2-2: Occupant Interview summary

Name	Building Area
Calvin Jackson	Operating Room Area of Clinic
Judie Jordan	Laboratory
David Mausent	2C Wing of Clinic
Julie Reloza-Keating	1D Wing of Clinic
Diane Walters	2D Wing of Clinic
Nicole Perry	2D Wing of Clinic

2.2 SUMMARY OF INTERVIEW INFORMATION

The answers from the interviews were compiled and the following section summarizes the opinions of the interviewees regarding comfort, air quality, infection control, and energy conservation.

2.2.1 Heating, Cooling and Other Comfort Issues

The laboratory gets too hot in the summer. There are multiple large refrigerators in the space and the current supply air and exhaust system can't maintain the space at required temperatures. If the laboratory space temperature requirements cannot be maintained no work can be conducted until temperature is within allowable limits. To mitigate the issue the occupants keep the doors open and use and portable industrial fans to blow air away from the refrigerators. Speculations into reasons is that it is either the layout of the supply and exhaust or a possible under sizing of AHU-9 cooling and/or air moving capacity.

Most comfort complaints are due to the thermostat located in another person's office and often stem from differences in personal preference. Another problem is the many space heaters that people bring in for their own comfort. Areas where open offices were converted to individual offices are hard to control. Some of them will experience simultaneous heating and cooling as they have baseboard from one VAV zone while the air is supplied from different VAV. Part of the remodel included long runs of flex duct which reduce the airflow; this can also be a reason for discomfort.

The learning lab (Rm. 2D116) has 12 computers and gets uncomfortably warm when fully occupied.

The stairwell located in the south east corner of the A-wing gets extremely hot with the solar load on the glass walls. Space temperature is often over 100°F in the summer. There seems to be no circulation of air, upon inspection the RCx team found that the return air inlet and supply air outlet are located next to each other and the return air opening of the fan coil unit is not ducted to the plenum.

Elmendorf limits the chilled water flow in the summer to prevent the underground wells from drying up. As a result, the chilled water temperature to the air handling units is between 50-52°F instead of 46°F per mechanical design drawings.

2.2.2 Air Quality Issues

There are no complaints about air quality.

2.2.3 Infection Control Issues

Due to the laboratory being too hot in the summer, the lab doors are kept open and a temporary fan is used in the space. Keeping doors open and blowing air is an infection control issue.

2.2.4 HVAC System Airflow Balance

No issues reported.

2.2.5 Energy Conservation Measures

No issues reported.

2.2.6 Operation and Maintenance Issues

The unit heaters will freeze up in the penthouses.

The water contains a lot of minerals and the AHU chilled water coils will fill up with mineral deposits when the humidification is running. The static pressure increases beyond operational limits and the calcification deposits can significantly reduce the airflow distributed to the spaces. Building operators clean the coils, and are testing different cleaners, but are worried about the longevity of the coils.

The humidification dispersion units in AHU-8 and AHU-9 freeze up when it’s cold, and operators have to physically remove them to let them defrost.

There are issues with evenly distributed airflow over the preheat coil in AHU-9 and the heating coil in AHU-3. A few pieces of cardboard are being used to re distribute airflow, and prevent sections of coil from freezing out and blocking flow.

Sometimes water has to be poured on the snowmelt sensor to keep the system going to clear the whole area in the back of the building. This occurs when the sensor does not detect moisture, while there is still snow on the pavement.

2.3 IDENTIFIED RCX PROJECT GOALS (TRENDING, TESTING AND TAB)

The information collected during the interview process revealed that certain areas and mechanical systems were associated with more frequent issues. This information will help guide selections for system trending, testing, and TAB measurements. Additional feedback pertaining to project goals was gathered during the interviews including the following:

- TAB measurements should assist in identifying or diagnosing if airflow, cooling coil and heating water coil issues are present for AHU-8 and AHU-9.
- A representative sample of VAV boxes and space temperatures should be trended to further understand the space comfort issues.

2.4 POTENTIAL IMPROVEMENT OPPORTUNITIES

Interviews with facility operators and building occupants were also used to uncover potential areas for improvement opportunities. Based on the interview feedback, the following major improvement opportunities were identified:

- The medical gas exhaust fan is ducted into exhaust for EF-11. Should EF-11 be off and the medical gas exhaust fan be on, medical gas would go back into the building. A controls interlock should be implemented to prevent this from occurring.
- Treatment of water going to the humidifiers. The purpose of Humidifier Water Treatment Systems would be to prevent scaling and precipitation of source water minerals which cause low heat transfer efficiency, high maintenance costs and affect the longevity of the coils. Reverse osmosis filtration of the humidification water should be implemented.
- Revise ACCU-15 to better remove heat from Stair 2 (change return duct location).

3.0 APPENDIX A

COMPLETED INTERVIEW FORMS

OCCUPANT INTERVIEW FORM – MAINTENANCE STAFF

Project Name: RCx Alaska VA Healthcare System	**Site Contact Name(s)** **Mike Kief**
Survey By:	**Site Contact Phone**
Survey Date	**Site Contact E-Mail**

Briefly describe the Renovation, Retrofit and Equipment Replacement history for this site:	Construction was completed and the building was occupied in 2010. A few revisions were made to the floor plan just before the building was occupied. • In section 1D East a locker was turned into a larger clean linen. • Open office space was turned into offices in work area 2D125 •
Briefly describe site Control Systems – Make, Age, Capabilities:	BAS is Allerton version 2.6, originally installed in 2010 and the system has the latest updates. BAS controls all HVAC equipment with the exception of a few locally controlled unit heaters.
Is the Control System capable of providing Trending Data? Is it set up to do so? How much memory is available?	Yes, BAS is trending most of the points that were included in the original commissioning of the system. The hard drive was emptied and older trends moved to discs in order to prevent it from filling up.
What control system upgrades would you like to see implemented?	None, the BAS does what it needs to.
From which areas in the building do you receive the greatest number of complaints for heating, cooling or other comfort problems?	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized. Most comfort complaints are due to the thermostat located in another person's office. Areas where open offices were converted to individual offices are hard to control. Some of them will experience simultaneous heating and cooling as they have baseboard from one VAV zone while the air is supplied from different VAV. Part of the remodel included long runs of flex duct which reduces the airflow. The learning lab 2D116 has 12 computers and gets too warm when fully occupied. The stair located in the south east corner of the A-wing get extremely hot with the solar load. Space temperature is over 100 deg F in the summer. There seems to be no circulation of air, the RA and SA is located next to each other and the RA opening of the fan coil unit is not ducted to the RA plenum.
Are there zones with air quality issues and what are the typical complaints?	None.

Are there zones with infection control issues? Please, describe the issues in detail .	None.
What would you describe as your worst building problem and how do you deal with that?	Can't run humidification year around. See description below.
Briefly describe site HVAC Systems - Equipment Age, Make, Capacities, and Configuration:	The building utilizes heating and cooling water served via heat exchangers from a central plant with natural gas boilers and ground water cooling wells located on nearby Elmendorf Air force Base. In the VA clinic, duplex 100% capacity base mounted pumps are used to provide circulation through heat exchangers and distribution loops. Ten air handling units provide ventilation and conditioning to the spaces. Air is distributed to zone VAV boxes with hot water heating coils. Perimeter zones have additional hot water baseboard to meet heating loads. Relative Humidity (RH) is maintained in all building spaces with humidification modules within the AHUs utilizing air atomization. Two central compressors provides 100psig compressed air for the humidification system. Spaces that require greater RH levels utilizes air atomization in local ductwork serving the respective space. An additional air handling unit served the generator room. A snowmelt system consisting of a heat exchanger and pumps provides snow melting for four zones.
What know issues do you have with the HVAC equipment?	The unit heaters will freeze up in the penthouses. The water contains a lot of minerals and the AHU chilled water coils will fill up with mineral deposits when the humidification is running. The static pressure goes way up and it really reduces the airflow distributed to the spaces. We clean the coils, and are testing different cleaners, but we are worried about the longevity of the coils. In addition the humidification dispersion units in AHU-8 and 9 freeze up when it's cold, and we have to remove them to let them defrost. There are issues with evenly distributed airflow over the preheat coil in units 9 and the heating coil in AHU-3. A few pieces of cardboard is being used to re distribute airflow. The medical gas exhaust fan is ducted into exhaust for EF-11. Should EF-11 be off and the medical gas exhaust fan be on, medical gas would go back into the building. Sometimes we have to pour water on the snowmelt sensor to keep the system going to clear the whole area.
Has Heating System always met Load? Under what conditions has your heating system not met load? What was the solution to this problem?	Yes
Has Cooling System always met Load? Under what conditions has	No, AHU-9 cannot meet cooling load in lab. Elmendorf limits the chilled water flow in the summer to prevent the underground

your cooling system not met load? What was the solution to this problem?	wells from drying up. As a result, the chilled water temperature to the air handling units is between 50-52 deg F instead of 46 deg F per mechanical drawings.
How are the HVAC systems scheduled?	AHU-6&9 24/7. All other AHUs 6am-7pm
What HVAC adjustments do you make to unoccupied areas or spaces (turn off HVAC, adjust thermostat to minimum heating and cooling, close off damper, etc.)?	None
Do you feel you have any undersized or oversized HVAC equipment?	AHU-9 undersized cooling. We increased the flow through the coil by recommendation from eh manufacturer but we still don't have enough cooling in the space.
In your opinion, is the building HVAC system well balanced? If no, explain:	Yes.
Do you maintain and utilize a Computerized Maintenance Management System? Describe:	Vista is used to enter workorders and as a checklist.
What are some <u>recent</u> energy conservation measures that have been implemented?	None. The OA reset for the HGS was removed in the building due to keep the boiler operating stable.

<u>Other Observations & Comments</u>

The flow meter for utility hot water is way off since it is installed too close to angles and take offs to get a good reading. The heating utility data is inaccurate as a result.

OCCUPANT INTERVIEW FORM – MAINTENANCE STAFF

Project Name: RCx Alaska VA Healthcare System	**Site Contact Name(s)** **Gerry Xavier**
Survey By:	**Site Contact Phone**
Survey Date	**Site Contact E-Mail Gerry.xavier@va.gov**

How do you monitor energy use and cost?	Mark gathers utility bills, clerks and pays. Steve Mathes might track and benchline.
Are there any previous energy study documents available?	Check with Steve Mathes. The building has an energy star rating. Energy score of 75.
Briefly describe the Renovation, Retrofit and Equipment Replacement history for this site:	See conversation with Mike Kief
Briefly describe site Control Systems – Make, Age, Capabilities:	See conversation with Mike Kief
Is the Control System capable of providing Trending Data? Is it set up to do so? How much memory is available?	See conversation with Mike Kief
What control system upgrades would you like to see implemented?	See conversation with Mike Kief
From which areas in the building do you receive the greatest number of complaints for heating, cooling or other comfort problems?	See conversation with Mike Kief
Are there zones with air quality issues and what are the typical complaints?	See conversation with Mike Kief
Are there zones with infection control issues? Please, describe the issues in detail .	Talk to the infection control nurse Deb Riner and Industrial Hygenist Linda Perone 907-257 3711
What would you describe as your worst building problem and how do you deal with that?	The building envelope. Condensation is forming in the walls of the penthouses and the water leaks into the ceilings below. The roof is forming large bubbles. An envelope study has been performed but no solution or cause of action has been determined.

	Slips trips and falls plans to expand snowmelt
Briefly describe site HVAC Systems - Equipment Age, Make, Capacities, and Configuration:	See conversation with Mike Kief
Has Heating System always met Load? Under what conditions has your heating system not met load? What was the solution to this problem?	See conversation with Mike Kief
Has Cooling System always met Load? Under what conditions has your cooling system not met load? What was the solution to this problem?	See conversation with Mike Kief
How are the HVAC systems scheduled?	See conversation with Mike Kief
What HVAC adjustments do you make to unoccupied areas or spaces (turn off HVAC, adjust thermostat to minimum heating and cooling, close off damper, etc.)?	See conversation with Mike Kief
Do you feel you have any undersized or oversized HVAC equipment?	See conversation with Mike Kief
In your opinion, is the building HVAC system well balanced? If no, explain:	See conversation with Mike Kief
Do you maintain and utilize a Computerized Maintenance Management System? Describe:	See conversation with Mike Kief

What are some <u>recent</u> energy conservation measures that have been implemented? How well do you think they were implemented? Are there any other energy conservation measures that you think should be implemented?	See conversation with Mike Kief

<u>Other Observations & Comments</u>

There are 6 plug in electric stations in the back, each 12amp, 120V. In addition 4 buses are plugged in where ever, smoke shack etc…

 RCx Project

JAMES
(415) 738-9097
DAV energy

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

In order to understand the current needs and issues related to the mechanical systems in the building DAV Energy is conducting interviews with a few building occupants. Please take a moment to answer the questions in the table below and feel free to enlist the opinions of your co-workers. Return the completed form to Mike Rogers, mike.rogers@davenergy.com, before ***December 24, 2013****. We sincerely appreciate your time and involvement. Please contact Mike Rogers with DAV Energy or Mark Blehm with the Anchorage VA for any questions you may have regarding the project. See contact information below.*

Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

Project Name: VISN 20 RCx Alaska	**Name of Interviewee:** Calvin Jackson
Point of Contact at the VA: Mark Blehm, mark.blehm2@va.gov	**Interviewee Contact Phone:** 257-6718
Point of Contact with DAV Energy: Mike Rogers, michael.rogers@davenergy.com	**Interviewee Contact E-Mail:** Calvin.Jackson@VA.GOV
Survey Date: 11/9/14	**Interviewee Room Number:** D 203

Are there conference rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	NO
Are there rooms in your area that are un occupied? List Room Names	NO

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	NO
Are there spaces where fans are used for additional cooling? List Room Names	NO
Are there spaces where portable unit heaters are used for additional heat? List Room Names	NO
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	NO
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	NURES Station
Are there zones with air quality issues and what are the typical complaints?	NO
Are there zones with infection control issues? Please, describe the issues in detail.	NO
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	Yes
What would you describe as your worst building problem and how do you deal with that?	My AREA : 1D203 Put on Jacket

Other Observations & Comments

James (415) 756-9097
DAV energy

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

In order to understand the current needs and issues related to the mechanical systems in the building DAV Energy is conducting interviews with a few building occupants. Please take a moment to answer the questions in the table below and feel free to enlist the opinions of your co-workers. Return the completed form to Mike Rogers, mike.rogers@davenergy.com, before ***December 24, 2013****. We sincerely appreciate your time and involvement. Please contact Mike Rogers with DAV Energy or Mark Blehm with the Anchorage VA for any questions you may have regarding the project. See contact information below.*

Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

1.9.14

Project Name: **VISN 20 RCx Alaska**	**Name of Interviewee:** Judie Jordan
Point of Contact at the VA: Mark Blehm, mark.blehm2@va.gov	**Interviewee Contact Phone:** 907.257.6973
Point of Contact with DAV Energy: Mike Rogers, michael.rogers@davenergy.com	**Interviewee Contact E-Mail:** Judith.jordan@va.gov
Survey Date:	**Interviewee Room Number:** 1C.131

Are there conference rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	No
Are there rooms in your area that are un occupied? List Room Names	YES: 1C.134 Locker room has a door closed 1C.137 File room has a door closed 1C-138 Barium room has a door closed 1C-116 Storage room has a door closed 1C-128 Storage room has a door closed 1C-141 Storage room has a door closed

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	NO
Are there spaces where fans are used for additional cooling? List Room Names	YES: 1C-147 various places in Lab
Are there spaces where portable unit heaters are used for additional heat? List Room Names	YES: 1C-131
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	NO
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	LAB: 1C-147 RAD: 1C-117 (ultrasound)
Are there zones with air quality issues and what are the typical complaints?	NO
Are there zones with infection control issues? Please, describe the issues in detail.	~~NO~~ YES: doors to 1C-147 (LAB) should stay closed.
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	YES
What would you describe as your worst building problem and how do you deal with that?	Heat in the Lab during the summer Keep open doors & use an industrial fan blowing at / away from wall of refrigerators

Other Observations & Comments

Refrigeration exhaust contributes to heat in the Lab - a walk-in refrigerator that exhausts to outside would fix our problem - !

Keeping doors open and blowing air around is an infection control issue.

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

In order to understand the current needs and issues related to the mechanical systems in the building DAV Energy is conducting interviews with a few building occupants. Please take a moment to answer the questions in the table below and feel free to enlist the opinions of your co-workers. Return the completed form to Mike Rogers, mike.rogers@davenergy.com, before ***December 24, 2013****. We sincerely appreciate your time and involvement. Please contact Mike Rogers with DAV Energy or Mark Blehm with the Anchorage VA for any questions you may have regarding the project. See contact information below.*

Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

Project Name: **VISN 20 RCx Alaska**	**Name of Interviewee:** DAVID MARCETT
Point of Contact at the VA: Mark Blehm, mark.blehm2@va.gov	**Interviewee Contact Phone:** 257-4943
Point of Contact with DAV Energy: Mike Rogers, michael.rogers@davenergy.com	**Interviewee Contact E-Mail:**
Survey Date: 1/09/14	**Interviewee Room Number:**

Are there conference rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	NO
Are there rooms in your area that are un occupied? List Room Names	NO

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	NO
Are there spaces where fans are used for additional cooling? List Room Names	YES INDIVIDUAL CUBICLES
Are there spaces where portable unit heaters are used for additional heat? List Room Names	YES CUBICLES
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	NO
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	YES
Are there zones with air quality issues and what are the typical complaints?	YES
Are there zones with infection control issues? Please, describe the issues in detail.	NO
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	YES
What would you describe as your worst building problem and how do you deal with that?	NONE

Other Observations & Comments

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

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Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

Project Name: **VISN 20 RCx Alaska**	**Name of Interviewee:** JULIE RELOZA-KEATING
Point of Contact at the VA: Mark Blehm, mark.blehm2@va.gov	**Interviewee Contact Phone:** 257-4843
Point of Contact with DAV Energy: Mike Rogers, michael.rogers@davenergy.com	**Interviewee Contact E-Mail:** JULIE.RELOZA-KEATING@VA.GOV
Survey Date: 1·9·2014	**Interviewee Room Number:** 1D-110

Are there conference rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	YES- CLINIC ROOMS - 1D- 107, 108, 109, 111, 113, 135 Patient Care Rooms USED 0830-1530 Each pod has 3-5 people in it @ any time
Are there rooms in your area that are un occupied? List Room Names	1D-101, 1D-159 1D-134 - Duty Utility 1D-155 1D-156 > Supply Room

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	NO
Are there spaces where fans are used for additional cooling? List Room Names	NO
Are there spaces where portable unit heaters are used for additional heat? List Room Names	YES 1D-110, 1D-115, 1D-145 1D-143 1D-164 1D-171
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	1D-110, 1D-145, 1D-143
Are there zones with air quality issues and what are the typical complaints?	
Are there zones with infection control issues? Please, describe the issues in detail.	
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	YES
What would you describe as your worst building problem and how do you deal with that?	AC ~~too~~ can get too cold during Summer months → turn on heater / Layer clothing / blanket from OR

Other Observations & Comments

Bogue

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

In order to understand the current needs and issues related to the mechanical systems in the building DAV Energy is conducting interviews with a few building occupants. Please take a moment to answer the questions in the table below and feel free to enlist the opinions of your co-workers. Return the completed form to Mike Rogers, mike.rogers@davenergy.com, before ***December 24, 2013****. We sincerely appreciate your time and involvement. Please contact Mike Rogers with DAV Energy or Mark Blehm with the Anchorage VA for any questions you may have regarding the project. See contact information below.*

Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

Project Name: VISN 20 RCx Alaska	**Name of Interviewee:** Diane Walters
Point of Contact at the VA: Mark Blehm, mark.blehm2@va.gov	**Interviewee Contact Phone:** 257x5480
Point of Contact with DAV Energy: Mike Rogers, michael.rogers@davenergy.com	**Interviewee Contact E-Mail:** Diane.Walters3@va.gov
Survey Date: 1-9-14	**Interviewee Room Number:** 2D-183

Are there conference rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	Every Rm. in our area are occupied everyday there are 2 Rooms - Conf Rms occupied quite a lot ECR / DCR - usually chilly
Are there rooms in your area that are un occupied? List Room Names	No

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	NO
Are there spaces where fans are used for additional cooling? List Room Names	NO
Are there spaces where portable unit heaters are used for additional heat? List Room Names	Yes - Rm 2D-185
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	No
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	Front + Back Rec are mostly Cold 2D183 ~~2D-196~~ 2D-192
Are there zones with air quality issues and what are the typical complaints?	N/A
Are there zones with infection control issues? Please, describe the issues in detail.	N/A
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	yes
What would you describe as your worst building problem and how do you deal with that?	usually chilly in our area - most complain but we wear extra clothing

Other Observations & Comments

Dir. Office 2D-196 > chilly
2D-199

Dear Sir or Madam,

The Department of Veterans Affairs is implementing a retro-commissioning (RCx) program for the Alaska VA Healthcare System in Anchorage, AK. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning (HVAC) systems in existing buildings. RCx is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants.

In order to understand the current needs and issues related to the mechanical systems in the building DAV Energy is conducting interviews with a few building occupants. Please take a moment to answer the questions in the table below and feel free to enlist the opinions of your co-workers. Return the completed form to Mike Rogers, mike.rogers@davenergy.com, before ***December 24, 2013****. We sincerely appreciate your time and involvement. Please contact Mike Rogers with DAV Energy or Mark Blehm with the Anchorage VA for any questions you may have regarding the project. See contact information below.*

Thank you,

The DAV Energy RCx Team

OCCUPANT INTERVIEW FORM – BUILDING STAFF

Project Name: VISN 20 RCx Alaska	**Name of Interviewee:** Nicole Perry
Point of Contact at the VA: Mark Blehm, mark.blehm2@va.gov	**Interviewee Contact Phone:** 257-7484
Point of Contact with DAV Energy: Mike Rogers, michael.rogers@davenergy.com	**Interviewee Contact E-Mail:** nicole.perry2@va.gov
Survey Date:	**Interviewee Room Number:** 2D-122

Are there conference rooms, shared offices or other rooms in your area that regularly have many occupants? List Room Name, Type, No of Occ and approx. hours per week of occupancy.	2D-119, 4 2D-118, 4 40 hrs 2D-117B- conf Room
Are there rooms in your area that are un occupied? List Room Names	

Are there spaces in which the supply air diffuses are blocked or altered with to improve comfort? List Room Names	no
Are there spaces where fans are used for additional cooling? List Room Names	2D-118 2D-122
Are there spaces where portable unit heaters are used for additional heat? List Room Names	2D-119 2D 117A
Are there any known issues with air pressurization? An example would be a door that won't shut or that is hard to open	no
From which areas do you receive the greatest number of complaints for heating, cooling or other comfort problems?	2D-119 2D-118
Are there zones with air quality issues and what are the typical complaints?	Automobile exhaust fumes - 2D-119
Are there zones with infection control issues? Please, describe the issues in detail.	no
Area you familiar with the process of entering a work order to the facility maintenance staff when you have an issue with something building related?	yes
What would you describe as your worst building problem and how do you deal with that?	• Overhead paging system volume too loud & unable to be adjusted in offices. Disruptive to work. • Fluctuating & difficult to control temps. • Widely fluctuating temps - hot to cold - cold draft outside office 2D-118 - frequently hotter so that have to use fan

Other Observations & Comments

If thermostat in 2D-122 is turned up to 75 the back 1/2 of the area is a good temp, but the front 1/2 is too hot. If temp is at 72 back 1/2 is freezing

Appendix-E

For Final RCx Report

Facility Performance Analysis and Benchmarking

VISN 20 Alaska VA Healthcare System

Facility Performance Analysis and Performance Baseline

FEBRUARY 25, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

Prepared by:

DAV Energy Solutions, Inc.
1804 Garnet Ave, Suite 279
San Diego, CA 92109
(619) 770-8552

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ABBREVIATIONS

AC/ACU	Air conditioning / Air conditioning unit	HX	Heat exchanger
AH/AHU	Air handler / Air handling unit	kBtu	Thousand British thermal units
BAS	Building automation system	kLb	Thousand pounds
BTU	British thermal unit	kW	Thousand watts
CCF	Hundred cubic feet (measure of natural gas usage)	kWh	Kilowatt hour
CFM	Cubic feet per minute	MA/ MAT	Mixed air / Mixed air temperature
CHW	Chilled water	MAU	Makeup air unit
CHWS/ CHWR	Chilled water supply / Chilled water return	MBh	Thousand British thermal units per hour
CO_2	Carbon dioxide	MBtu	Thousand British thermal units
CT	Cooling tower	MMBTU	Million British thermal units
CV	Constant volume	MZ/MZU	Multiple zone / Multiple zone units
CW	Condenser water	OA/OSA	Outside air
CWS/ CWR	Condenser water supply / condenser water return	OAT	Outside air temperature
DA/ DAT	Discharge air / Discharge air temperature	PTAC	Packaged terminal air conditioner
DDC	Direct digital control	RA/ RAT	Return air / Return air temperature
DX	Direct expansion	RCx	Retro-commissioning
EA/ EAT	Exhaust air / Exhaust air temperature	RF	Return fan
EF	Exhaust fan	RH	Relative humidity
ERC	Energy recovery coil(s)	ROI	Return on Investment
EUI	Energy utilization index	RTU	Rooftop (packaged HVAC) unit
F	Fahrenheit	SA/ SAT	Supply air / Supply air temperature
FCU	Fan coil unit	SF	Supply fan
FY	Fiscal year	SP	Static pressure
GPM	Gallons per minute	Sq Ft	Square Foot
HP	Horsepower	TAB	Test, adjust and balance
HVAC	Heating, ventilating, and air-conditioning	Therms	Energy equal to 100,000 British Thermal units (BTU)
HV/ HVU	Heating ventilating unit	VAV	Variable air volume
HW	Hot water	VFD	Variable frequency drive
HWS/ HWR	Hot water supply / Hot water return	WC	Water Column

1.0 Executive Summary

The Department of Veterans Affairs is implementing a Retro-Commissioning (RCx) program for the VA Medical Center in Anchorage, Alaska. The purpose of the RCx program is to optimize the operation of heating, ventilating and air-conditioning systems in existing buildings. Retro-commissioning is a systematic process for verifying that installed equipment is operating efficiently and capable of providing the services necessary to meet the needs of the building occupants. Building system optimization offered as part of an RCx program should fulfill the following goals:

- Reduce energy and demand costs.
- Bring equipment to its proper operational state.
- Reduce occupant complaints.
- Improve indoor environmental quality.
- Reduce premature equipment failures.
- Improve facility operation and maintenance procedures.
- Reduce staff time spent on emergency or complaint calls.

1.1 VA PROJECT OBJECTIVES

The Department of Veterans Affairs VISN 20 presented ten overarching project objectives in the RFQ. The RCx team reviewed the objectives to achieve a thorough understanding of key project requirements and will accomplish them as outlined below.

1. Perform HVAC system diagnostics through the analysis of trend logs and functional equipment testing. These activities will evaluate system performance, including equipment condition, current operating conditions, and deferred maintenance issues. In addition, they will assess key hospital HVAC performance criteria related to maintaining infection control through proper air filtration and relative air pressurization where applicable. Deficiencies identified during monitoring and testing will be documented in the Issues Log.
2. Complete simple repairs and setpoint adjustments as required to correct issues identified during monitoring and testing activities and to achieve project goals. The objectives of this activity are to improve the operation of the facility and to eliminate obvious issues so they do not mask underlying major issues.
3. Provide recommendations for minor and major repairs or corrective actions that are needed. Recommendations may include infection control improvements, occupant comfort improvements, indoor air quality improvements, system efficiency improvements, needed capital improvements, modifications to preventative maintenance practices, staff

training, and energy metering and benchmarking enhancements where applicable.

4. Review and update all major HVAC equipment lists in Excel format including large AHUs, central pumps, chillers, etc. Equipment size, fan airflow and coil capacity information will be transferred from available drawings, maintenance records, existing TAB reports, etc. Equipment tag information (model, serial, HP) will be gathered where accessible. Where CFM/GPM information cannot be obtained from existing drawings and reports they will be estimated based on engineering design equations, obtained through airflow and water flow measurements or determined by other appropriate methods.

2.0 Introduction

This report provides a summary of the facility's energy consumption over the past two years based on the utility information provided by the VA facilities. Data was missing for a few months and estimates for those months were used to create accurate summaries and averages. The estimates were calculated from extrapolating data from similar months.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs, and
4. Identify energy or capital improvement projects for implementation in the future.

The following summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	**Facility Performance Analysis & Performance Baseline**	**Current**
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	3/26/2014
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

3.0 Energy Use Analysis

3.1 UTILITY SUMMARY

This campus receives electricity from Anchorage Municipal Light and Power, heating and cooling water is supplied from a central boiler plant located on Joint Base Elmendorf-Richardson.

Table 3-1: Utility Rates below summarizes the utility rates for all utilities used on site. These rates were used in the energy use evaluation and will be used for energy calculations. These rates include all applicable surcharges and taxes.

Table 3-1: Utility Rates

Rate Period	Average Use Rate
Electric:	$0.105 /kWh
Natural Gas	$0.80 / Therm

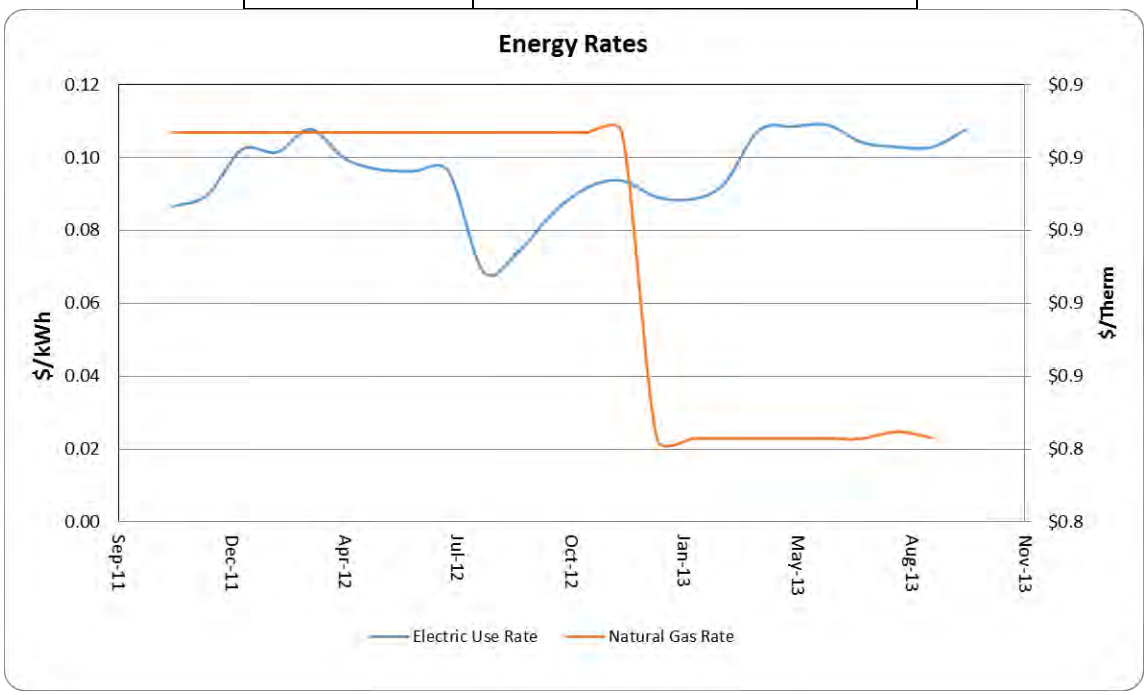

Figure 3-1 illustrates the change in the electric and natural gas rate over the last two years. The electric rate has trended slightly upward. It is unknown what caused the dip in August of 2012. The natural gas rate was the same throughout fiscal year 2012 and was lowered for fiscal year 2013.

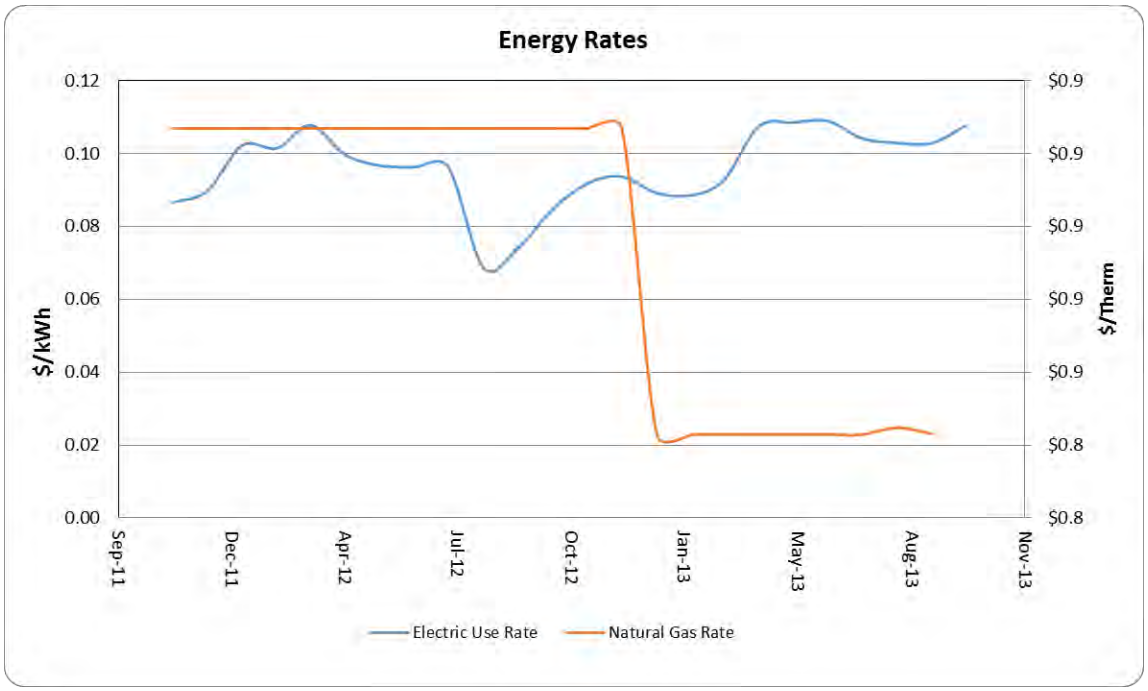

Figure 3-1: Energy rates

3.2 ELECTRIC DEMAND AND CONSUMPTION

The building falls under Anchorage Municipal Light and Power Rate Structure Large Commercial with a monthly demand above 20kW. A copy of the rate structure is included in **Appendix A**. The current cost for electricity consumption is $0.082128 per kWh. The current cost is for electricity demand is $16.96 per kW of demand. Demand is determined by using the maximum average rate of energy use for any 15-minute interval. The billing demand shall be the greater of the following: the recorded maximum demand for the month, or 80% of the maximum demand recorded during the preceding 11 months.

Figure 3-2 illustrates the monthly electricity consumption which has averaged 260,690 kWh over the past two years. Electricity consumption varies between 236,700 and 299,100 kWh per month, and shows very little seasonal variation. The average monthly (and annual) electricity consumption has remained fairly constant since October 2011.

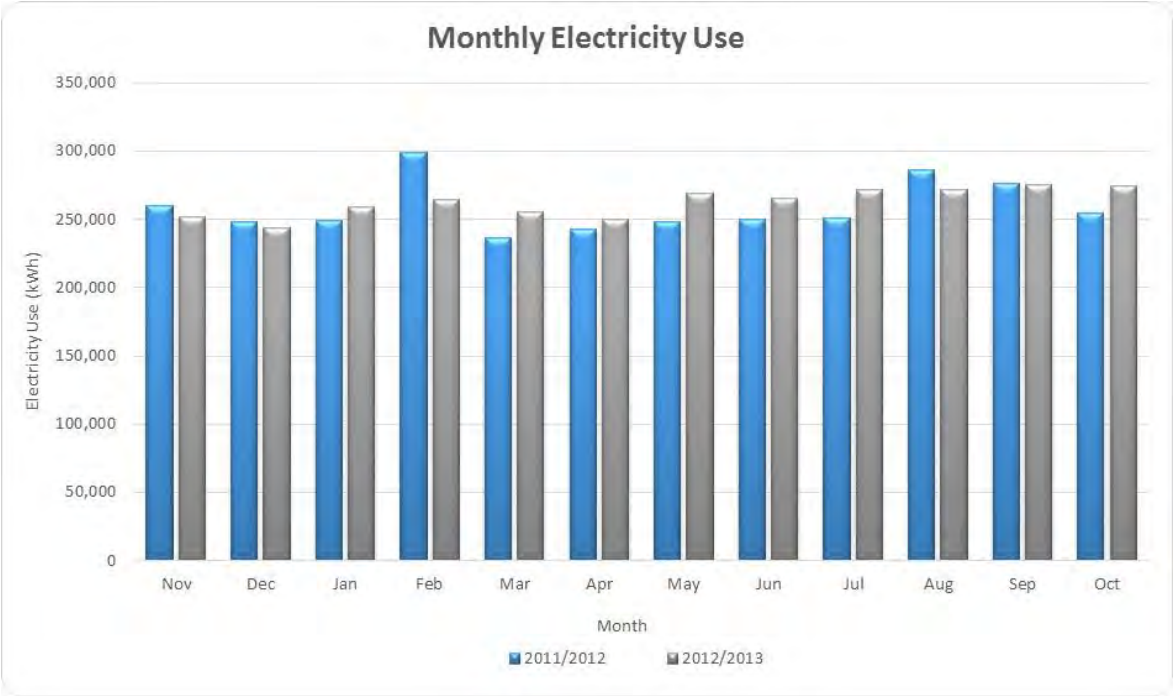

Figure 3-2: Electricity use profile

Figure 3-3 illustrates the electric consumption compared to monthly average outside air temperatures. This graph shows the same electric use regardless of outside air temperature. Warmer temperatures are usually associated with higher electric costs when a building has mechanical cooling. At the Anchorage VA the summer outside air temperatures are in the 60s and 70s, air handling unit fans run at relatively constant speed throughout the year and the cooling pumps supplying cooling well water from JBEAR operate year around to supply cooling to server rooms and data center.

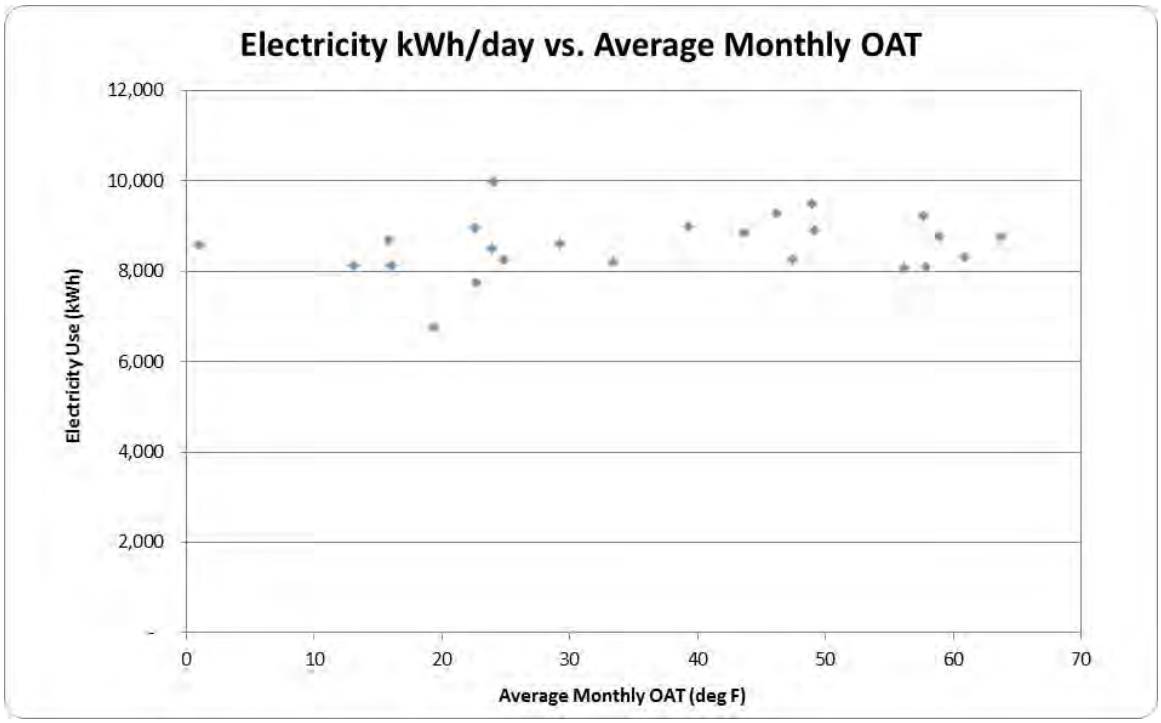

Figure 3-3: Electric Consumption Profile vs Average Monthly Outside Air Temperature

3.3 GAS CONSUMPTION

The heating water to the Anchorage VA Hospital is supplied from a central boiler plant at nearby JBEAR. A flow meter tracks building flow and the Anchorage VA hospital pays for the natural gas use that is calculated based on the measured flow at the flow meter. The average cost for FY2013 is $0.80 per therm.

Figure 3-4 illustrates the monthly natural gas consumption over the past two years. Natural gas consumption reflects some seasonal variation peaking during the winter months and bottoming in the summer months. The average maximum monthly natural gas consumption is approximately 42,000 Therms. The summer minimum fluctuated between 16,500 and 25,000 Therms. Natural Gas use during the summer is for domestic hot water heating and reheat in the zones.

There are large differences between the reported natural gas use in FY2013 versus FY2012. As the average outside air temperature has remained in the same range and the use and HVAC equipment operation is similar, the most likely cause of the differences is inaccurate flow meter readings. The flow meter is installed at a 90 degree bend and without sufficient straight pipe the turbulence can cause errors in the readings.

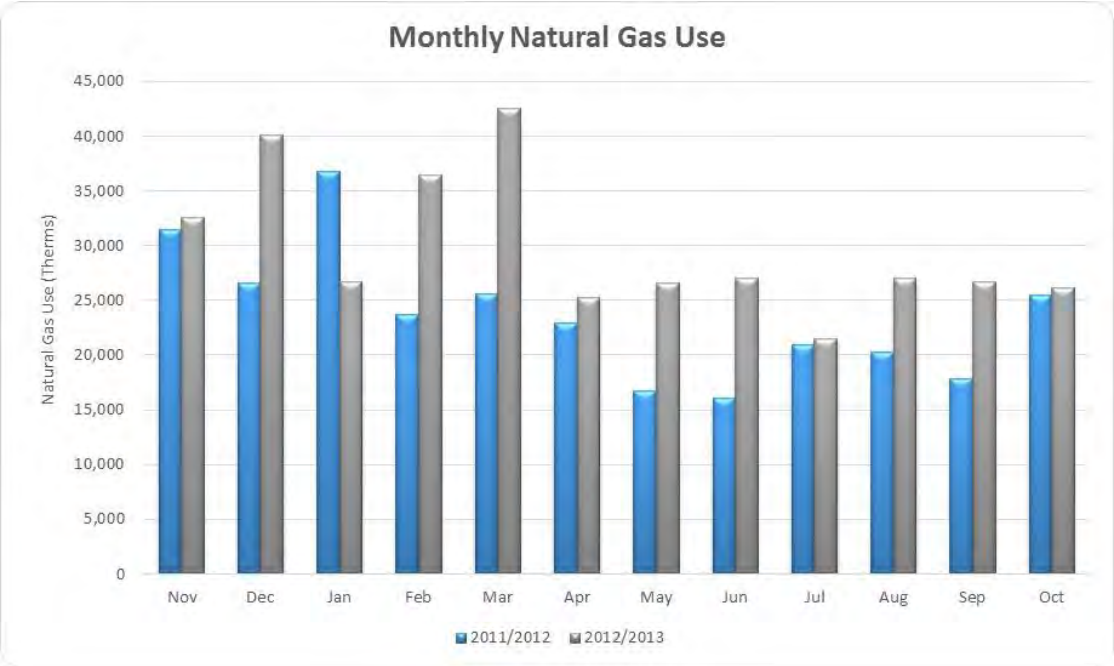

Figure 3-4: Natural Gas Consumption Profile

Figure 3-5 illustrates the natural gas consumption compared to monthly average outside air temperatures. This graph shows some correlation to average monthly outside air temperatures with an expected increase during colder temperatures due to increased heating loads.

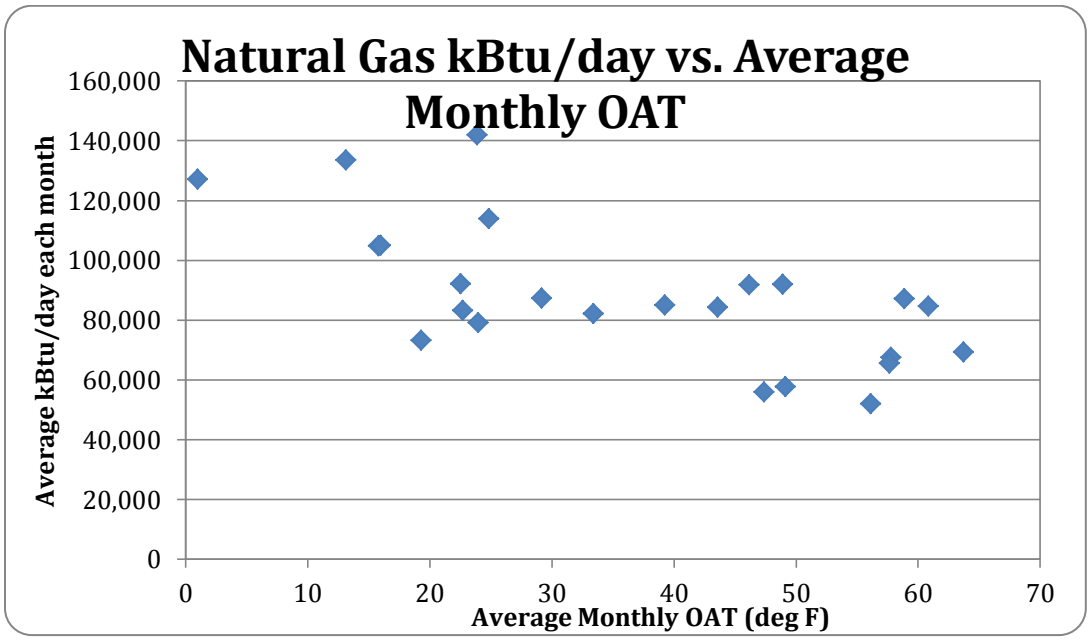

Figure 3-5: Natural Gas consumption vs Average Monthly Outside Air Temperature

3.4 TOTAL ENERGY CONSUMPTION AND COST

The total annual energy cost for FY2013 was $650,000 including electricity and natural gas costs.

Figure 3-6 and **Figure 3-7** illustrate two years of monthly energy consumption and expenses for the Anchorage VA. Electric consumption has remained steady over the period while the cost of electricity has increased some. The reported natural gas data shows a large increase in FY 2013 use, while the natural gas rate was decreased.

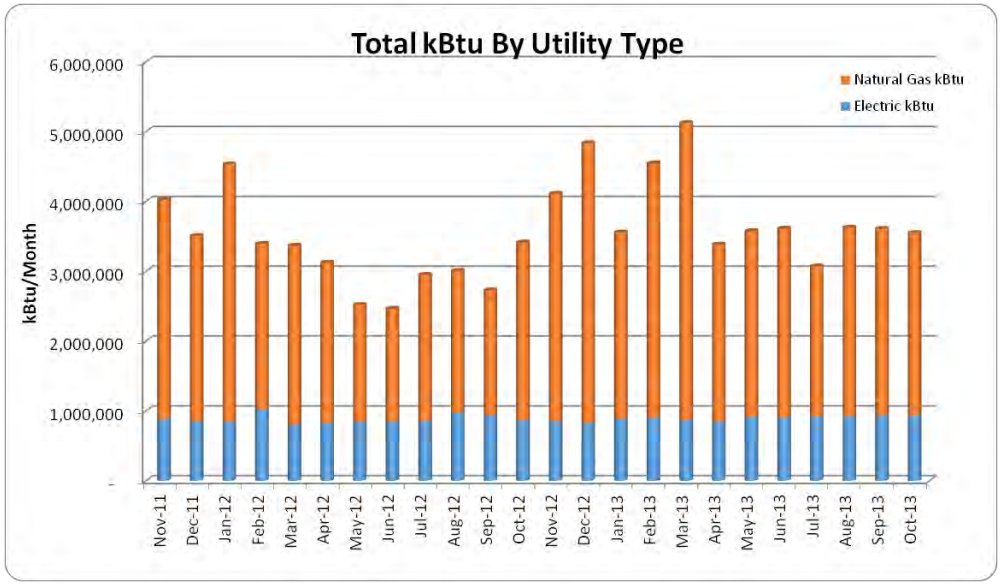

Figure 3-6: Total Energy Consumption by Utility

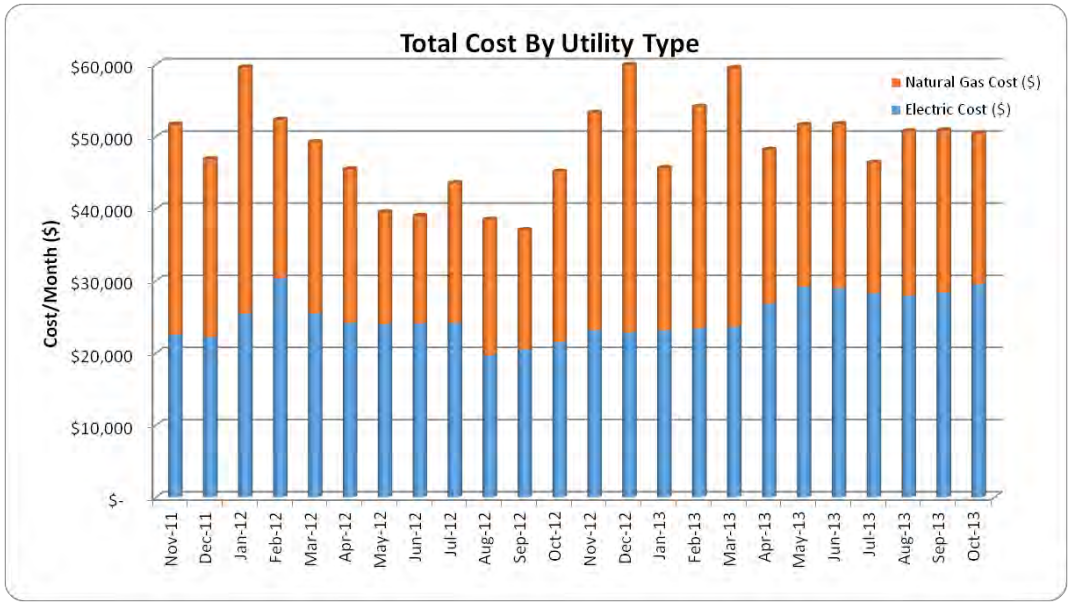

Figure 3-7: Total Energy Cost by Utility Type

Appendix-A

For Final RCx Report

Retro-Commissioning Plan

Error! Reference source not found. and **Error! Reference source not found.** show the breakdown of FY2013 energy consumption and energy cost by utility type. The figures make clear the large difference in cost per unit of energy for electricity compared to natural gas.

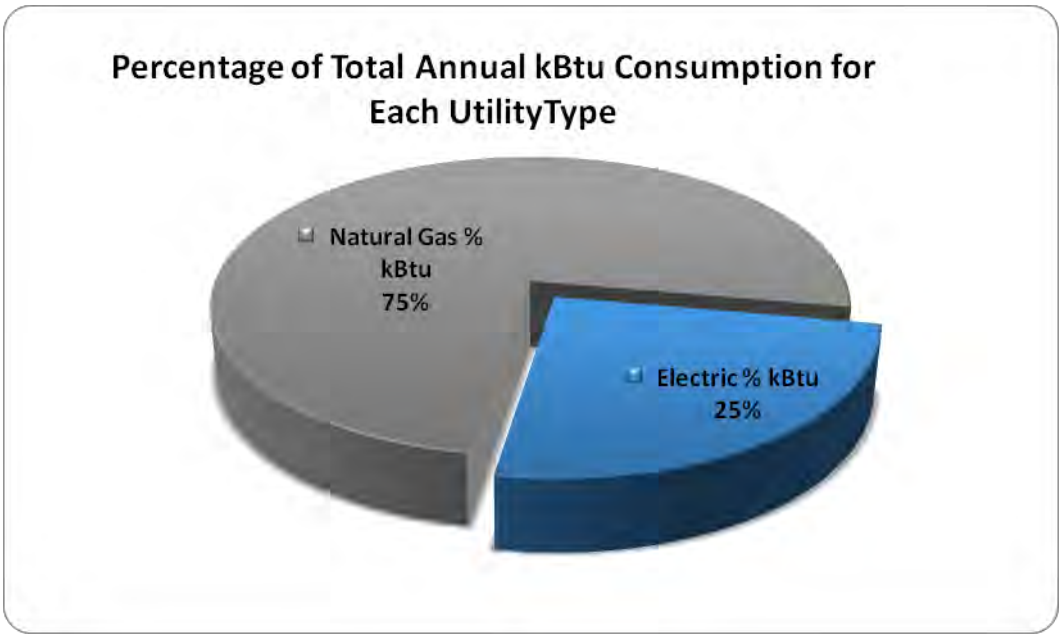

Figure 3-8: FY2013 Energy Consumption Breakdown

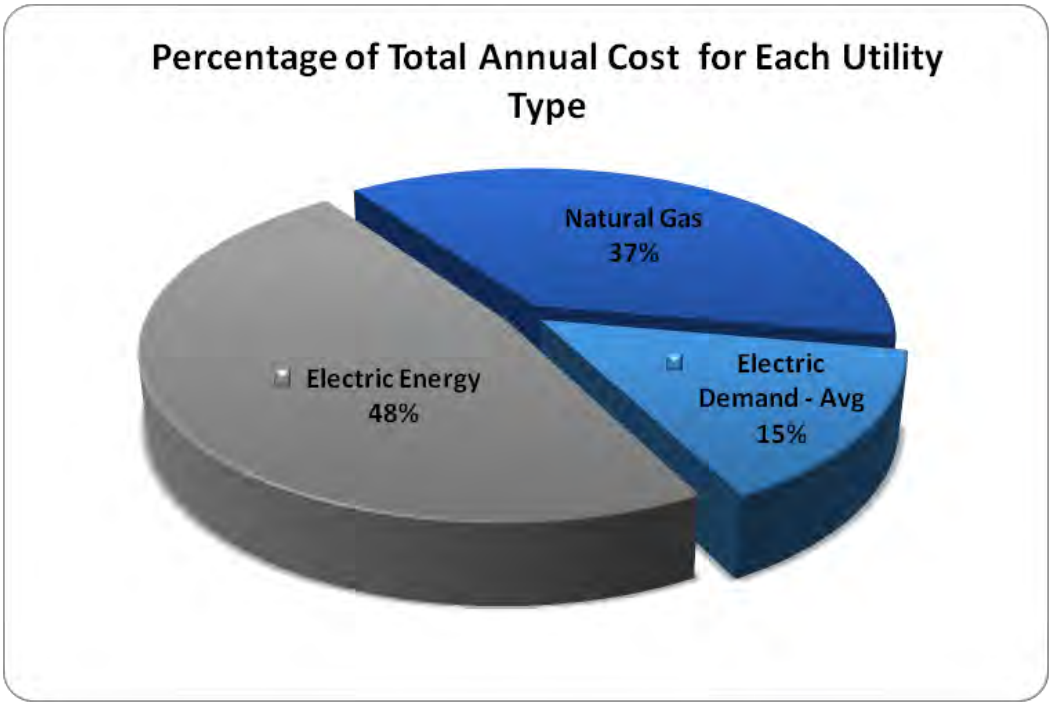

Figure 3-9: FY2013 ENERGY COST BREAKDOWN

4.0 Energy Use Baseline and Benchmarking

Energy Use Intensity (EUI) is one of the key metrics used to evaluate building energy performance. It can be used to track progress of energy reduction goals over time and to compare the energy use of similar facilities. Generally, a low EUI signifies good energy performance. However, certain property types will always use more energy than others. For example, an elementary school uses relatively little energy compared to a hospital.

EUI is calculated by dividing the total energy consumed by the building in one year by the total conditioned floor area of the building. This building was built in 2010 and has been Energy Star Rated with a score of 79. This was based on utility data ending in April 2012. The electric use has remained constant for the facility since construction. The reported natural gas use varies widely and has increased dramatically. It is believed that the flow meter is reading incorrectly due to the location of the installation.

The annual comparison from year to year is included in the table below.

Table 4-1: Energy Use Intensity

Year	Period Ending April 2012*	FY 2012	FY 2013
kBtu/Sq Ft/year	179	204	257
Energy Star Rating (period ending April 2012):	**79**		
*This number comes from provided Energy Star Summary			

Energy Star reports the national median site EUI at 211 kBtu/sq.ft. In the 2007 Commercial Buildings Energy Consumption Survey (CBECS) database reports a large hospital at 235 kBtu/sq.ft.

The difference between the flow measured through the meter and the flow at the pump can be seen in the graph below for the month of January 2014.

Appendix-A

For Final RCx Report

Retro-Commissioning Plan

Error! Reference source not found. and **Error! Reference source not found.** show the breakdown of FY2013 energy consumption and energy cost by utility type. The figures make clear the large difference in cost per unit of energy for electricity compared to natural gas.

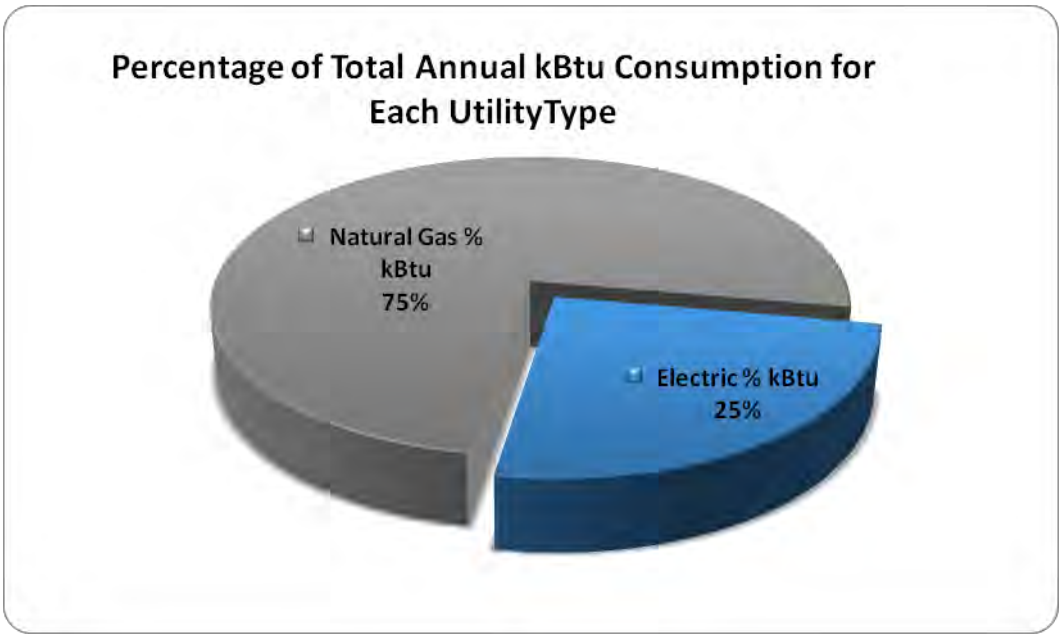

Figure 3-8: FY2013 Energy Consumption Breakdown

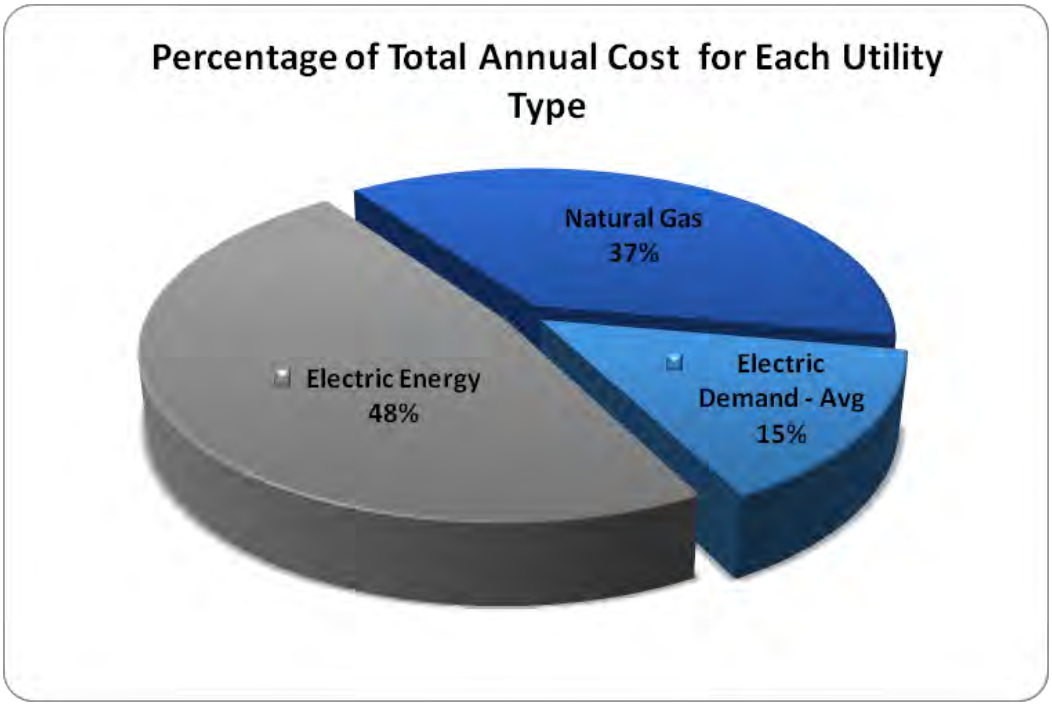

Figure 3-9: FY2013 ENERGY COST BREAKDOWN

4.0 Energy Use Baseline and Benchmarking

Energy Use Intensity (EUI) is one of the key metrics used to evaluate building energy performance. It can be used to track progress of energy reduction goals over time and to compare the energy use of similar facilities. Generally, a low EUI signifies good energy performance. However, certain property types will always use more energy than others. For example, an elementary school uses relatively little energy compared to a hospital.

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The annual comparison from year to year is included in the table below.

Table 4-1: Energy Use Intensity

Year	Period Ending April 2012*	FY 2012	FY 2013
kBtu/Sq Ft/year	179	204	257
Energy Star Rating (period ending April 2012):	**79**		
*This number comes from provided Energy Star Summary			

Energy Star reports the national median site EUI at 211 kBtu/sq.ft. In the 2007 Commercial Buildings Energy Consumption Survey (CBECS) database reports a large hospital at 235 kBtu/sq.ft.

The difference between the flow measured through the meter and the flow at the pump can be seen in the graph below for the month of January 2014.

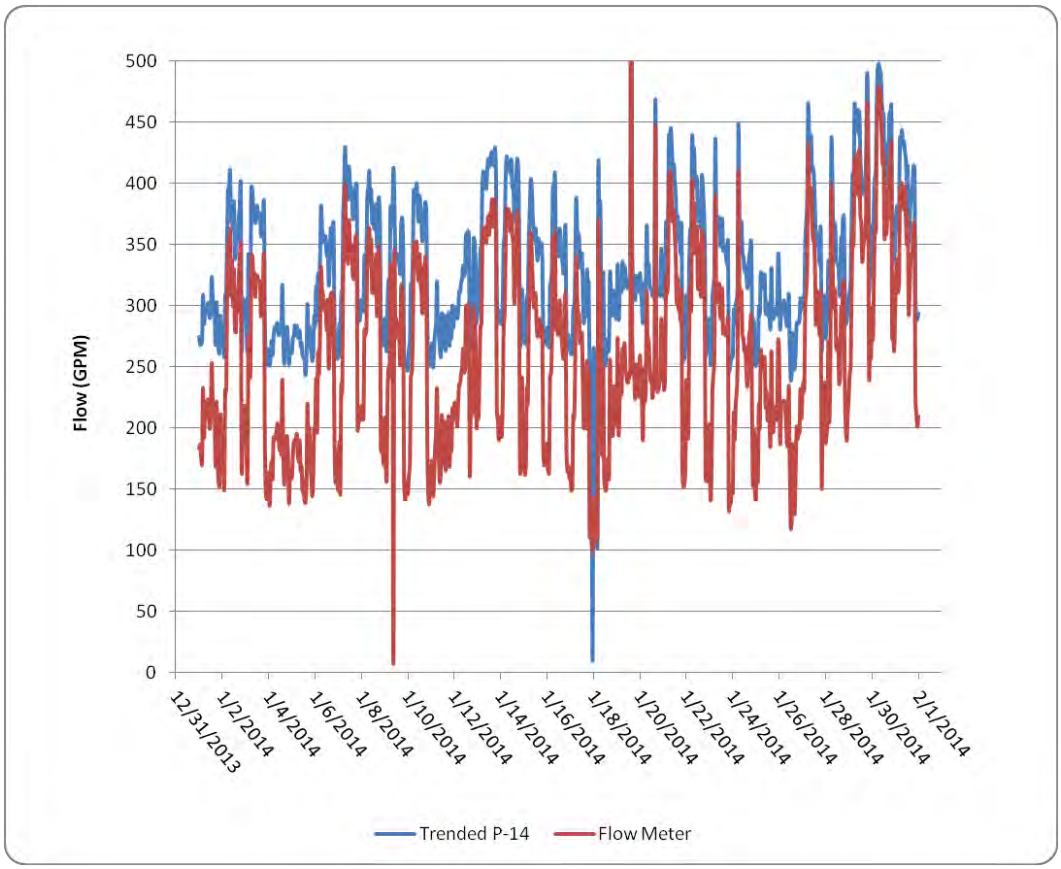

Figure 4-1: Flow Meter vs Pump P-14

4.1 TOTAL ENERGY CONSUMPTION AND COST

The building electrical data was disaggregated into the major energy users. **Error! Reference source not found.** show that Air Handling unit fans are the biggest electrical users, followed by lighting, plug loads and air compressors.

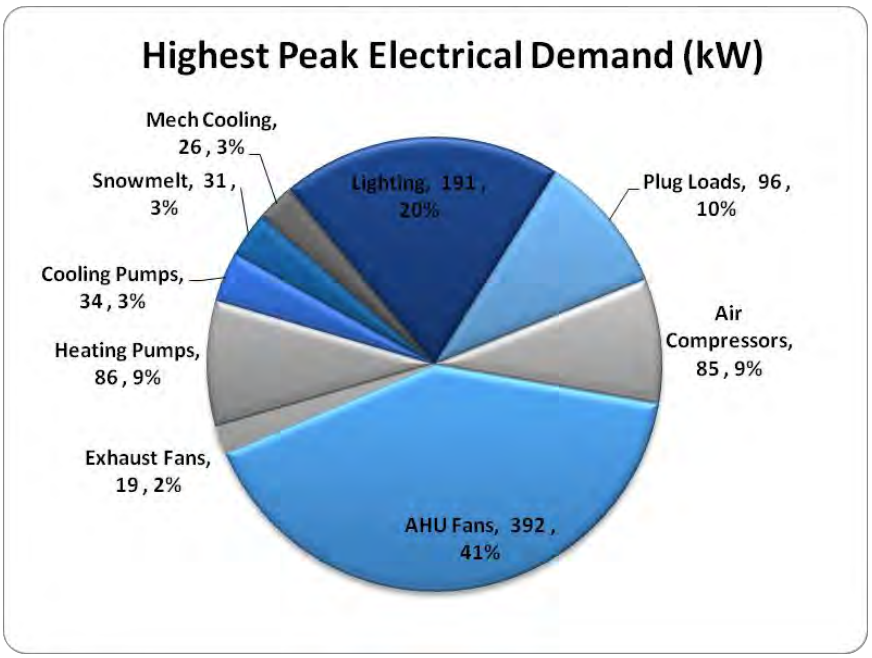

Figure 4-2: Electrical demand Allocation

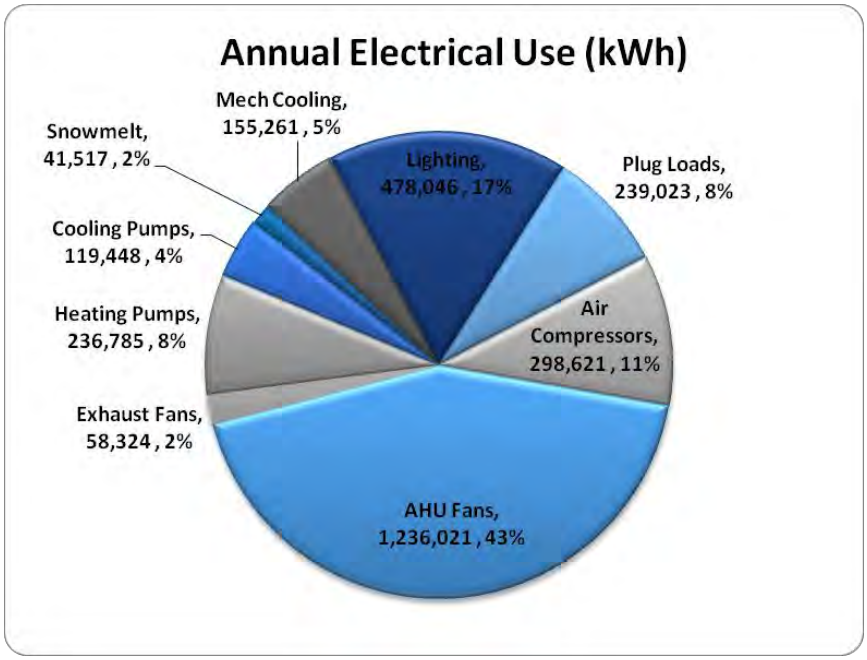

Figure 4-3: Electrical Use Allocation

4.2 NATURAL GAS ENERGY AND COST ALLOCATION

Natural gas in used for heating, domestic hot water and snowmelt. A disaggregation of the natural gas use can be seen below.

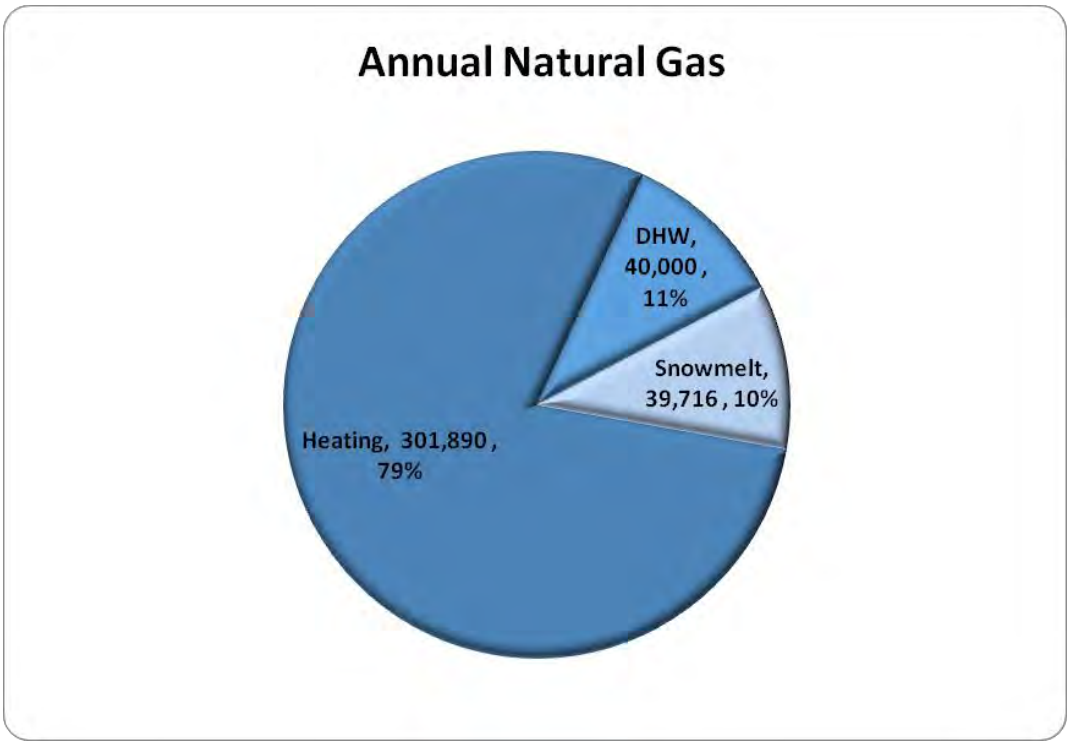

Figure 4-4: Natural Gas Allocation

5.0 Appendix A: Energy Utility Rate Structure Information

Please see the following page for Energy Utility Rate Structure Information.

General Service: Large at Secondary Voltage

Any service with a demand exceeding 20 kW for three consecutive months and metered at secondary voltage.*

Schedule 22

(Monthly Charge)

Customer Charge **$ 44.15**			
Demand Charge **$ 16.96 /kW**			
	Energy Charge	**4.829**	**¢ /kWh**
	Cost of Power Adjustment	**3.326**	**¢ /kWh**
	Regulatory Cost Charge	**0.0578**	**¢ /kWh**
	Total Per kWh		**8.2128 ¢**
MOA Underground Surcharge **2% on all charges/rates except RCC**			

Minimum Monthly Charge $44.15

**Demand is determined by using the maximum average rate of energy use for any 15-minute interval. The billing demand shall be the greater of the following: the recorded maximum demand for the month, or 80 percent of the maximum demand recorded during the preceding 11 months, or the customer demand, under a special contract for a customer with on-site generation.*

6.0 Appendix B: Utility Data

Please see the following page for Utility Data

Electric Utility Summary

Rate Structure:
Large Commercial

	Year	kW/mo	kWh/yr	$/yr	kWh/ day	Agg. $/ kWh	Load Factor	kBtu/yr	kBtu/ day
	11/12	629	3,102,960	$ 284,167	8,463	$ 0.092	0.59	10,590,402	29,015
	12/13	642	3,153,600	$ 315,254	8,673	$ 0.100	0.58	10,763,237	29,488
Peak Monthly Avg		635	281,880	$ 26,880	9,200	$ 0.104	0.64	962,056	31,400
Avg OR Sum of Monthly Avg		610	**3,128,280**	**$ 299,711**	8,557	$ 0.096	0.58	**10,676,820**	29,206

**Don't list the month OR year unless the actual utility data is filled out. The zeroes will go into the averages.*

Meter #: 299,100

Bill #	Month	Year	Month/Yr	Days/ Month	Electric Demand Peak kW	Electric Use kWh/ month	Electric Cost $	Elec Use kWh/ day	Aggregate $/ kWh	Load Factor	kBtu/mo	kBtu/ day	Avg. Mean Temp (F)
1	Nov	2011	Nov-11	30	591	260,400	$ 22,543	8,680	$ 0.087	61.2%	888,745	29,625	16
2	Dec	2011	Dec-11	32	621	247,920	$ 22,216	7,748	$ 0.090	52.0%	846,151	26,442	23
3	Jan	2012	Jan-12	29	617	249,240	$ 25,460	8,594	$ 0.102	58.0%	850,656	29,333	1
4	Feb	2012	Feb-12	30	629	299,100	$ 30,331	9,970	$ 0.101	66.1%	1,020,828	34,028	24
5	Mar	2012	Mar-12	35	612	236,700	$ 25,501	6,763	$ 0.108	46.0%	807,857	23,082	19
6	Apr	2012	Apr-12	27	597	242,820	$ 24,184	8,993	$ 0.100	62.7%	828,745	30,694	39
7	May	2012	May-12	30	591	248,160	$ 23,992	8,272	$ 0.097	58.3%	846,970	28,232	47
8	Jun	2012	Jun-12	31	586	250,260	$ 24,084	8,073	$ 0.096	57.4%	854,137	27,553	56
9	Jul	2012	Jul-12	31	587	251,340	$ 24,167	8,108	$ 0.096	57.5%	857,823	27,672	58
10	Aug	2012	Aug-12	31	576	286,320	$ 19,663	9,236	$ 0.069	66.9%	977,210	31,523	58
11	Sep	2012	Sep-12	31	583	276,180	$ 20,486	8,909	$ 0.074	63.7%	942,602	30,407	49
12	Oct	2012	Oct-12	31	579	254,520	$ 21,541	8,210	$ 0.085	59.1%	868,677	28,022	33
13	Nov	2012	Nov-12	31	611	252,180	$ 23,149	8,135	$ 0.092	55.4%	860,690	27,764	16
14	Dec	2012	Dec-12	30	626	243,780	$ 22,831	8,126	$ 0.094	54.1%	832,021	27,734	13
15	Jan	2013	Jan-13	29	625	259,560	$ 23,126	8,950	$ 0.089	59.7%	885,878	30,548	23
16	Feb	2013	Feb-13	32	642	264,660	$ 23,429	8,271	$ 0.089	53.7%	903,285	28,228	25
17	Mar	2013	Mar-13	30	622	255,060	$ 23,636	8,502	$ 0.093	56.9%	870,520	29,017	24
18	Apr	2013	Apr-13	29	633	249,900	$ 26,832	8,617	$ 0.107	56.8%	852,909	29,411	29
19	May	2013	May-13	29	622	269,280	$ 29,205	9,286	$ 0.108	62.2%	919,053	31,691	46
20	Jun	2013	Jun-13	32	632	265,800	$ 28,933	8,306	$ 0.109	54.8%	907,175	28,349	61
21	Jul	2013	Jul-13	31	614	271,620	$ 28,282	8,762	$ 0.104	59.4%	927,039	29,904	64
22	Aug	2013	Aug-13	31	620	271,740	$ 27,947	8,766	$ 0.103	59.0%	927,449	29,918	59
23	Sep	2013	Sep-13	29	615	275,820	$ 28,364	9,511	$ 0.103	64.5%	941,374	32,461	49
24	Oct	2013	Oct-13	31	618	274,200	$ 29,520	8,845	$ 0.108	59.7%	935,845	30,189	44
25													
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Electric Monthly Averages

Jan	1	-	29	621.2	254,400	$ 24,292.7	8,772.4	$ 0.1	58.8%	868,267	29,940	12
Feb	2	-	31	635.1	281,880	$ 26,879.6	9,092.9	$ 0.1	59.7%	962,056	31,034	24
Mar	3	-	33	617.2	245,880	$ 24,568.5	7,565.5	$ 0.1	51.1%	839,188	25,821	22
Apr	4	-	28	614.9	246,360	$ 25,507.9	8,798.6	$ 0.1	59.6%	840,827	30,030	34
May	5	-	30	606.6	258,720	$ 26,598.3	8,770.2	$ 0.1	60.2%	883,011	29,933	47
Jun	6	-	32	609.0	258,030	$ 26,508.3	8,191.4	$ 0.1	56.0%	880,656	27,957	59
Jul	7	-	31	600.7	261,480	$ 26,224.9	8,434.8	$ 0.1	58.5%	892,431	28,788	61
Aug	8	-	31	597.6	279,030	$ 23,805.1	9,001.0	$ 0.1	62.8%	952,329	30,720	58
Sep	9	-	30	598.8	276,000	$ 24,425.0	9,200.0	$ 0.1	64.0%	941,988	31,400	49
Oct	10	-	31	598.5	264,360	$ 25,530.8	8,527.7	$ 0.1	59.4%	902,261	29,105	39
Nov	11	-	31	601.2	256,290	$ 22,846.3	8,403.0	$ 0.1	58.2%	874,718	28,679	16
Dec	12	-	31	623.4	245,850	$ 22,523.2	7,930.6	$ 0.1	53.0%	839,086	27,067	18

If there are multiple meters, copy input table from above for each meter and sum in the above sheet for the whole building/facility.

VISN 20 Alaska: Electrical Data (ACCOUNT #10179218)

Bill #	Month	Year	Month/Yr	Days/ Month	Electric Demand Peak kW	Electric Use kWh/ month	Electric Cost $	Elec Use kWh/ day	Aggregate $/ kWh	Load Factor	kBtu/mo	kBtu/ day
1	Nov	2011	Nov-11	30	425	193,200	$ 16,525	6,440	$ 0.086	63.2%	659,392	21,980
2	Dec	2011	Dec-11	32	456	179,400	$ 16,139	5,606	$ 0.090	51.3%	612,292	19,134
3	Jan	2012	Jan-12	29	451	188,400	$ 19,798	6,497	$ 0.105	60.1%	643,009	22,173
4	Feb	2012	Feb-12	30	462	235,500	$ 23,429	7,850	$ 0.099	70.8%	803,762	26,792
5	Mar	2012	Mar-12	35	445	158,100	$ 17,484	4,517	$ 0.111	42.3%	539,595	15,417
6	Apr	2012	Apr-12	27	432	189,300	$ 18,051	7,011	$ 0.095	67.6%	646,081	23,929
7	May	2012	May-12	30	418	181,200	$ 17,324	6,040	$ 0.096	60.2%	618,436	20,615
8	Jun	2012	Jun-12	31	413	183,900	$ 17,453	5,932	$ 0.095	59.8%	627,651	20,247
9	Jul	2012	Jul-12	31	413	183,900	$ 17,453	5,932	$ 0.095	59.8%	627,651	20,247
10	Aug	2012	Aug-12	31	405	211,200	$ 14,229	6,813	$ 0.067	70.1%	720,826	23,252
11	Sep	2012	Sep-12	31	412	210,900	$ 14,310	6,803	$ 0.068	68.8%	719,802	23,219
12	Oct	2012	Oct-12	31	409	179,400	$ 16,108	5,787	$ 0.090	59.0%	612,292	19,751
13	Nov	2012	Nov-12	31	440	186,900	$ 16,973	6,029	$ 0.091	57.0%	637,890	20,577
14	Dec	2012	Dec-12	30	456	179,100	$ 16,706	5,970	$ 0.093	54.5%	611,268	20,376
15	Jan	2013	Jan-13	29	461	198,000	$ 17,258	6,828	$ 0.087	61.7%	675,774	23,303
16	Feb	2013	Feb-13	32	476	199,500	$ 17,537	6,234	$ 0.088	54.6%	680,894	21,278
17	Mar	2013	Mar-13	30	459	190,500	$ 17,807	6,350	$ 0.093	57.7%	650,177	21,673
18	Apr	2013	Apr-13	29	467	185,700	$ 20,655	6,403	$ 0.111	57.1%	633,794	21,855
19	May	2013	May-13	29	451	207,000	$ 22,047	7,138	$ 0.107	65.9%	706,491	24,362
20	Jun	2013	Jun-13	32	449	196,800	$ 21,033	6,150	$ 0.107	57.1%	671,678	20,990
21	Jul	2013	Jul-13	31	440	206,700	$ 20,961	6,668	$ 0.101	63.1%	705,467	22,757
22	Aug	2013	Aug-13	31	443	199,500	$ 20,276	6,435	$ 0.102	60.6%	680,894	21,964
23	Sep	2013	Sep-13	29	434	206,700	$ 20,856	7,128	$ 0.101	68.5%	705,467	24,326
24	Oct	2013	Oct-13	31	452	201,600	$ 21,904	6,503	$ 0.109	59.9%	688,061	22,196
25												
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VISN 20 Alaska: Electrical Data (Account #10179219)

Bill #	Month	Year	Month/Yr	Days/ Month	Electric Demand Peak kW	Electric Use kWh/ month	Electric Cost $	Elec Use kWh/ day	Aggregate $/ kWh	Load Factor	kBtu/mo	kBtu/ day
1	Nov	2011	Nov-11	30	166	67,200	$ 6,018	2,240	$ 0.090	56.1%	229,354	7,645
2	Dec	2011	Dec-11	32	165	68,520	$ 6,077	2,141	$ 0.089	54.0%	233,859	7,308
3	Jan	2012	Jan-12	29	167	60,840	$ 5,661	2,098	$ 0.093	52.4%	207,647	7,160
4	Feb	2012	Feb-12	30	167	63,600	$ 6,901	2,120	$ 0.109	53.0%	217,067	7,236
5	Mar	2012	Mar-12	35	167	78,600	$ 8,017	2,246	$ 0.102	56.0%	268,262	7,665
6	Apr	2012	Apr-12	27	165	53,520	$ 6,133	1,982	$ 0.115	50.1%	182,664	6,765
7	May	2012	May-12	30	173	66,960	$ 6,668	2,232	$ 0.100	53.8%	228,534	7,618
8	Jun	2012	Jun-12	31	173	66,360	$ 6,632	2,141	$ 0.100	51.6%	226,487	7,306
9	Jul	2012	Jul-12	31	174	67,440	$ 6,715	2,175	$ 0.100	52.2%	230,173	7,425
10	Aug	2012	Aug-12	31	171	75,120	$ 5,433	2,423	$ 0.072	59.2%	256,385	8,270
11	Sep	2012	Sep-12	31	171	65,280	$ 6,177	2,106	$ 0.095	51.3%	222,801	7,187
12	Oct	2012	Oct-12	31	171	75,120	$ 5,433	2,423	$ 0.072	59.2%	256,385	8,270
13	Nov	2012	Nov-12	31	171	65,280	$ 6,177	2,106	$ 0.095	51.3%	222,801	7,187
14	Dec	2012	Dec-12	30	170	64,680	$ 6,125	2,156	$ 0.095	52.9%	220,753	7,358
15	Jan	2013	Jan-13	29	164	61,560	$ 5,868	2,123	$ 0.095	53.8%	210,104	7,245
16	Feb	2013	Feb-13	32	166	65,160	$ 5,891	2,036	$ 0.090	51.2%	222,391	6,950
17	Mar	2013	Mar-13	30	164	64,560	$ 5,829	2,152	$ 0.090	54.8%	220,343	7,345
18	Apr	2013	Apr-13	29	165	64,200	$ 6,178	2,214	$ 0.096	55.9%	219,115	7,556
19	May	2013	May-13	29	171	62,280	$ 7,157	2,148	$ 0.115	52.3%	212,562	7,330
20	Jun	2013	Jun-13	32	183	69,000	$ 7,900	2,156	$ 0.114	49.2%	235,497	7,359
21	Jul	2013	Jul-13	31	174	64,920	$ 7,321	2,094	$ 0.113	50.2%	221,572	7,147
22	Aug	2013	Aug-13	31	177	72,240	$ 7,671	2,330	$ 0.106	54.9%	246,555	7,953
23	Sep	2013	Sep-13	29	181	69,120	$ 7,508	2,383	$ 0.109	55.0%	235,907	8,135
24	Oct	2013	Oct-13	31	166	72,600	$ 7,617	2,342	$ 0.105	58.9%	247,784	7,993
25												
26												

Gas Utility Summary

Rate Structure:

	Year	Thms/yr	$/yr	Thms/ day	$/ therm	kBtu/ yr	kBtu/ day
	11/12	284,594	$ 263,782	777	$ 0.9	28,459,351	77,971
	12/13	383,951	$ 330,802	985	$ 0.9	35,849,326	98,217
Peak Monthly Avg		34,075	$ 30,892	1,096	$ 0.93	3,407,535	109,567
Avg OR Sum of Monthly Avg		**321,543**	**$ 285,494**	878	$ 0.89	**32,154,338**	87,843

**Don't list the month OR year unless the actual utility data is filled out. The zeroes will go into the averages.*

Meter #:

Bill #	Month	Year	Month/Yr	Days/ Month	Gas Use Therms	Gas Cost $/ Month	Gas Use Thms/ Day	$/ therm	kBtu/ Mo	kBtu/ day	Avg. Mean Temp (F)
1	Nov	2011	Nov-11	30	31,435	$ 29,136	1,048	$ 0.9	3,143,472	104,782.4	16
2	Dec	2011	Dec-11	32	26,606	$ 24,660	831	$ 0.9	2,660,567	83,142.7	23
3	Jan	2012	Jan-12	29	36,827	$ 34,134	1,270	$ 0.9	3,682,678	126,988.9	1
4	Feb	2012	Feb-12	30	23,739	$ 22,003	791	$ 0.9	2,373,900	79,130.0	24
5	Mar	2012	Mar-12	35	25,605	$ 23,733	732	$ 0.9	2,560,527	73,157.9	19
6	Apr	2012	Apr-12	27	22,964	$ 21,285	851	$ 0.9	2,296,413	85,052.3	39
7	May	2012	May-12	30	16,749	$ 15,524	558	$ 0.9	1,674,893	55,829.8	47
8	Jun	2012	Jun-12	31	16,104	$ 14,926	519	$ 0.9	1,610,367	51,947.3	56
9	Jul	2012	Jul-12	31	20,928	$ 19,398	675	$ 0.9	2,092,841	67,511.0	58
10	Aug	2012	Aug-12	31	20,311	$ 18,826	655	$ 0.9	2,031,077	65,518.6	58
11	Sep	2012	Sep-12	31	17,868	$ 16,561	576	$ 0.9	1,786,805	57,638.9	49
12	Oct	2012	Oct-12	31	25,458	$ 23,596	821	$ 0.9	2,545,810	82,122.9	33
13	Nov	2012	Nov-12	31	32,525	$ 30,147	1,049	$ 0.9	3,252,519	104,920.0	16
14	Dec	2012	Dec-12	30	40,052	$ 37,123	1,335	$ 0.9	4,005,208	133,506.9	13
15	Jan	2013	Jan-13	29	26,722	$ 22,524	921	$ 0.8	2,672,182	92,144.2	23
16	Feb	2013	Feb-13	32	36,431	$ 30,708	1,138	$ 0.8	3,643,067	113,845.8	25
17	Mar	2013	Mar-13	30	42,545	$ 35,862	1,418	$ 0.8	4,254,543	141,818.1	24
18	Apr	2013	Apr-13	29	25,315	$ 21,338	873	$ 0.8	2,531,463	87,291.8	29
19	May	2013	May-13	29	26,586	$ 22,410	917	$ 0.8	2,658,595	91,675.7	46
20	Jun	2013	Jun-13	32	27,055	$ 22,805	845	$ 0.8	2,705,498	84,546.8	61
21	Jul	2013	Jul-13	31	21,458	$ 18,087	692	$ 0.8	2,145,752	69,217.8	64
22	Aug	2013	Aug-13	31	26,995	$ 22,805	871	$ 0.8	2,699,531	87,081.6	59
23	Sep	2013	Sep-13	29	26,676	$ 22,490	920	$ 0.8	2,667,566	91,985.0	49
24	Oct	2013	Oct-13	31	26,134	$ 20,907	843	$ 0.8	2,613,403	84,303.3	44
25			-				-	$ -	-	-	
26			-				-	$ -	-	-	

Gas Monthly Averages

Jan	1	-	29	31,774	$ 28,329.0	1,095.7	$ 0.9	3,177,430	109,566.6	12
Feb	2	-	31	30,085	$ 26,355.4	970.5	$ 0.9	3,008,484	97,047.9	24
Mar	3	-	33	34,075	$ 29,797.4	1,048.5	$ 0.9	3,407,535	104,847.2	22
Apr	4	-	28	24,139	$ 21,311.4	862.1	$ 0.9	2,413,938	86,212.1	34
May	5	-	30	21,667	$ 18,966.9	734.5	$ 0.9	2,166,744	73,449.0	47
Jun	6	-	32	21,579	$ 18,865.5	685.1	$ 0.9	2,157,932	68,505.8	59
Jul	7	-	31	21,193	$ 18,742.4	683.6	$ 0.9	2,119,297	68,364.4	61
Aug	8	-	31	23,653	$ 20,815.2	763.0	$ 0.9	2,365,304	76,300.1	58
Sep	9	-	30	22,272	$ 19,525.9	742.4	$ 0.9	2,227,186	74,239.5	49
Oct	10	-	31	25,796	$ 22,251.8	832.1	$ 0.9	2,579,606	83,213.1	39
Nov	11	-	31	31,980	$ 29,641.4	1,048.5	$ 0.9	3,197,996	104,852.3	16
Dec	12	-	31	33,329	$ 30,891.7	1,075.1	$ 0.9	3,332,887	107,512.5	18

Appendix-F

For Final RCx Report

Systems Diagnostic Monitoring Plan

&

Monitoring Results Report

VISN 20 Alaska VA Healthcare System

Systems Diagnostic Monitoring Plan

JANUARY 28, 2013

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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1.1 Introduction 3
1.2 Diagnostic Monitoring Objectives 4
1.3 Monitoring approach 4
1.4 Sensor Calibration 5
1.5 Systems and Equipment Monitored 5

ACRONYMS

BAS	Building Automation System
BOD	Basis of Design
CWP	Condenser Water Pump
CWR	Condenser Water Return
DHRC	Dedicated Heat Recovery Chiller
DHW	Domestic Hot Water
EMS	Energy Management System
GPM	Gallons per Minute
GSHP	Ground Source Heat Pump
hp	Horsepower
SCW	Softened Cold Water
TAB	Testing and Balancing

1.0 Systems Diagnostic Monitoring Plan

1.1 INTRODUCTION

As part of its RCx efforts at the Anchorage VA hospital in VISN 20, DAV Energy presents the following diagnostic monitoring plan. This report includes a description of the monitoring activities planned including the equipment to be monitored, means of monitoring, frequency and duration.

By analyzing the data collected DAV Energy aims to identify issues, confirm compliance with the CFR, identify improvement opportunities and highlight problems that may require more rigorous and focused investigation. This is being completed under **Key Deliverable 6- Systems Diagnostic Monitoring Plan**.

The following summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	In Progress
6	**Systems Diagnostic Monitoring Plan**	**Complete**
7	Systems Diagnostic Monitoring Report	3/26/2014
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

1.2 DIAGNOSTIC MONITORING OBJECTIVES

Diagnostic monitoring evaluates historical system performance by analyzing data collected from the control system or portable loggers. This data is graphed over time to obtain information on the equipment on/off schedules, temperature control, and other system components. It provides the means to confirm whether the existing sequence of operations is being followed, identify instances of deviation from the sequences, identify other equipment issues and deficiencies, and identify potential energy conservation measures.

The objectives of diagnostic monitoring include the following:

- Confirm operating issues identified during field observations.
- Identify equipment operating hours and cycling patterns.
- Identify operating temperatures, pressures, humidity, speeds, and flow rates where available.
- Determine correlations between system operating variables and other parameters (e.g. ambient temperature, occupancy).
- Determine and confirm as-built control sequences of operation.
- Identify systems that do not respond to control setpoints or cannot maintain setpoints.
- Find incidents of simultaneous heating and cooling, inappropriate economizer operation, excessive variable frequency drive (VFD) speeds, and other incidents of non-optimal operation.
- Identify sensors whose values do not correspond to measured conditions, indicating a need for calibration or replacement.

1.3 MONITORING APPROACH

The following are the types of monitoring that will be employed for the Anchorage VA hospital.

- **Building Automation System Trend Logs**: Trend logs set up in the BAS are data logs recorded at 15 min intervals for the duration of the trending period (typically a minimum of two weeks). Trend logs are ideal sources of data because they can be set up for any duration or interval and can be exported electronically for use in analysis software.

- **Portable Data Loggers**: Portable data loggers are capable of storing large quantities of data and exporting that data electronically for use in analysis software. They can be configured for a variety of variables, and are small enough to be placed in most locations without interruption to service or affecting other activities in the same location. Their limitations lie in the practicalities of accessing the equipment or components to be

logged, and in the logistical schedule and budget constraints of each project.

BAS trends will be preferred to using portable data loggers, both for efficiency of obtaining data and for the completeness of data that is available. For example, portable data loggers cannot record setpoint values or measure damper positions in VAV boxes. The Anchorage VA hospital is a new facility and the BAS encompasses a vast number of points for all equipment. Data trends were set up as part of the original commissioning and many of those trends are continuously ongoing. Portable data loggers will be used only for equipment not available on BAS.

Ideally, data would be collected continuously for every parameter of HVAC system operation and control. However, there are practical limitations to the number of variables that can feasibly be monitored and analyzed during the course of an investigation. At the Anchorage VA Medical Center there is a limitation in memory at the operator workstation. Not all of the points available for each piece of equipment will be trended. In addition to the continuous trends already in place a selection of points will be trended at 15 minute intervals over a two week period. The points selected for trending will give the information necessary to achieve the objectives of diagnostic monitoring. DAV Energy will also collect the historical data to evaluate equipment operation during other seasons.

Trends will be set up for a sampling of VAV boxes. Sample sizes were guided by industry standards such as “M&V Guidelines: Measurement and Verification for Federal Energy Projects, Version 3.0” Appendix B Sampling Guidelines.

1.4 SENSOR CALIBRATION

Spot measurements are included in the appropriate functional test protocols included in the Systems Test Procedure Plan.

1.5 SYSTEMS AND EQUIPMENT MONITORED

At the Anchorage VA Medical Center the following equipment will be monitored:

- All Air Handler Units with the exception or AHU-10 which is used only when the generator operates.
- A sampling of VAV boxes and their respective spaces.
- Snowmelt Systems

- Heating/Chilled Water temperatures and Components
- Air Compressors serving HVAC equipment

Continuously trended points and the points to be trended can be seen in the forms below:

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 1

Prepared By: AK *Date:* 1/8/2014

Notes:

Instructions: Columns b. and c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
17	OSA Temp.	°F	5 min	pre 2012	BCM-A

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 2

Prepared By: AK *Date:* 1/8/2014

Notes:

AHU Name: AHU-1

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	SF Airflow	CFM		NT	no trend data
3	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
4	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
5	RF Airflow	CFM	5 min	pre 2012	have existing 5-min trend data
6	Return Duct Static Pressure	"WC		NT	no trend data
7	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
8	OSA Airflow	CFM		NT	no trend data
9	Econ Command	%	5 min	pre 2012	have existing 5-min trend data
10	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
11	Heating GHST	°F		NT	no trend data
12	Heating GHRT	°F		NT	no trend data
13	Heating Vlv. Pos.	%		NT	no trend data
14	Hum. Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
15	Supply Air Hummidity	%	5 min	pre 2012	have existing 5-min trend data
16	Space Avg Hummidity	%	5 min	pre 2012	have existing 5-min trend data
17	Cooling CHGST	°F		NT	no trend data
18	Cooling CHGRT	°F		NT	no trend data
19	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
20	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 3

Prepared By: AK *Date:* 1/8/2014

Notes:

AHU Name: AHU-2

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	SF Airflow	CFM	5 min	pre 2012	have existing 5-min trend data
3	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
5	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
6	RF Airflow	CFM		NT	no trend data
7	Return Duct Static Pressure	"WC		NT	no trend data
9	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
10	OSA Airflow	CFM	5 min	NT	no trend data
12	Econ Command	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
13	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
14	Heating GHST	°F		NT	no trend data
15	Heating GHRT	°F		NT	no trend data
16	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
17	Hum. Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
18	Supply Air Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
19	Space Avg Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
21	Cooling CHGST	°F		NT	no trend data
22	Cooling CHGRT	°F		NT	no trend data
23	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
24	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 4

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: AHU-3

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
3	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
4	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
5	Econ Command	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
6	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
7	Heating Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
8	Hum. Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
9	Supply Air Hummidity	%	5 min	pre 2012	have existing 5-min trend data
10	Space Avg Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
11	Cooling Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
12	Supply Air Temp.	°F	15 min	1/8/2014	New 15-min trend started for 2 week run.

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 5

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: AHU-4

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
3	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
4	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
5	Econ Command	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
6	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
7	Heating Vlv. Pos.	%	5 min	1/8/2014	New 15-min trend started for 2 week run.
8	Hum. Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
9	Supply Air Hummidity	%	5 min	1/8/2014	New 15-min trend started for 2 week run.
10	Space Avg Hummidity	%	5 min	pre 2012	have existing 5-min trend data
11	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
12	Supply Air Temp.	°F	15 min	1/8/2014	New 15-min trend started for 2 week run.

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 6

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: AHU-5

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
3	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
4	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
5	Econ Command	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
6	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
7	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
8	Hum. Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
9	Supply Air Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
10	Space Avg Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
11	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
12	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 7

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: AHU-6

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	SF Airflow	fpm	5 min	pre 2012	have existing 5-min trend data
3	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
4	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
5	RF Airflow	fpm		NT	no trend data
6	Return Duct Static Pressure	"WC		NT	no trend data
7	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
8	Return Air CO2	PPM	5 min	pre 2012	have existing 5-min trend data
9	OSA Airflow	fpm	5 min	pre 2012	have existing 5-min trend data
10	Econ Command	%	5 min	pre 2012	have existing 5-min trend data
11	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
12	Heating GHST	°F		NT	no trend data
13	Heating GHRT	°F		NT	no trend data
14	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
15	Hum. Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
16	Supply Air Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
17	Space Avg Hummidity	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
18	Cooling CHGST	°F		NT	no trend data
19	Cooling CHGRT	°F		NT	no trend data
20	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
21	Supply Air Temp.	°F	15 min	1/8/2014	New 15-min trend started for 2 week run.

System Monitoring Plan (100% OSA AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 8

Prepared By: JTWB *Date:*

Notes:

AHU Name: AHU-7

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	SF Airflow	CFM	5 min	pre 2012	have existing 5-min trend data
3	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
4	Pre Heat Air Temp	°F	5 min	pre 2012	have existing 5-min trend data
5	Pre-Heat GHST	°F		NT	no trend data
6	Pre-Heat GHRT	°F		NT	no trend data
7	Pre-Heat Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
8	Hum. Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
9	Supply Air Hummidity	%	5 min	pre 2012	have existing 5-min trend data
10	Space Avg Hummidity	%	5 min	pre 2012	have existing 5-min trend data
11	Cooling CHGST	°F		NT	no trend data
12	Cooling CHGRT	°F		NT	no trend data
13	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
14	Heating GHST	°F		NT	no trend data
15	Heating GHRT	°F		NT	no trend data
16	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
17	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan (100% OSA AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 9

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: AHU-8

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
2	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
3	Pre-Heat Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
4	Hum. Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
5	Supply Air Hummidity	%	5 min	pre 2012	have existing 5-min trend data
6	Space Avg Hummidity	%	5 min	pre 2012	have existing 5-min trend data
7	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
8	DX Coil enable	on/off	5 min	pre 2012	have existing 5-min trend data
9	Heating Vlv. Pos.	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
10	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan (100% OSA AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 10

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: AHU-9

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	SF Airflow	CFM		NT	no trend data
3	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
4	Pre Heat Air Temp	°F		NT	no trend data
5	Pre-Heat GHST	°F		NT	no trend data
6	Pre-Heat GHRT	°F		NT	no trend data
7	Pre-Heat Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
8	Hum. Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
9	Supply Air Hummidity	%	5 min	pre 2012	have existing 5-min trend data
10	Space Avg Hummidity	%	5 min	pre 2012	have existing 5-min trend data
11	Cooling CHGST	°F		NT	no trend data
12	Cooling CHGRT	°F		NT	no trend data
13	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
14	Heating GHST	°F		NT	no trend data
15	Heating GHRT	°F		NT	no trend data
16	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
17	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 11

Prepared By: AK *Date:* 1/8/2014

Notes:

AHU Name: AHU-11

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
2	SF Airflow	CFM	5 min	pre 2012	have existing 5-min trend data
3	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
5	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
6	RF Airflow	CFM		NT	no trend data
7	Return Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
9	Ret Air Temp.	°F		NT	no trend data
10	OSA Airflow	CFM		NT	no trend data
12	Econ Command	%	15 min	1/8/2014	New 15-min trend started for 2 week run.
13	Mixed Air. Temp.	°F	15 min	1/8/2014	New 15-min trend started for 2 week run.
14	Heating GHST	°F		NT	no trend data
15	Heating GHRT	°F		NT	no trend data
16	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
17	Cooling CHGST	°F		NT	no trend data
18	Cooling CHGRT	°F		NT	no trend data
19	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
20	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
22	Space Temp Link 1	°F	15 min	1/8/2014	AHU 11 - Space T 1
23	Space Temp Link 2	°F	15 min	1/8/2014	AHU 11 - Space T 2
24	Space Temp Link 3	°F	15 min	1/8/2014	AHU 11 - Space T 3

System Monitoring Plan (Re-Circulating AHU)

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 12

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: Entryway AHU

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	SF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
2	Supply Duct Static Pressure	"WC	5 min	pre 2012	have existing 5-min trend data
3	RF VFD Speed	%	5 min	pre 2012	have existing 5-min trend data
4	Ret Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
5	Mixed Air. Temp.	°F	5 min	pre 2012	have existing 5-min trend data
6	Heating Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
7	Cooling Vlv. Pos.	%	5 min	pre 2012	have existing 5-min trend data
8	Humidity Valve Pos.	%	5 min	pre 2012	have existing 5-min trend data
9	Supply Air Temp.	°F	5 min	pre 2012	have existing 5-min trend data
10	Supply Air Hummidity	%	5 min	pre 2012	have existing 5-min trend data
11	Space Avg Hummidity	%	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 13

Prepared By: JTWB *Date:* 1/8/2014

Notes:

AHU Name: ACU-15

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Stair 2 Space Temperature 1st Floor	°F		NT	no trend data
2	Stair 2 Space Temperature 2nd Floor	°F		NT	no trend data
3	ACU-15 Status	°F		NT	no trend data
4	Supply Air Tempearture	°F		NT	no trend data
5	Return Air Temperature	°F	15 min	1/8/2014	New 15-min trend started for 2 week run.
6	Baseboard	on/off		NT	no trend data

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 14

Prepared By: JTWB & AK *Date:* 1/9/2014

Notes:

VAV Box Trending

#	VAV Box Name	Data Point Common Name						Frequency	Notes
1	VAV-1-101	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
2	VAV-1-121	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	1A266 - Occ Int
3	VAV-1-221	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	2A210 - Occ Int
4	VAV-1-203	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	2A167 - Occ Int
5	VAV-2-102	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
6	VAV-2-210	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
7	VAV-3-104	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	1D110-Occ Int
8	VAV-3-206	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	2D152-Occ Int
9	VAV-3-215	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	2D183-Occ Int
10	VAV-4-108	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
11	VAV-4-109	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
12	VAV-4-216	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	2D127-Occ Int
13	VAV-4-117	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	1B176-Occ Int
14	VAV-5-106	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
15	VAV-5-116	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	1C131 - Occ Int
16	VAV-5-204	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	
17	VAV-5-220	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	2C138 - Occ Int
18	VAV-9-102	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	Lab
19	VAV-9-103	Supply Temp (°F)	Desired CFM	Actual CFM	HWS Valve (%)	Space Temp (°F)	Space Temp Set-Pt. (°F)	15 min	Lab

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 15

Prepared By: JTWB *Date:* 1/8/2014

Notes:

Snowmelt System

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Snowmelt Main HGS Temp	°F	5 min	pre 2012	have existing 5-min trend data

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 16

Prepared By: JTWB *Date:* 1/9/2014

Notes:

System Name: ***Chilled Water Heat Exchangers***

Instructions: Columns b. thru c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.
#	**Data Point Common Name**	**Equipment Tag #**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Chilled Glycol Pump 13A (VFD Spd)	P-13A	%	5 min	pre 2012	existing 5-min trend data
2	Chilled Glycol Pump 13B (VFD Spd)	P-13B	%	5 min	pre 2012	existing 5-min trend data
3	Differential Pressure		Psid	5 min	pre 2012	existing 5-min trend data
5	Well Water Temperature (EWT)	WW	°F	5 min	pre 2012	existing 5-min trend data
6	Chilled Glycol Supply Temperature		°F	5 min	pre 2012	existing 5-min trend data
8	Waste Water Valve		%	5 min	pre 2012	existing 5-min trend data
9	Chilled Glycol Loop ByPass Valve		%	5 min	pre 2012	existing 5-min trend data

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 17

Prepared By: JTWB *Date:* 1/9/2014

Notes:

System Name: ***Heating Water Heat Exchangers***

Instructions: Column b. describes an existing DDC data point. Columns c. and d. give the units and sample frequency. Column e. indicates date trend was started.

a.	b.	c.	d.	e.	f.
#	**Data Point Common Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	ByPass Valve Position	%	15 min	pre 2012	existing 5-min trend data
2	Heating Glycol Supply Temperature	°F	15 min	pre 2012	existing 5-min trend data
3	Heating Glycol Return Temperature	%	15 min	pre 2012	existing 5-min trend data
4	Differential Pressure	Psid	15 min	pre 2012	existing 5-min trend data

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 18

Prepared By: JTWB *Date:* 1/9/2014

Notes:

System Name: ***Heating Pumps***

Instructions: Columns b. thru c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.
#	**Data Point Common Name**	**Equipment Tag #**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Heated Glycol Pump 1A (VFD Spd)	P-1A	%	15 min	pre 2012	Clinic Primary Heating Loop
2	Heated Glycol Pump 1B (VFD Spd)	P-1B	%	15 min	pre 2012	Clinic Primary Heating Loop
5	Heated Glycol Pump 2A (VFD Spd)	P-2A	%	15 min	pre 2012	AHU-1, 2 & 7 Heating Coils
6	Heated Glycol Pump 2B (VFD Spd)	P-2B	%	15 min	pre 2012	AHU-1, 2 & 7 Heating Coils
9	Heated Glycol Pump 3A (VFD Spd)	P-3A	%	15 min	pre 2012	AHU-1, 2 & 7 Re-Heat & Perim Heat
10	Heated Glycol Pump 3B (VFD Spd)	P-3B	%	15 min	pre 2012	AHU-1, 2 & 7 Re-Heat & Perim Heat
13	Heated Glycol Pump 4A (VFD Spd)	P-4A	%	15 min	pre 2012	AHU-3, 4 & 8 Re-Heat & Perim Heat
14	Heated Glycol Pump 4B (VFD Spd)	P-4B	%	15 min	pre 2012	AHU-3, 4 & 8 Re-Heat & Perim Heat
17	Heated Glycol Pump 5A (VFD Spd)	P-5A	%	15 min	pre 2012	AHU-3, & 8 Heating Coils
18	Heated Glycol Pump 5B (VFD Spd)	P-5B	%	15 min	pre 2012	AHU-3, & 8 Heating Coils
21	Heated Glycol Pump 6A (VFD Spd)	P-6A	%	15 min	pre 2012	AHU-5, & 9 Heating Coils
22	Heated Glycol Pump 6B (VFD Spd)	P-6B	%	15 min	pre 2012	AHU-5, & 9 Heating Coils
25	Heated Glycol Pump 7A (VFD Spd)	P-7A	%	15 min	pre 2012	AHU-4, 5 & 9 Re-Heat & Perim Heat
26	Heated Glycol Pump 7B (VFD Spd)	P-7B	%	15 min	pre 2012	AHU-4, 5 & 9 Re-Heat & Perim Heat
29	Heated Glycol Pump 8A (VFD Spd)	P-8A	%	15 min	pre 2012	AHU-4, & 6 Heating Coils
30	Heated Glycol Pump 8B (VFD Spd)	P-8B	%	15 min	pre 2012	AHU-4, & 6 Heating Coils
33	Heated Glycol Pump 9A (Status)	P-9A	on/off	15 min	pre 2012	Radiant Floor Tertiary Loop
34	Heated Glycol Pump 9B (Status)	P-9B	on/off	15 min	pre 2012	Radiant Floor Tertiary Loop
36	Heated Glycol Pump 10A (VFD Spd)	P-10A	%	15 min	pre 2012	AHU-11 Heat, Re-Heat & Perim Heat
37	Heated Glycol Pump 10B (VFD Spd)	P-10B	%	15 min	pre 2012	AHU-11 Heat, Re-Heat & Perim Heat

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 19

Prepared By: JTWB *Date:* 1/8/2014

Notes:

System Name: ***Humidification Air Compressor System***

Instructions: Columns b. thru c. describe an existing DDC data point. Columns d. and e. give the units and sample frequency. Column f. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.
#	**Data Point Common Name**	**Equipment Tag #**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Air Compressor #3 (Amps)	AC-3	Amps	15 min	11/20/2013	STAND-ALONE DATA LOGGING
2	Compressed Air Tank/System (PSI)	AT-1	psi	5 min	pre 2012	existing 5-min trend data

System Monitoring Plan

Facility Name: VISN 20 - Anchorage VA Healthcare System

Sheet Number: 2

Prepared By: *Date:*

Notes:

Snowmelt System

Instructions: Columns b. thru d. describe an existing DDC data point. Columns e. and f. give the units and sample frequency. Column g. indicates date trend was started.

a.	b.	c.	d.	e.	f.	g.	h.
#	**Data Point Common Name**	**Equipment Tag #**	**Data Point DDC Name**	**Units**	**Sampling Frequency**	**Trend Start Date**	**Notes**
1	Heated Glycol Pump 11A (Status)	P-11A		on/off	15 min		Entrance Snowmelt Tertiary Loop
2	Heated Glycol Pump 11B (Status)	P-11B		on/off	15 min		Entrance Snowmelt Tertiary Loop
3	Heated Glycol Pump 12A (Status)	P-12A		on/off	15 min		Patio Snowmelt Tertiary Loop
4	Heated Glycol Pump 12B (Status)	P-12B		on/off	15 min		Patio Snowmelt Tertiary Loop
5	Snowmelt Main HGS Temp			°F	5 min		have existing 5-min trend data
13	East Slab Surface Temp			°F	15 min		have existing 5-min trend data
14	East Slab Core Temp			°F	15 min		have existing 5-min trend data
15	East Moisture Detection			on/off	15 min		have existing 5-min trend data
16	West Slab Surface Temp			°F	15 min		have existing 5-min trend data
17	West Slab Core Temp			°F	15 min		have existing 5-min trend data
18	West Moisture Detection			on/off	15 min		have existing 5-min trend data

VISN 20 Alaska VA Healthcare System

Systems Diagnostic Monitoring Report

MARCH 28, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
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Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Executive Summary

1.1 INTRODUCTION

As part of its RCx efforts at VISN 20, DAV Energy presents a summary of the systems that were monitored during the four to eight week data logging process, summary of findings and the issues identified. Deviations between the Diagnostic Monitoring Plan as it was originally outlined and the actual execution of the equipment monitoring process are also addressed. Detailed information to support these summaries is provided in the appendices. This is being completed under **Key Deliverable 7 Systems Diagnostic Monitoring Report**.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs, and
4. Identify energy or capital improvement projects for implementation in the future.

The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	In Progress
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	**Systems Diagnostic Monitoring Report**	**Complete**
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Diagnostic Monitoring Process

2.1 DIAGNOSTIC MONITORING OBJECTIVES

The objective of this Systems Diagnostic Monitoring Report is to present the activities that took place during the diagnostic monitoring portion of the RCx project. This includes the findings from data trended from the controls system as well as data collected through portable data loggers. The purpose of analyzing trend data is to assist in identifying problem areas. Onsite testing provides additional information on operational issues. Results from the testing will be presented in this report.

Diagnostic monitoring evaluates historical system performance by analyzing data collected from the control system or portable loggers. This data is graphed over time to obtain information on the equipment on/off schedules, temperature control, and other system components. It provides the means to confirm whether the existing sequence of operations is being followed, identify instances of deviation from the sequences, identify other equipment issues and deficiencies, and identify potential ECMs.

The objectives of diagnostic monitoring include the following:

- Confirm operating issues identified during field observations.
- Identify equipment operating hours and cycling patterns.
- Identify operating temperatures, pressures, humidity, speeds, and flow rates where available.
- Determine correlations between system operating variables and other parameters (e.g. ambient temperature, occupancy).
- Determine and confirm as-built control sequences of operation.
- Identify systems that do not respond to control set-points or cannot maintain set-points.
- Find incidents of simultaneous heating and cooling, inappropriate economizer operation, excessive variable frequency drive (VFD) speeds, and other incidents of non-optimal operation.
- Identify sensors whose values do not correspond to measured conditions, indicating a need for calibration or replacement.

2.2 DIAGNOSTIC MONITORING EXECUTION

Diagnostic monitoring was executed with data collected in two ways, trending on Building Automation Systems (BAS) and placement of one portable data logger. For buildings with a BAS, DAV and the facilities service contractor (FSI) established trend logs for AHUs, central plant equipment, and terminal units. The systems were setup to log point inputs and outputs at established intervals, such as every 5 or 15 minutes, and store this data on a local computer. Many of the data points were already being trended in the system which increased the length of time available on many points. The data was extracted from the system after 4 weeks for analysis, and then again after another 4 weeks for a reduced number of points. The number of points that could be trended was limited due to hard drive space constraints on the BAS hardware. AHU trending generally included discharge air temperatures, return air temperatures, mixed air temperatures, duct static pressures, humidity, fan speeds, damper positions, and valve positions. The central plant trending generally included pump speeds, heating and cooling loop temperatures, differential pressure, flow, and equipment power. Portable data logging was used to measure utility compressor power. This plant obtains district heating and cooling from Elmendorf Air Force Base located adjacent.

The data gathered during the monitoring period was prepared in graphical format and analyzed for potential issues and improvement opportunities. The analysis was performed to assess operation with respect to the understood Sequence of Control, (presented in Deliverable 3 - Facility Information Documents), and optimal control strategies for energy efficient operation.

The detailed monitoring approach including the equipment evaluated in the monitoring process was provided in the Diagnostic Monitoring Plan. The following outlines major deviations from the plan:

- Fewer VAV terminal units were measured – no major issues were discovered in the functional testing.

2.3 SCHEDULE

This section sets forth the intended detailed schedule of diagnostic testing tasks to be carried out at the Anchorage, Alaska VA Outpatient Clinic.

Table 2-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 through 1/10/2014 May 2014	Yes	Functional Testing was Completed in January of 2014 with potential wrap up testing in March to investigate items found during trend analysis
Onsite TAB Measurements	May 2014	Yes	Anticipate bringing in TAB contractor in March of 2014 to take selected measurements.
Prepare Deficiencies Log	1/6/2014 through 4/9/2014	Partial	Ongoing during functional testing and completed in the office after testing is finished.
Prepare Systems Testing Report and Deliver to VA for approval	4/9/2014	No	This report will summarize findings from the testing.

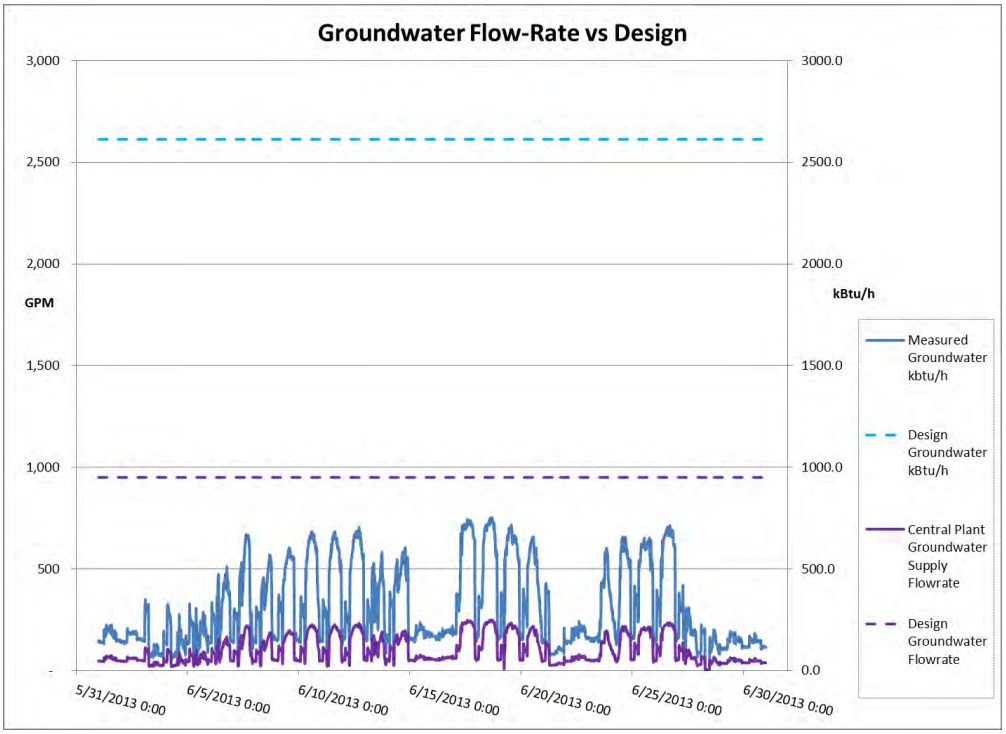
3.0 Diagnostic Monitoring Results

The following sections present key issues found during the diagnostic monitoring of equipment through DDC trending and portable data logging. Each section presents the most common issues identified and locations in which the issues were seen. Graphs displaying different instances of the issues for various pieces of equipment can be found in **Appendix A**.

3.1 COOLING SYSTEM / CHILLED GLYCOL SYSTEM

Cooling plant operation was assessed using diagnostic monitoring data. The data was also used to identify additional issues for repair and potential energy saving measures. Trend data indicated that the delivered chilled water temperature was below the design set-point in the summer forcing the system to run continuously to remove heat from the building, including at night. If the chilled well water temperature was lower, or the delivered flow-rate was higher, the clinic could save energy by running the system only during occupied hours as designed. This has numerous effects including requiring the chilled water and chilled glycol pumps to run extended hours, some of the AHUs then also run to remove heat from the building. Please see Figure 3.1.0 below showing the ground well chilled water flow rate, compared with the design flow rate of 850 GPM. Thus the Btu delivered is less than the Btu designed.

Figure 3.1.0 Cooling Groundwater BTU & Flow vs. Design

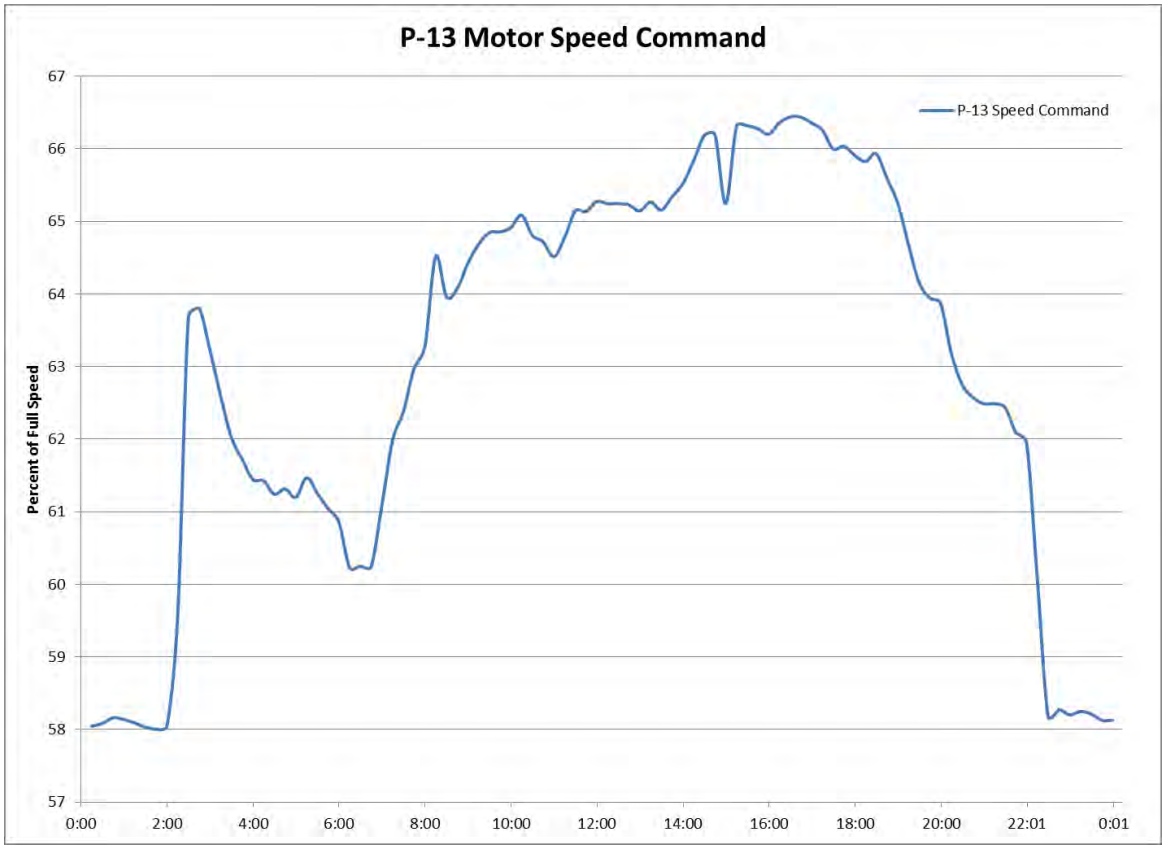


Information regarding the equipment and the most frequent issues identified through the monitoring process are presented in the following sections.

3.1.1 Schedule Control

The scheduling of equipment was analyzed to determine if any of the equipment was operating unnecessarily outside of building occupancy hours. The following list summarizes the trend analysis schedule findings and a graphical example is shown below in Figure 3.1.1.

Figure 3.1.1: Primary Chilled Water Loop Pump

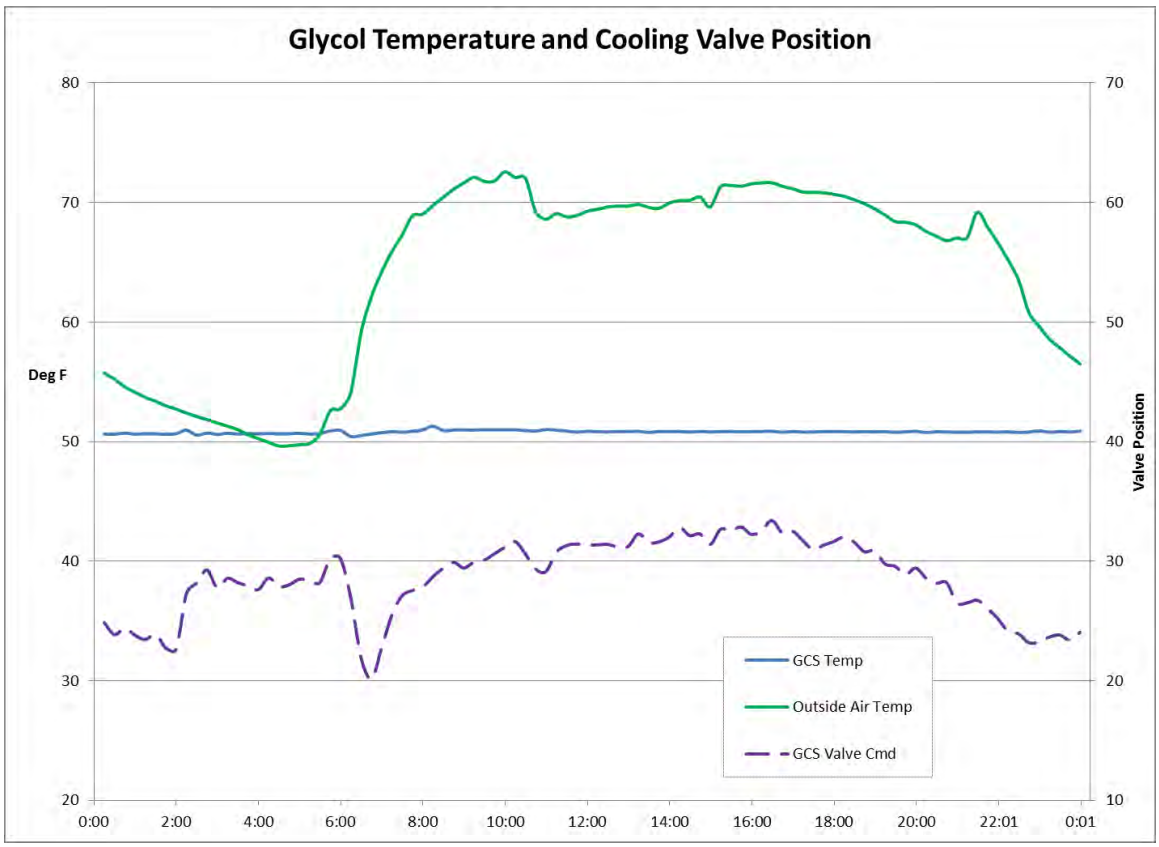


- The Primary Cooling Loop pumps (Pump 13A/B) runs constantly 24/7, rather than during occupied hours.
- The Cooling system is enabled 24/7, rather than only during occupied hours.

3.1.2 Temperature Control

The chilled water plant temperatures were analyzed to make sure that they are controlled properly and fall within range of their programmed set points. The following list summarizes the trend analysis findings and a graphical example is shown below in Figure 3.1.2.

Figure 3.1.2 Cooling Glycol Temperature and Valve Position



- Cooling Glycol is maintained at approximately 51 degrees F.
- A Pre-Cooling routine between 2:00 AM and 7:00 AM engages the cooling valve.
- The cooling valve modulates with outside air temperature, it is able to respond as the building needs more or less cooling.

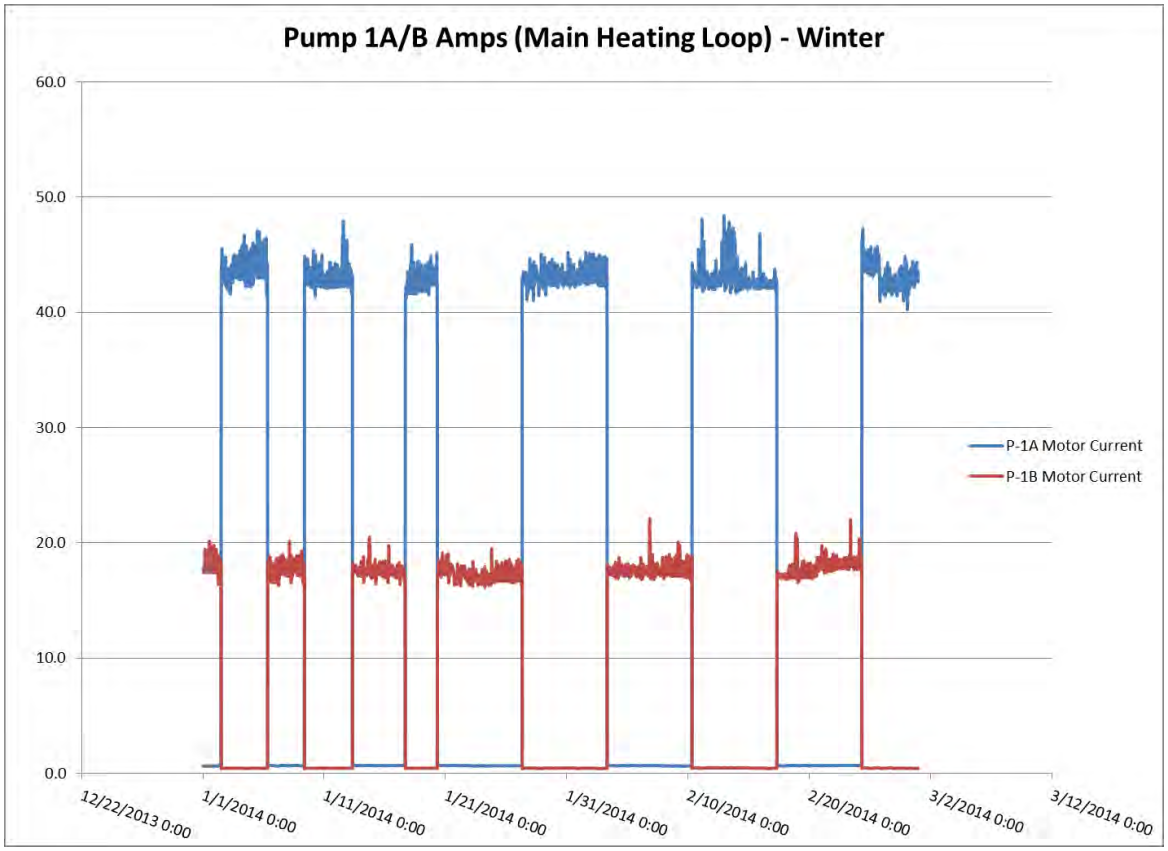
3.2 HEATING SYSTEM / HEATED GLYCOL SYSTEM

Heating system/plant operation was assessed using diagnostic monitoring data. The data was also used to identify additional issues for repair and potential energy saving measures. Trend data for the programmed hot water supply temperature set points, reset strategies, and system lockouts were observed for most systems. The most frequent issues identified through the monitoring process are presented in the following sections.

3.2.1 Schedule Control

The scheduling of equipment was analyzed to determine if any of the equipment was operating unnecessarily outside of building occupancy. The following list summarizes the trend analysis schedule findings and a graphical example is shown below in Figure 3.2.1.

Figure 3.2.1 – Main Heating Loop Pump (Winter 2014)

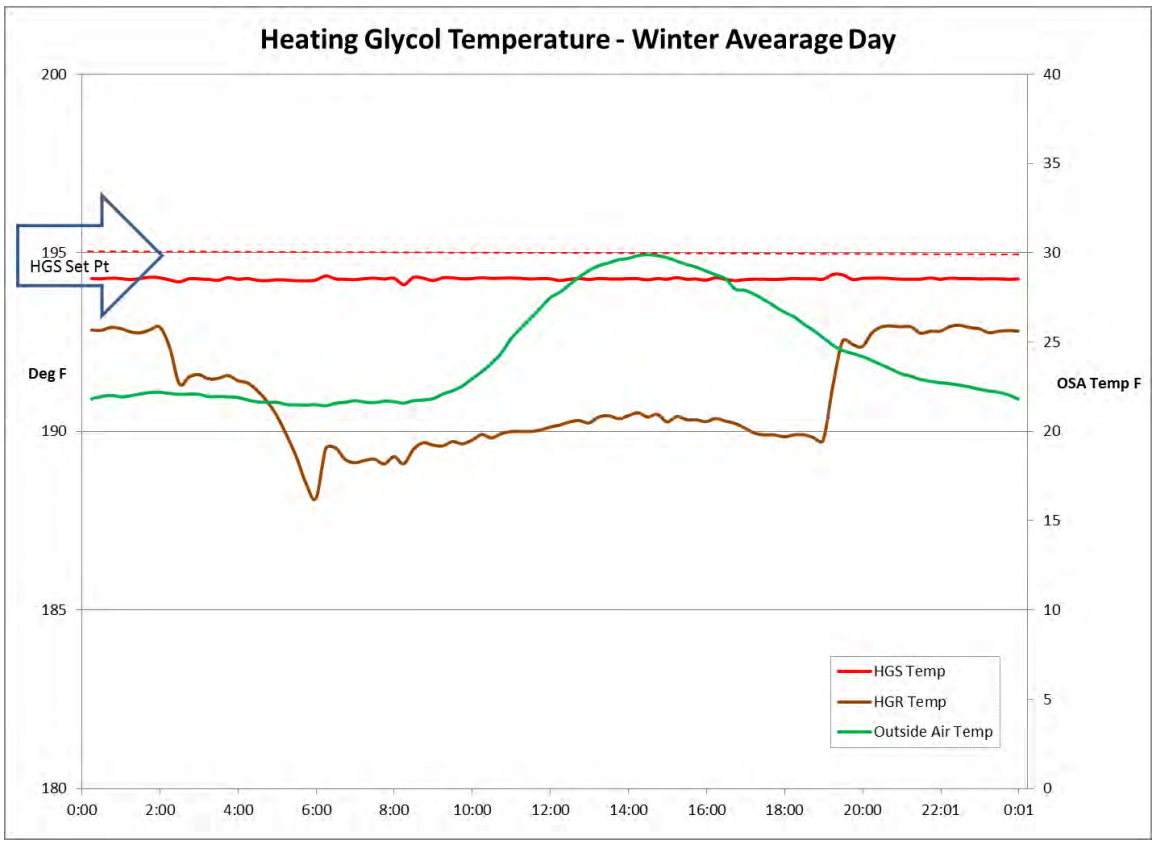


- The heating loop is enabled continuously; however pump B appears to run at lower amperage than A. From field inspection both motors are identical.

3.2.2 Temperature Control

The heating water plant temperatures were analyzed to make sure that they are controlled properly and fall within range of their programmed set points. The following list summarizes the trend analysis findings and a graphical example is shown below in Figure 3.2.2.

Figure 3.2.2 HGS Temperature and Set-Point



- The Heating Glycol supply temperature closely matches the set-point of 195 degrees F.
- The Heating Glycol return temperature is inverse of the outside air temperature, while the supply temperature remains constant, indicating that the system is able to respond correctly to heat the building

3.3 AIRSIDE SYSTEMS

Diagnostic monitoring data was used to assess airside system operation, identify additional issues for repair, and identify potential energy saving measures. There were ten Air Handling Units (AHUs) observed, along with chilled water and hot water supply data, and pump data in winter and summer seasons.

The monitoring process identified several issues, the most frequent of which are shown below by air handler:

3.3.1 AHU 1

SUMMER: Economizer cooling does not appear to be optimized when outside air (OSA) is between 55°F and 70°F; Economizer should be taking full advantage of optimal OSA when it is below return air temperature.

WINTER: There were no apparent issues.

3.3.2 AHU 2

SUMMER: Supply fan operates 24/7, though return fan shuts down each day at 10:00 pm. During occupied hours the supply pressure setpoint maintains 1” WC.

WINTER: Supply Fan operates 24/7, though return fan shuts down each day at 7:00 pm. Supply pressure set-point modulates between 1” to 1.2” WC, while during unoccupied hours it holds steady at 1”.

3.3.3 AHU 3

SUMMER: There is no economizer data. Supply Fan begins operation at 2:00am, shuts down at 10:00 pm, while the return fan starts at 6:00am and shuts down at approximately 10:00 pm. The supply fan VFD shows very little modulation vs. OSA except when below 50 °F. During occupied hours the Supply pressure set-point modulates stays around 1” and modulates up to 1.2” WC; during unoccupied hours it drops to 0” WC, i.e. it shuts down.

WINTER: There is no economizer data. During occupied hours the Supply pressure set-point modulates between 1” to 1.4” WC with quite a few hours steady at 1” WC during unoccupied hours it drops to 0” WC, i.e. it shuts down. Supply Fan VFD runs 24/7, though the return fan shuts down each day at 7:00 pm.

3.3.4 AHU 4

SUMMER: There is no economizer data. The supply fan operates in ranges of 76-85% (occupied, most common) and 42-47% (unoccupied) independent of temperature. At occupied it operates 1.4” WC static pressure, while in unoccupied it operates at 1.1” WC. Rather than maintaining 32% humidity (as in winter), it maintains 42% humidity.

WINTER: There is no economizer data. The supply fan operates in ranges of 76-85% (occupied, most common) and 42-47% (unoccupied) independent of temperature. At occupied it operates 1.4” WC static pressure, while in unoccupied it operates at 1.1” WC.

3.3.5 AHU 5

SUMMER: There is a correlation between outside air temperature and fan speed while in cooling mode. The supply and return fan turn on at 2:00 am and run at reduced speeds.

WINTER: There is no available economizer data or return air data. With minor variances, 65-80% operation is being maintained. The supply and return fans are enabled at 1:15 am and disabled at around 10:15 pm. There is no humidity data. Static pressure hovers between 0.7” and 1.1” WC.

3.3.6 AHU 6

SUMMER: There appear to be no apparent issues.

WINTER: The supply fan does not appear to modulate based on outside air, which is appropriate during winter. Supply fan and return fan turn on at 6:00 am and turn off at 8:00 pm. There is roughly 70% fan speed being maintained during occupied hours. There are no apparent issues.

3.3.7 AHU 7

SUMMER: There is no return fan; this unit operates at 100% outside air, which is normal. The fans are running from 2:00 am to 10:00 pm, with the fans ramping up at 2:00pm till close.

WINTER: There is no return fan; this unit operates at 100% outside air, which is normal. During occupied hours this maintains slightly above 70% of full speed. The supply fan maintains 71% of full speed at occupied hours between 6:00 am and 6:45 pm. From about 7:00 pm till 1:00 am, the air handler shut down but shows a feedback of 10% fan speeds per the data. At 1:00 am until 6:00 am it ramps up in a linear fashion to the 6:00 am occupied 71% condition, most likely to maintain static. From 1:00 am till 7:00 pm, the unit is maintaining a minimum 0.9” WC, a standard occupied set point.

3.3.8 AHU 8

SUMMER: The fan runs from 6:15 am to 10:15 pm. The supply fan maintains around 90% speed with minor modulations.

WINTER: There is no return fan, thus it uses 100% OSA; the supply fan appears to be running from 2:30 am to 7:00 pm maintaining roughly full speed Monday through Friday. The unit is not meeting its humidity setpoint.

3.3.9 AHU 9

SUMMER: Supply fan runs at 100% full time and there is no return fan. The unit is maintaining just under 40% space humidity regardless of outside air. Supply pressure is maintaining a constant air flow.

WINTER: Supply fan runs at 100% full time and there is no return fan. The unit is maintaining just under 30% space humidity regardless of outside air. Supply pressure is maintaining a constant air flow.

3.3.10 AHU 11

SUMMER: Economizer operates between 15% and 30% when OSA is between 50F and 90F. No supply fan speed data provided, however the return fan operates at a reduced static during unoccupied hours from 10:30PM to 6:00AM. Supply fan static pressure reduces to zero during unoccupied hours and maintains 0.15” when occupied.

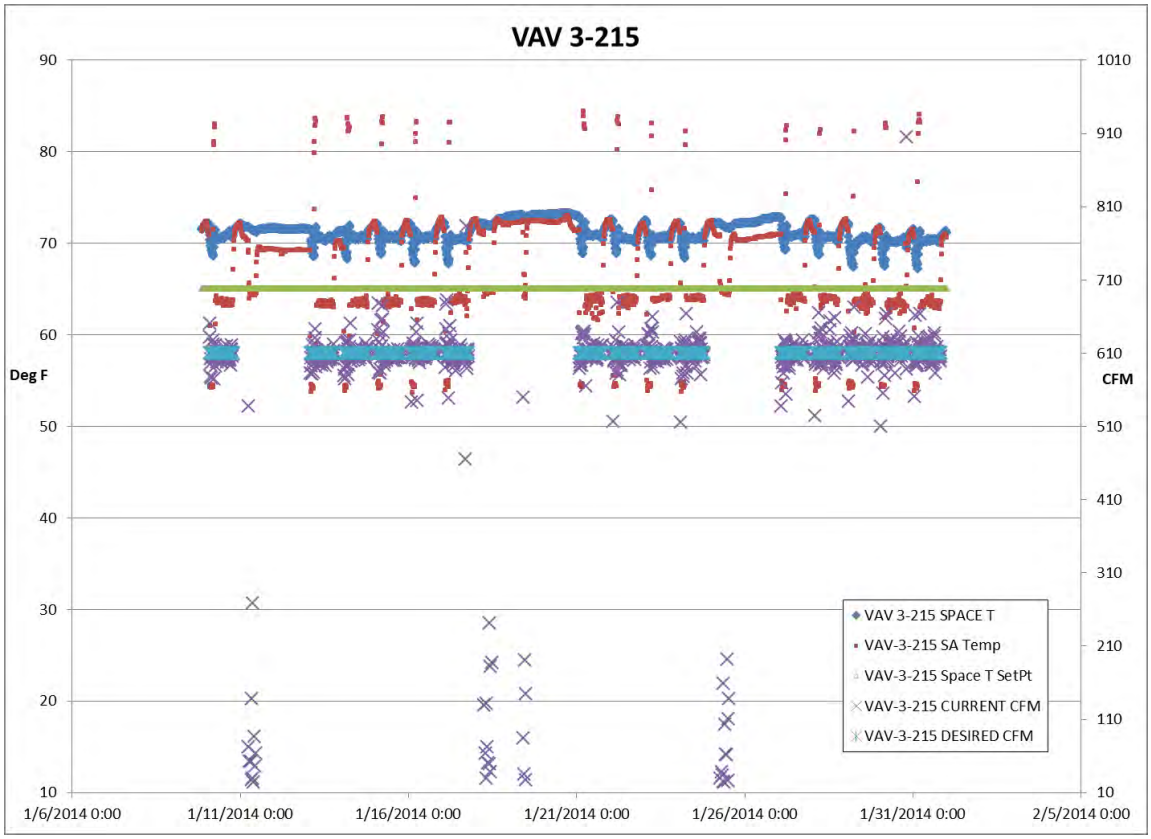
WINTER: From the data collected it is apparent that the supply fan runs daily from 6:00 AM to 7:00 PM. A constant 20% outside air is used, the economizer does not appear to modulate based on conditions. Supply pressure is maintained at approximately 1.3” during occupied hours only.

3.4 TERMINAL UNITS

Diagnostic monitoring data was used to assess terminal unit operation, identify additional issues for repair, and identify potential energy saving measures. The majority of the terminal units analyzed are maintaining setpoints for space temperature control, with a few exceptions in the terminals outlined below:

- **VAV 1-203:** Space temperature sensor failure.
- **VAV 1-221, VAV 3-215, VAV 4-216, VAV 5-220:** Temperature consistently above set point. A graphical example is shown in Figure 3.4.0 below.
- **VAV 8-106:** Not holding humidity set point.
- **VAV 9-102:** Low CFM.

Figure 3.4.0 – Parameters for VAV 3-215



Please note that the Space Temperature is consistently above the setpoint, indicating that the thermostat is likely in the wrong area, is blocked by furniture, or that the supply air short-cycles from the supply to the return duct. The CFM matches the CFM setpoint, which is typical of the VAV boxes analyzed.

4.0 Simple Repair Plan

The RCx team will provide simple repairs and setpoint adjustments as required to correct identified issues and achieve project goals. The objective of simple repairs is to improve the operation of the facility by eliminating issues that can be repaired quickly.

4.1 IDENTIFICATION OF SIMPLE REPAIRS

The HVAC systems are evaluated through site observation, system condition assessment, diagnostic monitoring, point to point testing, functional testing, and TAB measurements. All issues identified through these activities are documented in the Issues Log in **Appendix A**. Some of these issues require less than 30 minutes to correct, therefore qualifying as simple repairs. Simple repairs and setpoint adjustments may include the following:

- Lubrication of damper linkages
- Tightening of set screws on damper actuators
- Loosening of stuck dampers
- Correction of minor programming issues
- Re-connection of actuators to dampers
- Re-connection of pneumatic control tubing to actuators
- Restoration of automatic control to devices that have been deemed functional based on results of point to point and functional testing
    - Adjustment of setpoints or schedules
    - Clearing alarms and resetting tripped devices
    - Removing blockages from dampers or ductwork
    - Adjusting v-belt pulleys
    - Adding or adjusting filters to provide full coverage of airstream
    - Adjusting throttled valves or balancing valves that are out of adjustment
    - Calibration of sensors and pneumatic controllers
    - Adjustment of minimum flow settings

4.2 PRIORITIZATION OF SIMPLE REPAIRS

The simple repairs identified will be prioritized to help ensure that the most beneficial items are corrected as part of the RCx project. Prioritization of repairs will include input from the VA staff, RCx team and contractors. This may be based on the following items:

- VA project goals,
- Priority of buildings, HVAC systems, or spaces served,
- Impact to building and system energy use,
- Remaining equipment life and replacement schedule,
- Impact to infection control, or
- Impact to occupant comfort.

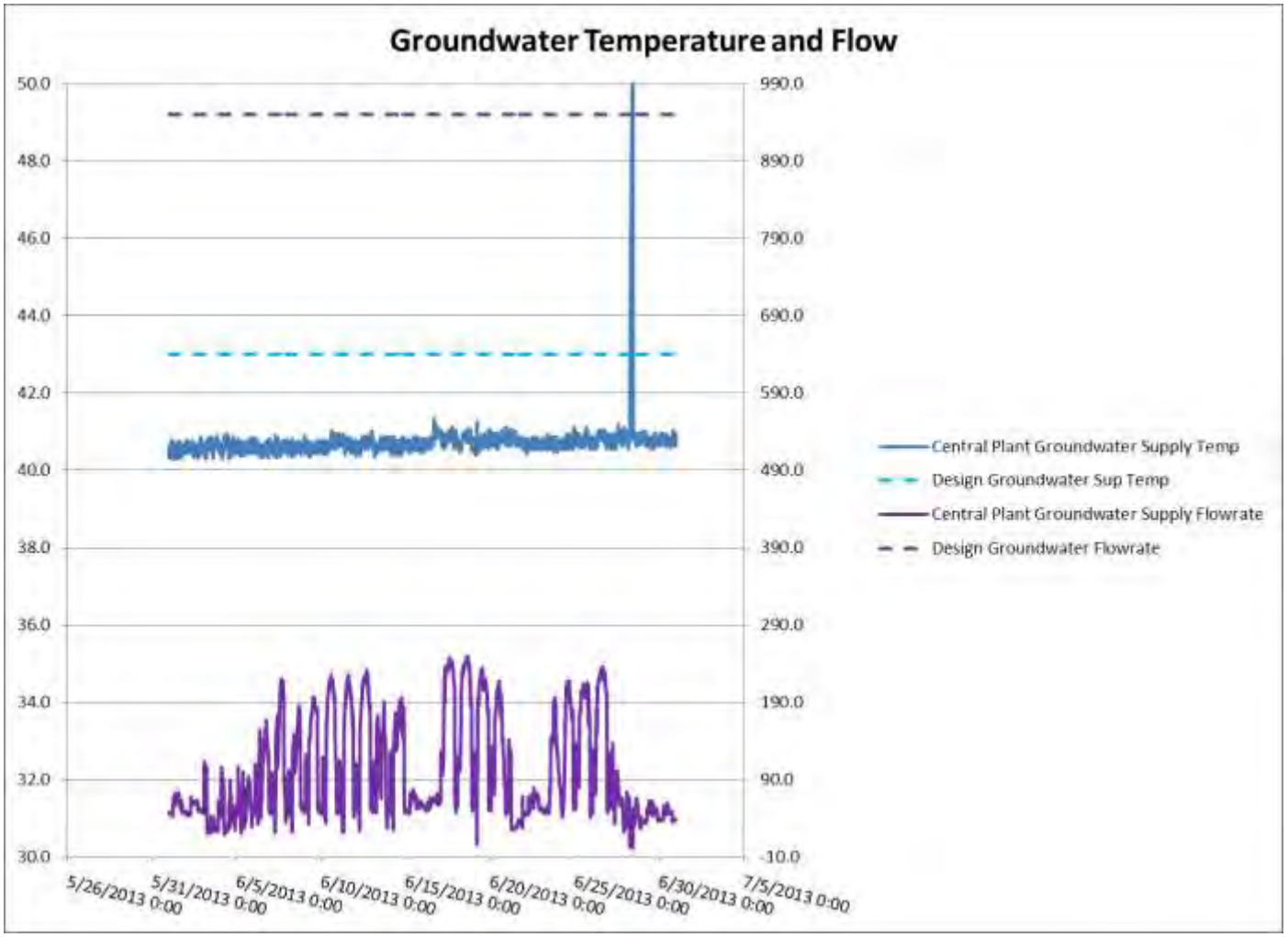
4.3 EXECUTION OF SIMPLE REPAIRS

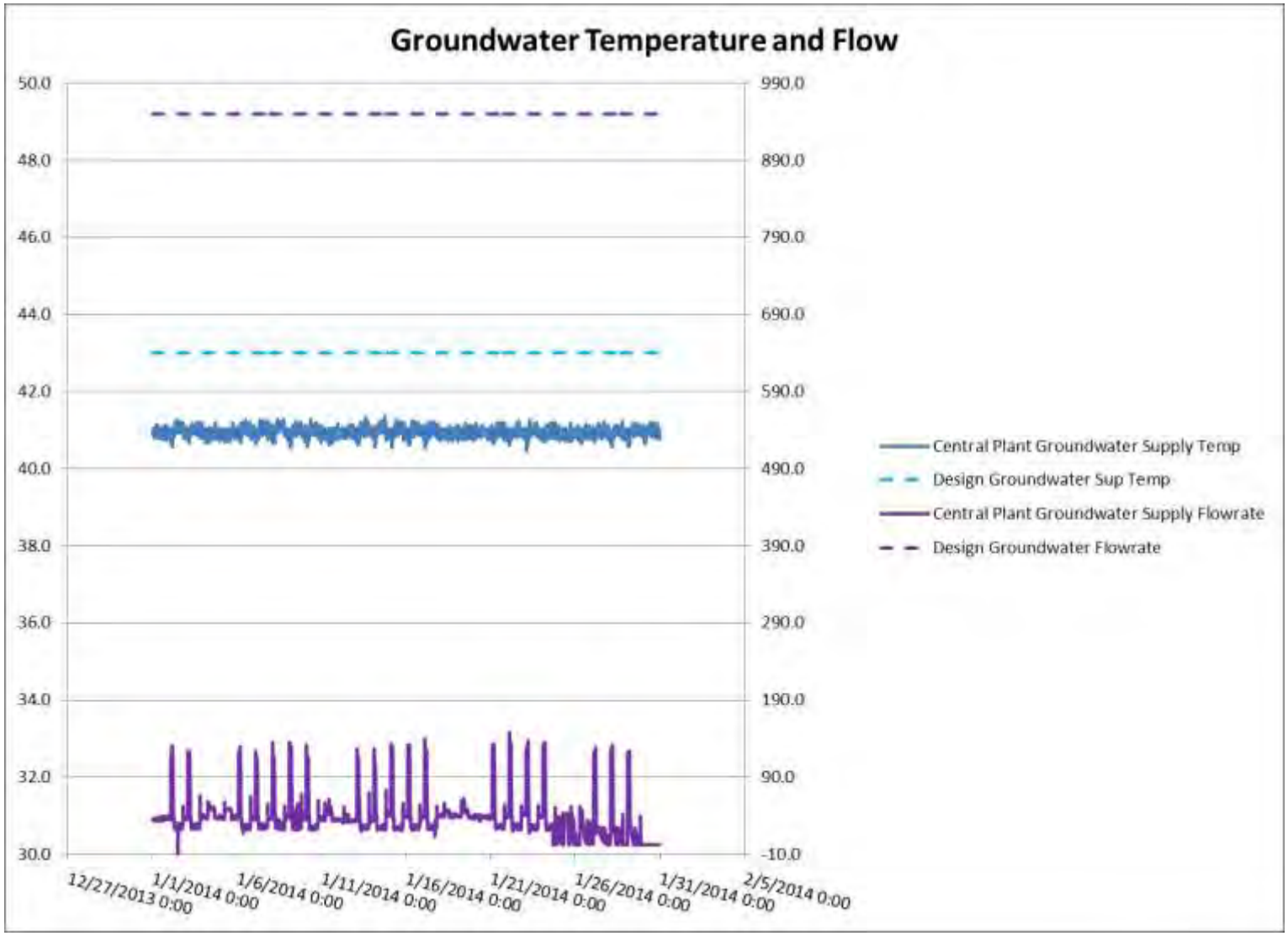
The prioritized and approved simple repairs will be implemented by the RCx team, VA staff or a contractor. Some of the repairs may take place as issues are identified during testing and others will be conducted after testing and monitoring are complete.

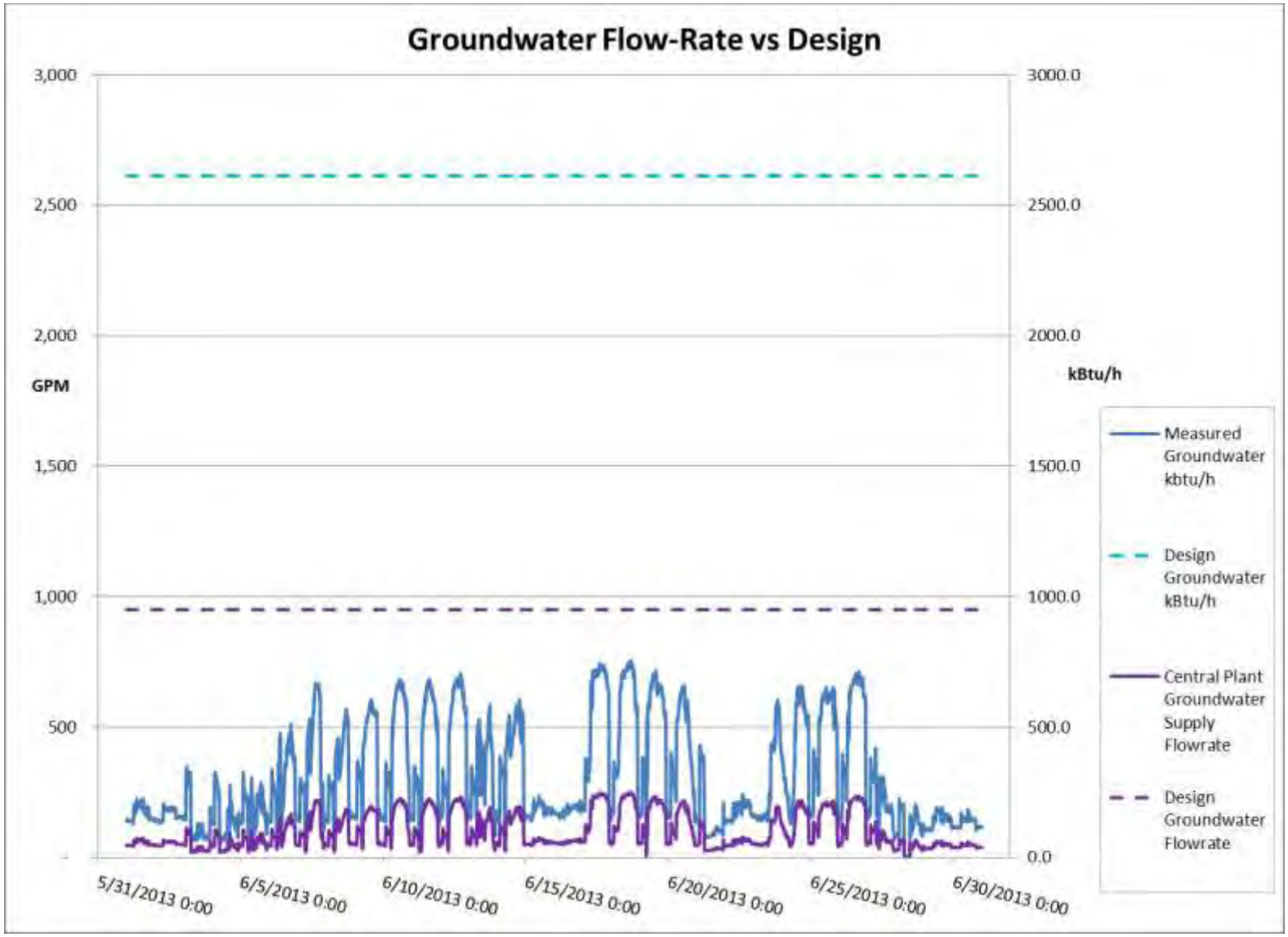
DDC sensors identified as outside of the acceptable tolerance range will be calibrated through offset adjustments on the control system. Calibration may be completed by the RCx team or a contractor at the time of testing or after testing has been completed. Where sensors cannot be calibrated through the use of offset adjustments, they may be recommended for replacement.

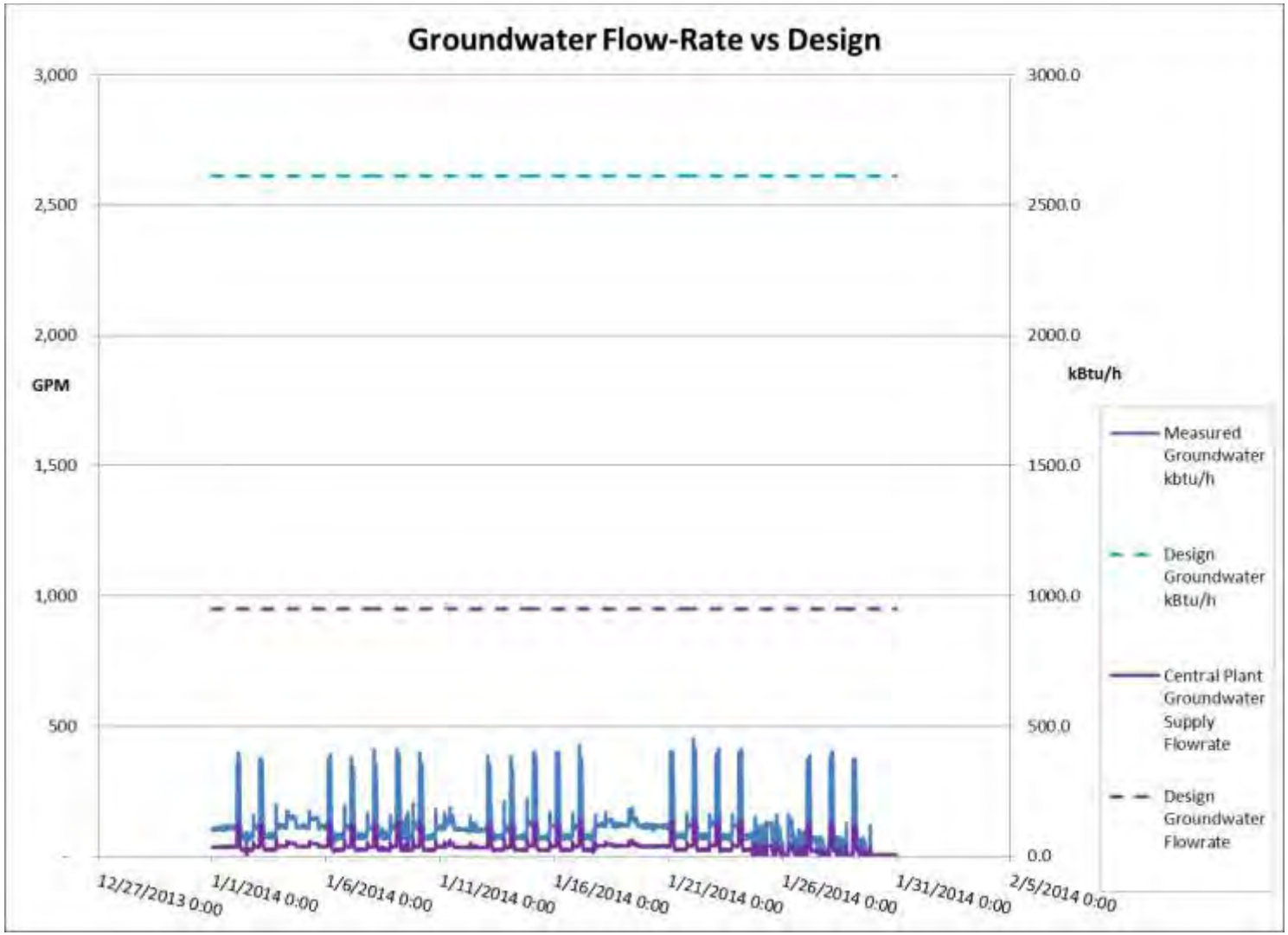
Please see the following pages for the Issues Log compiled for the Anchorage VA Medical Outpatient Clinic building.

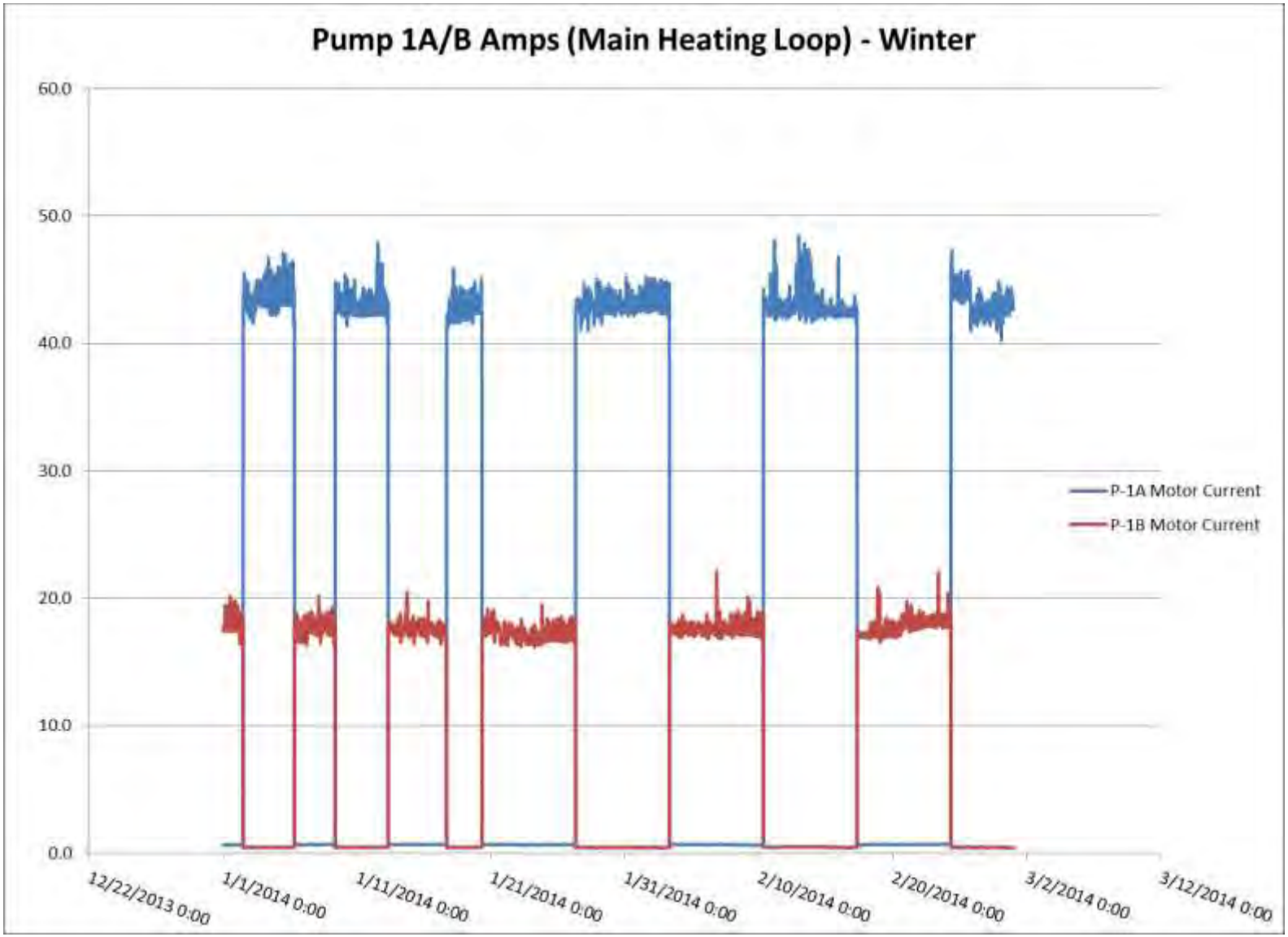
5.0 Appendix A: Diagnostic Monitoring Graphs

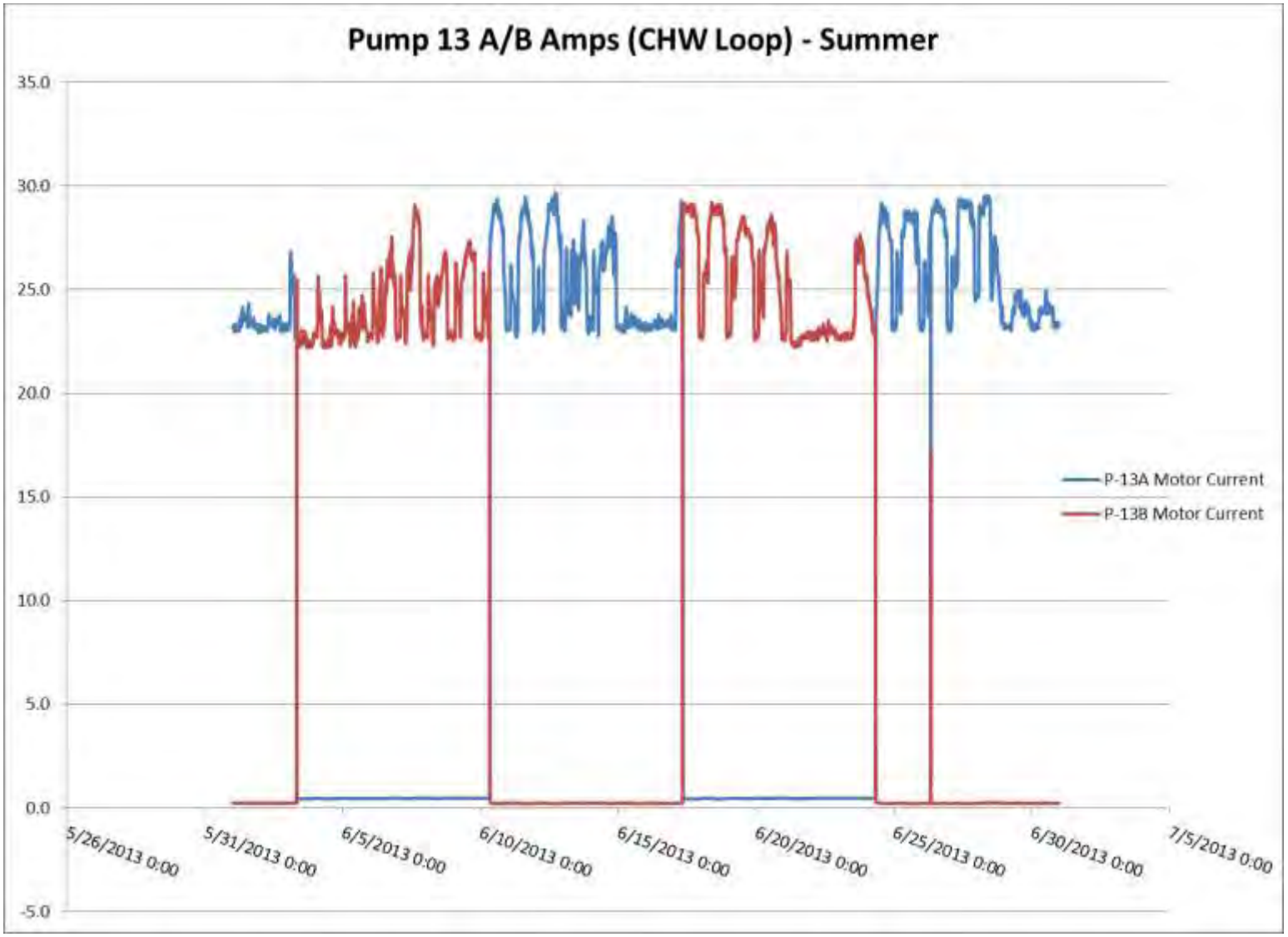


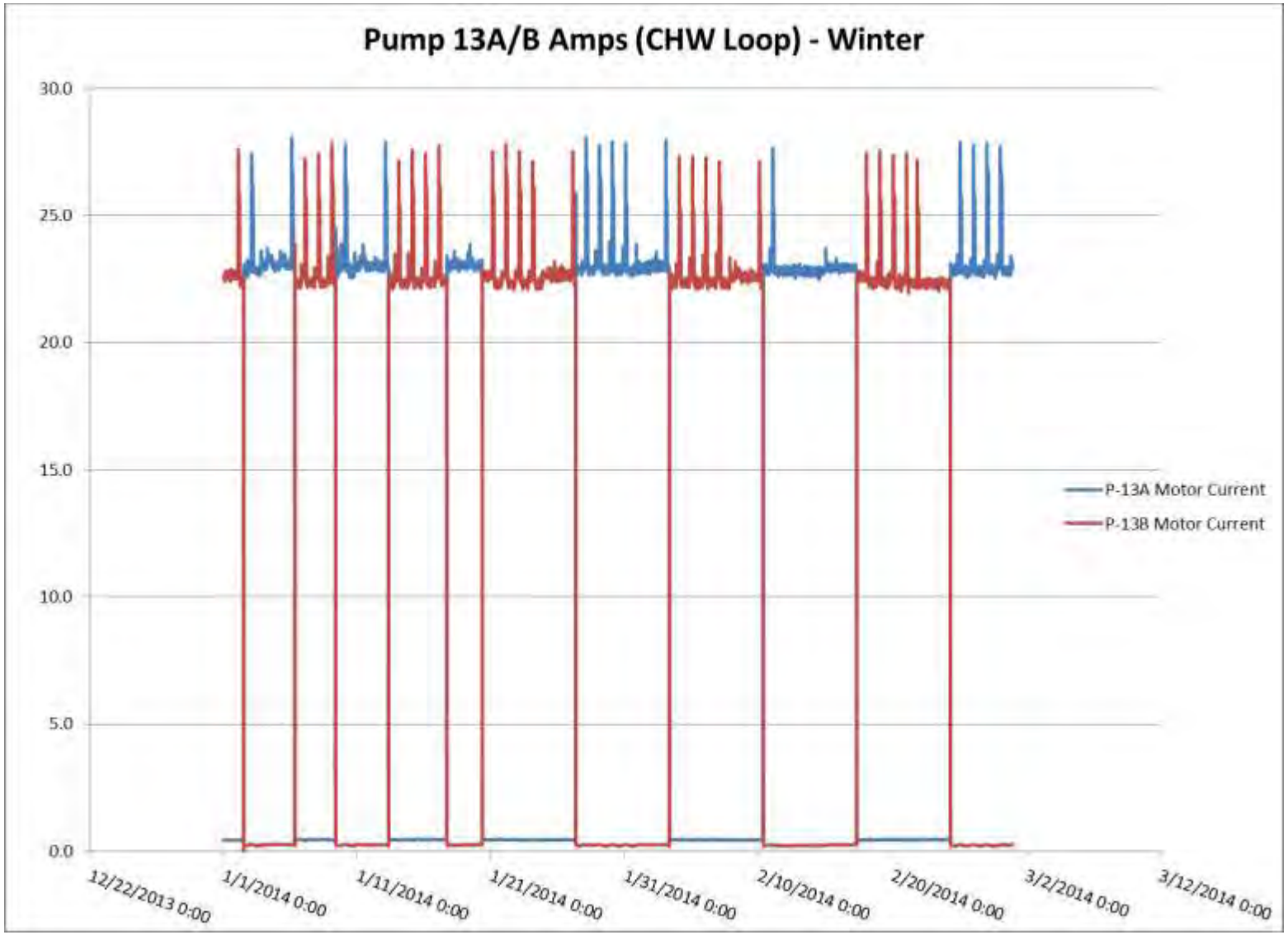

Groundwater Temperature and Flow
50.0
48.0
46.0
44.0
42.0
40.0
38.0
36.0
34.0
32.0
30.0
990.0
890.0
790.0
690.0
590.0
490.0
390.0
290.0
190.0
90.0
-10.0
12/27/2013 0:00
1/1/2014 0:00
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
Central Plant Groundwater Supply Temp
Design Groundwater Sup Temp
Central Plant Groundwater Supply Flowrate
Design Groundwater Flowrate

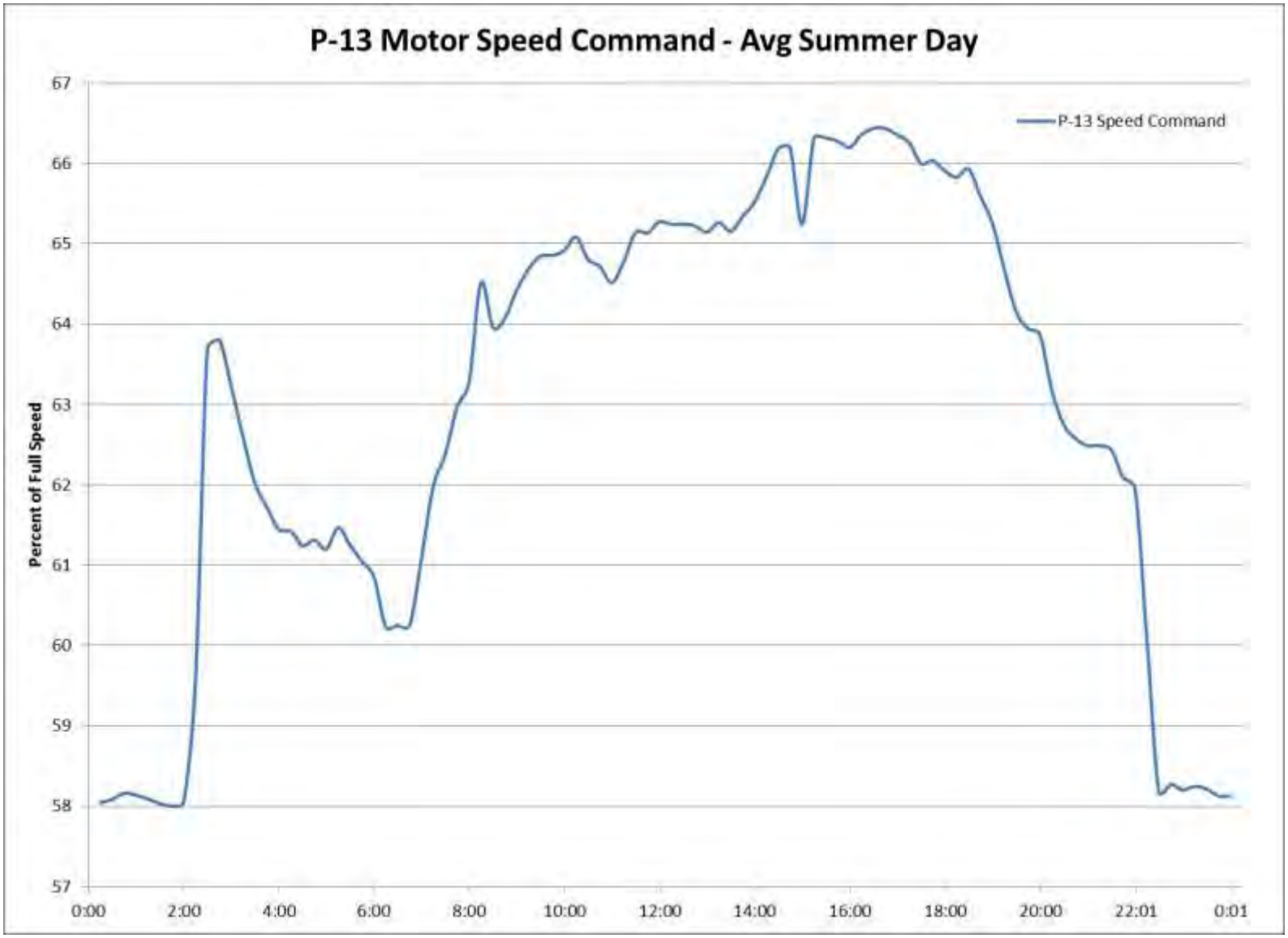

Groundwater Flow-Rate vs Design
3,000
2,500
2,000
1,500
1,000
500
-
GPM
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
kBtu/h
5/31/2013 0:00
6/5/2013 0:00
6/10/2013 0:00
6/15/2013 0:00
6/20/2013 0:00
6/25/2013 0:00
6/30/2013 0:00
Measured Groundwater kbtu/h
Design Groundwater kBtu/h
Central Plant Groundwater Supply Flowrate
Design Groundwater Flowrate

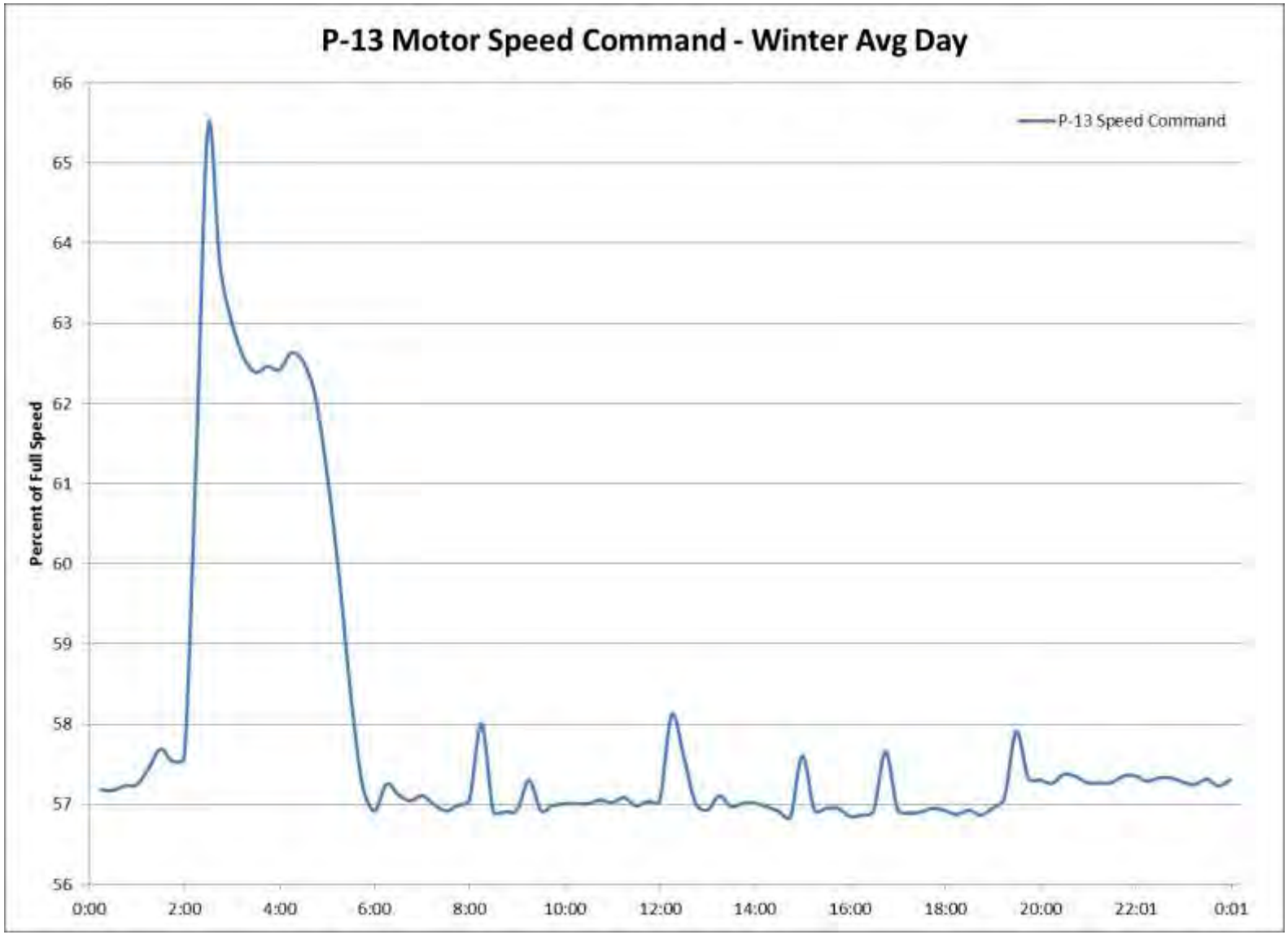

Groundwater Flow-Rate vs Design
3,000
2,500
2,000
1,500
1,000
500
-
GPM
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
kBtu/h
12/27/2013 0:00
1/1/2014 0:00
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
Measured Groundwater kbtu/h
Design Groundwater kBtu/h
Central Plant Groundwater Supply Flowrate
Design Groundwater Flowrate

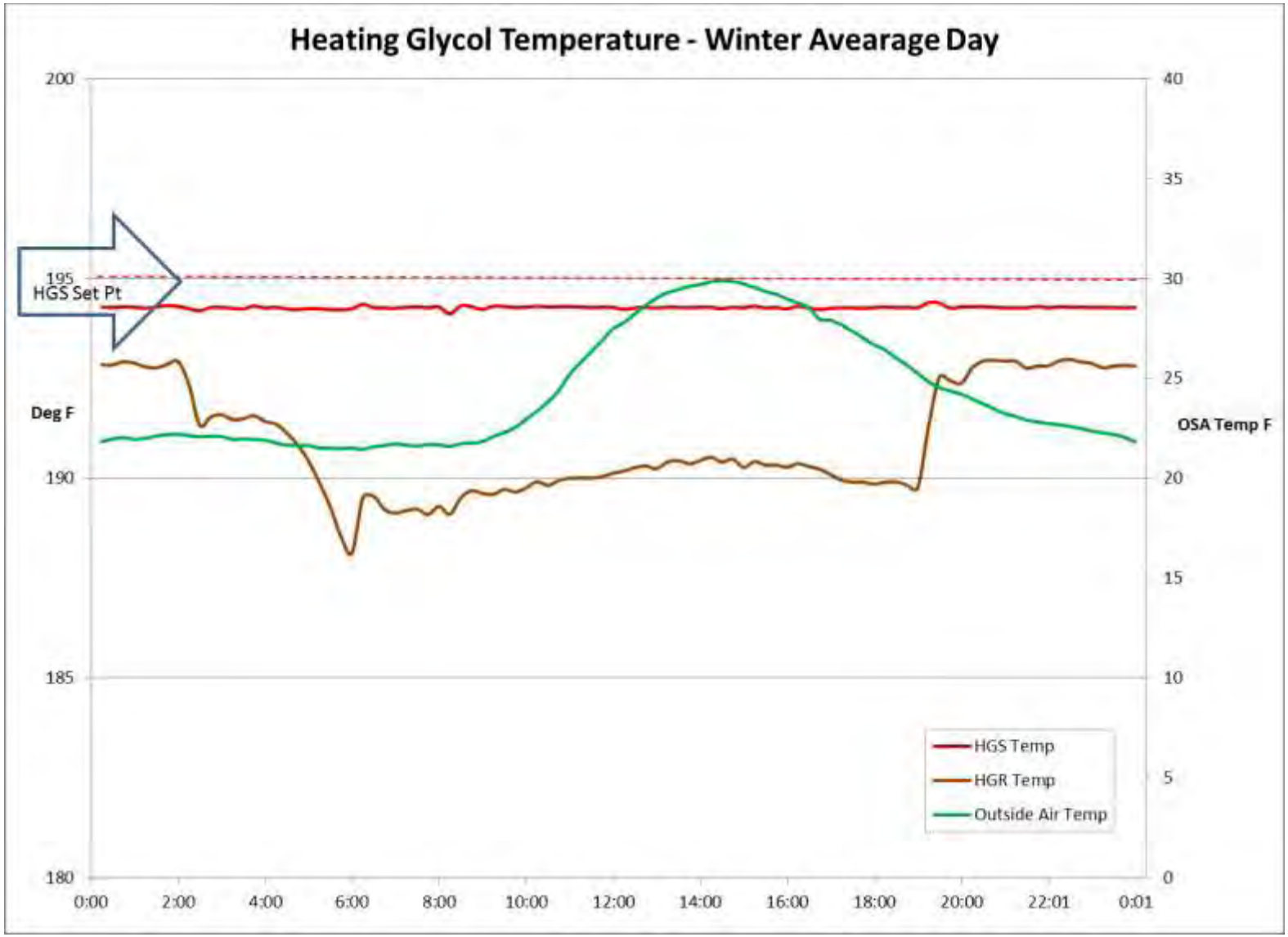

Pump 1A/B Amps (Main Heating Loop) - Winter
60.0
50.0
40.0
30.0
20.0
10.0
0.0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
P-1A Motor Current
P-1B Motor Current

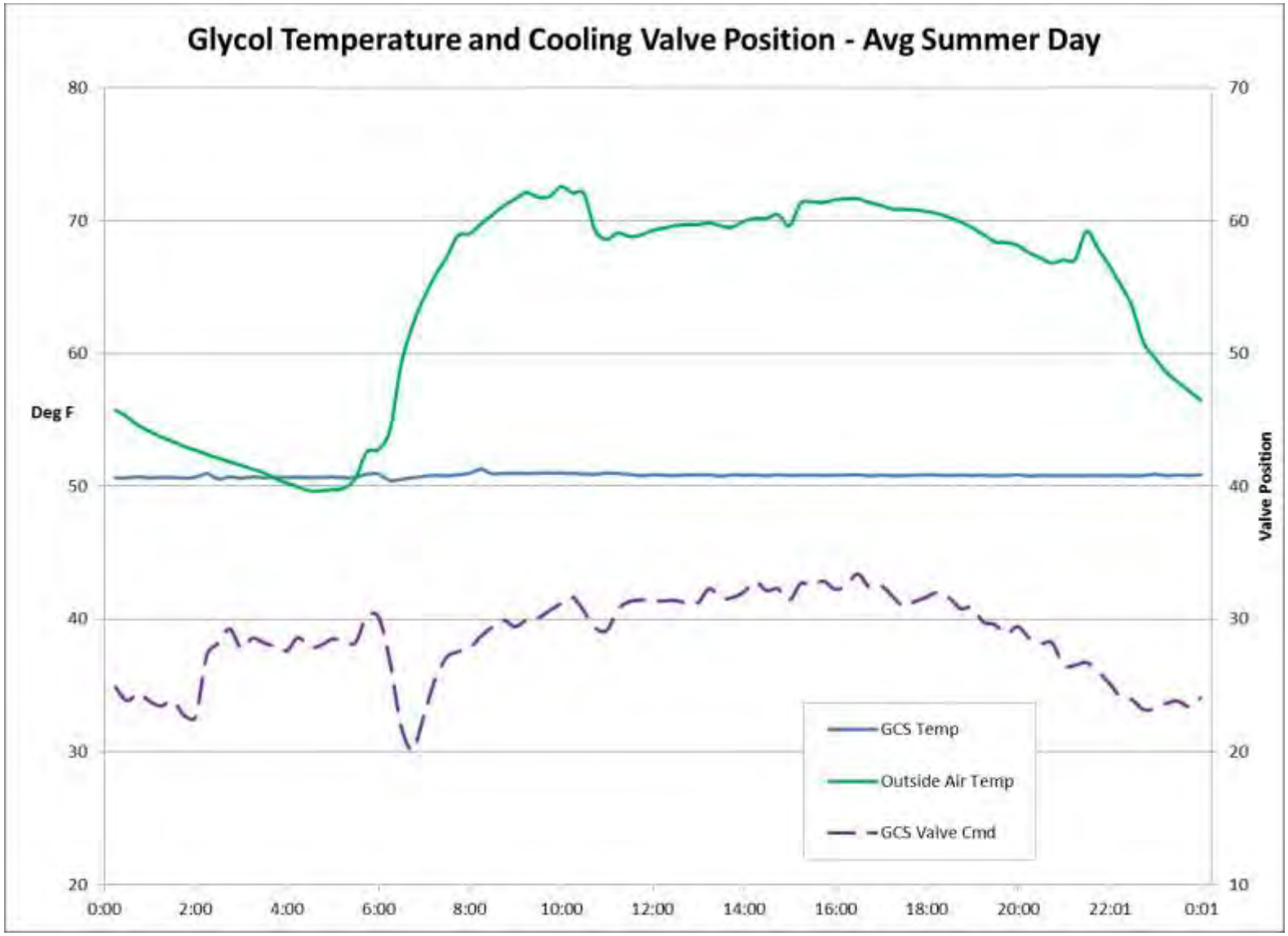

Pump 13 A/B Amps (CHW Loop) - Summer
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
5/26/2013 0:00
5/31/2013 0:00
6/5/2013 0:00
6/10/2013 0:00
6/15/2013 0:00
6/20/2013 0:00
6/25/2013 0:00
6/30/2013 0:00
7/5/2013 0:00
P-13A Motor Current
P-13B Motor Current

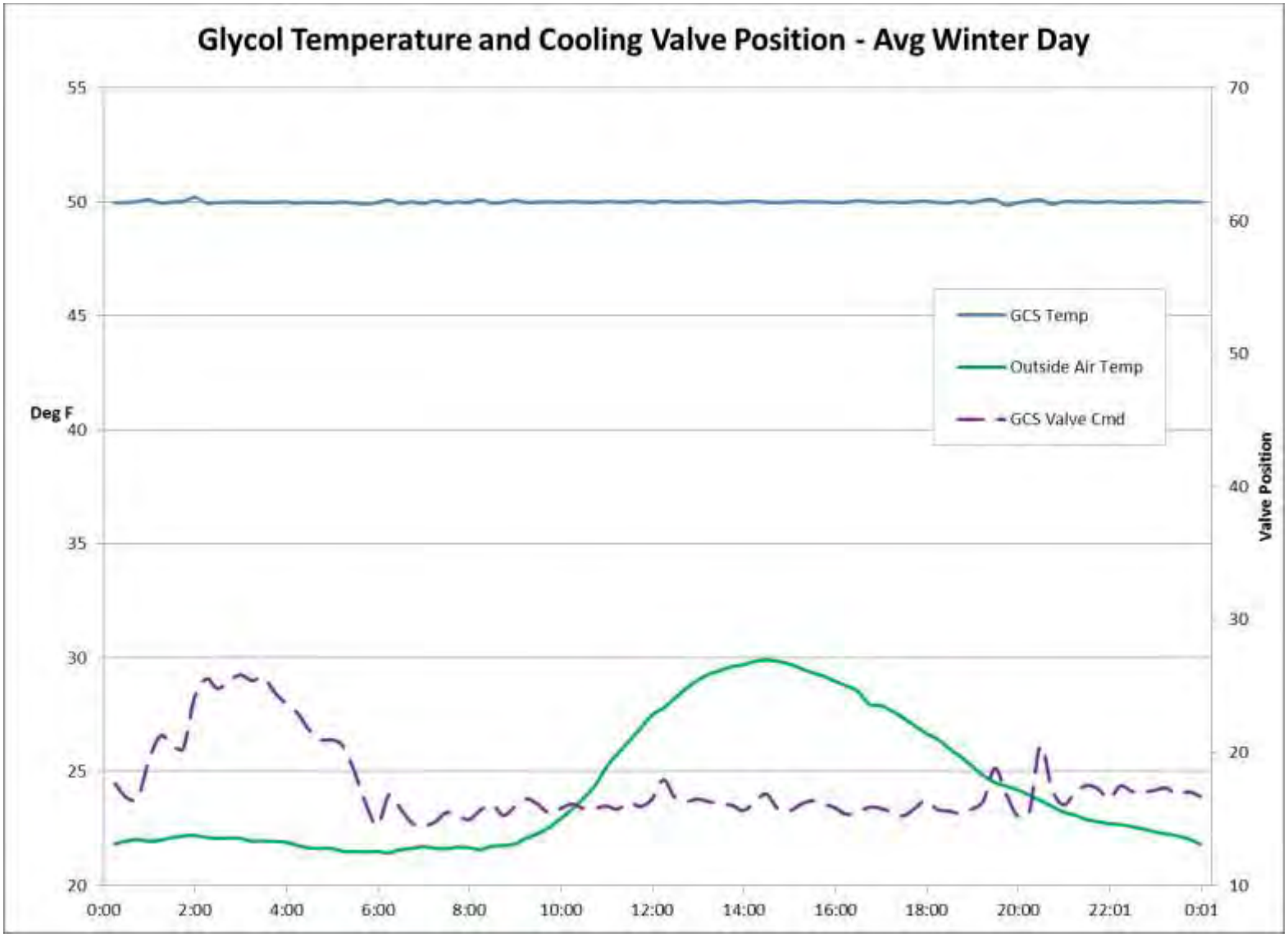

Pump 13A/B Amps (CHW Loop) - Winter
30.0
25.0
20.0
15.0
10.0
5.0
0.0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
P-13A Motor Current
P-13B Motor Current


P-13 Motor Speed Command - Avg Summer Day
P-13 Speed Command
Percent of Full Speed
67
66
65
64
63
62
61
60
59
58
57
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

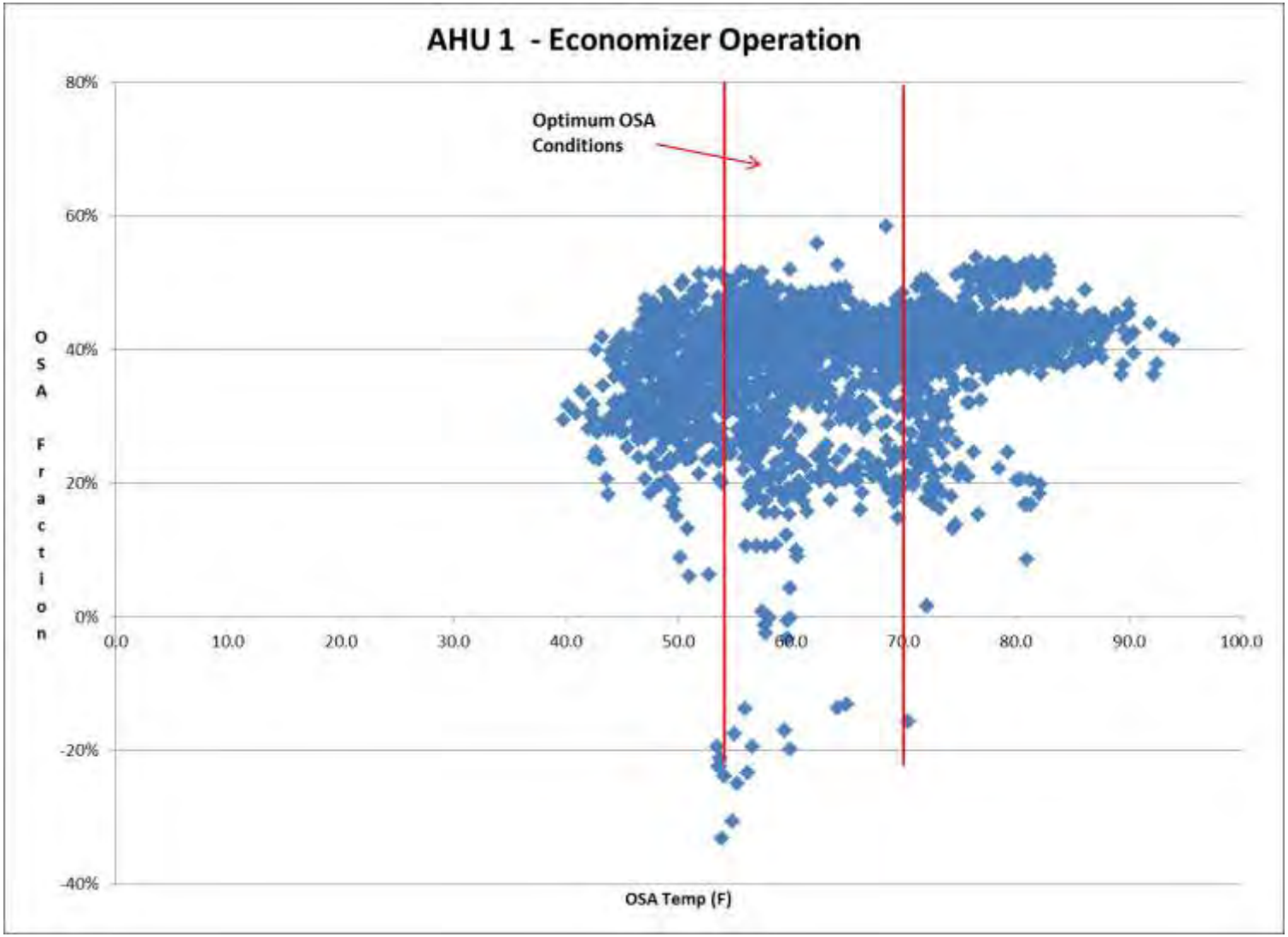

P-13 Motor Speed Command - Winter Avg Day
P-13 Speed Command
Percent of Full Speed
66
65
64
63
62
61
60
59
58
57
56
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

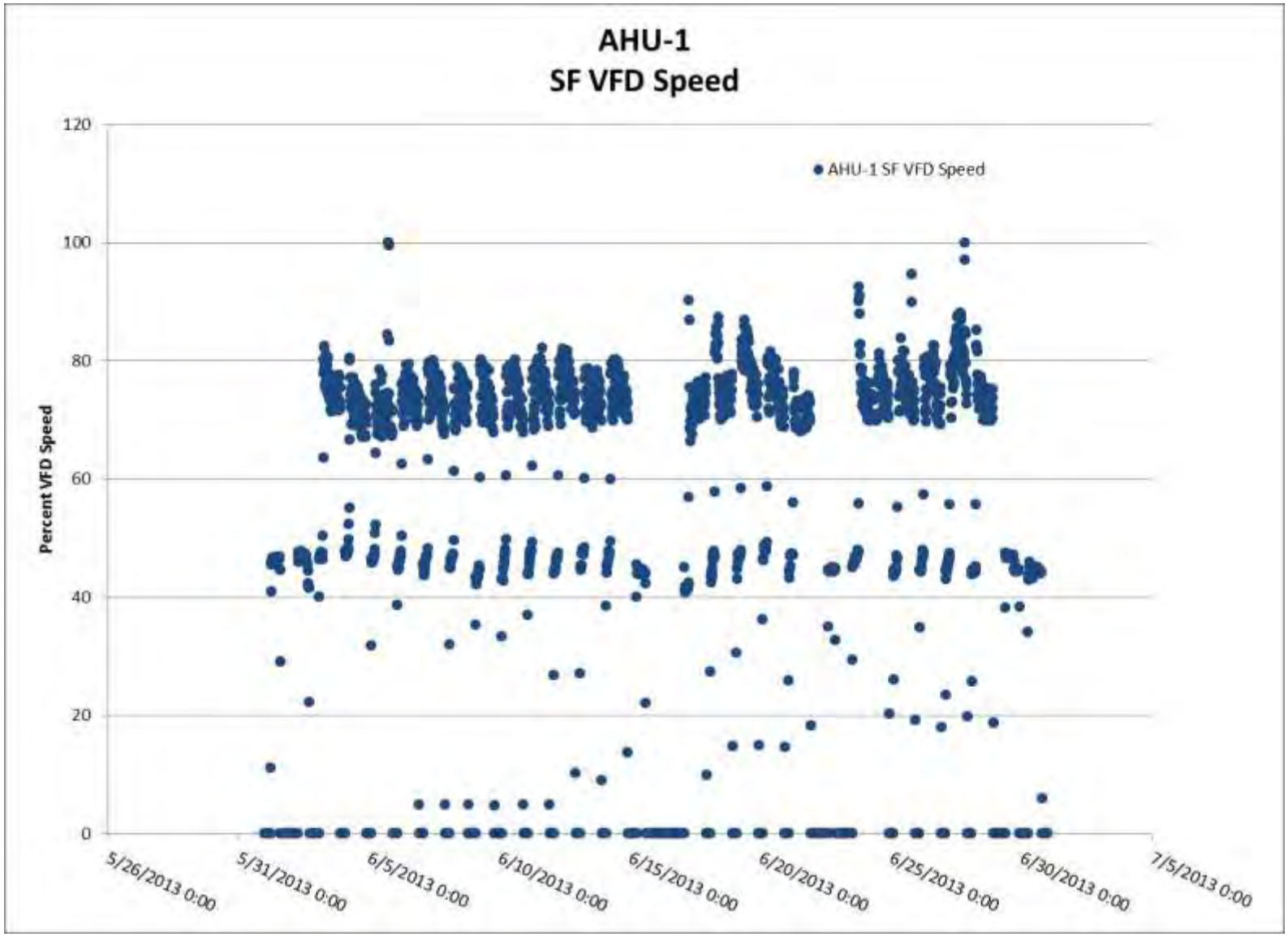

Heating Glycol Temperature - Winter Avearage Day
200
195
190
185
180
Deg F
40
35
30
25
20
15
10
5
0
OSA Temp F
HGS Set Pt
HGS Temp
HGR Temp
Outside Air Temp
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

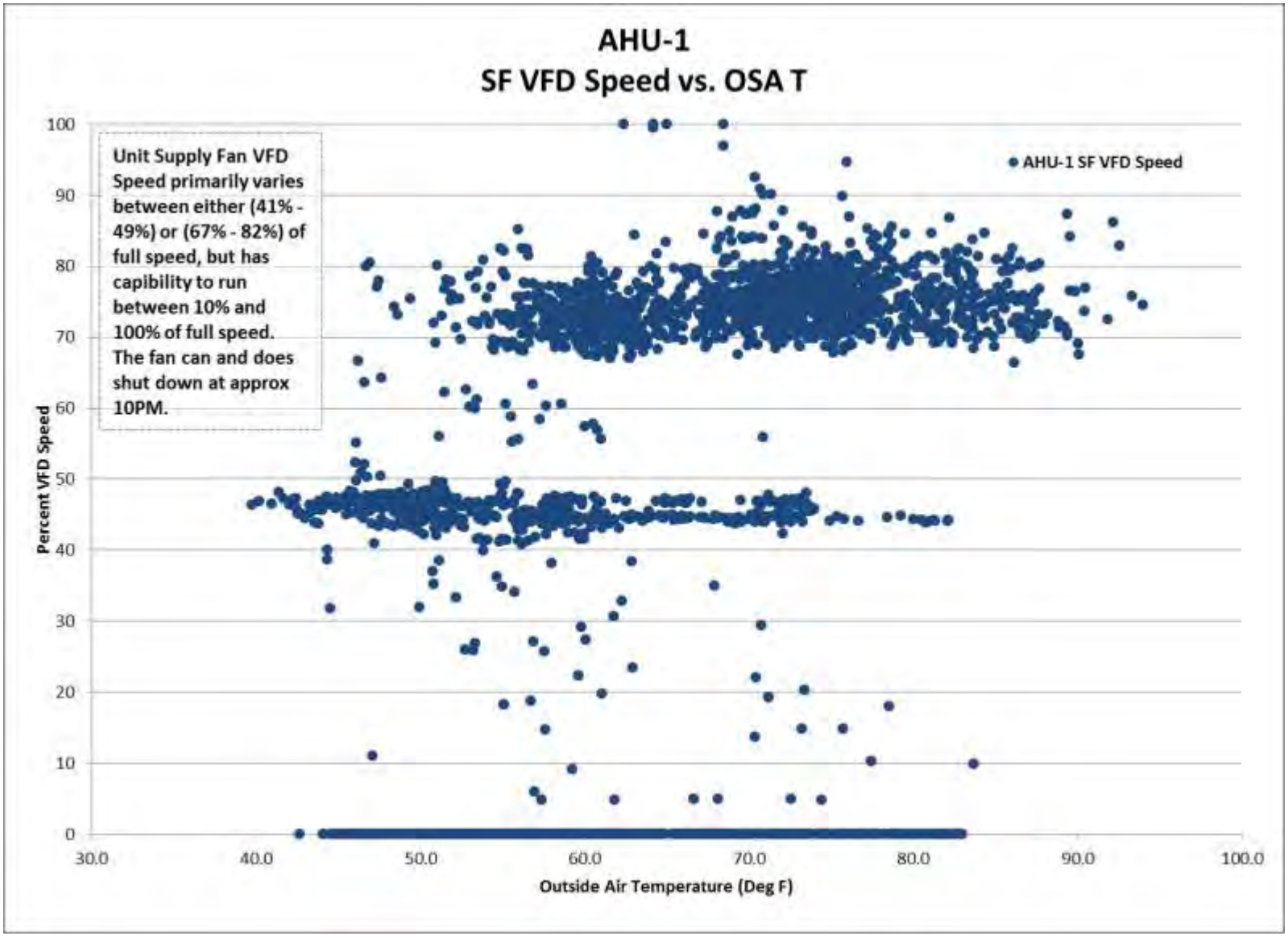

Glycol Temperature and Cooling Valve Position - Avg Summer Day
Deg F
Valve Position
80
70
60
50
40
30
20
70
60
50
40
30
20
10
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
GCS Temp
Outside Air Temp
GCS Valve Cmd

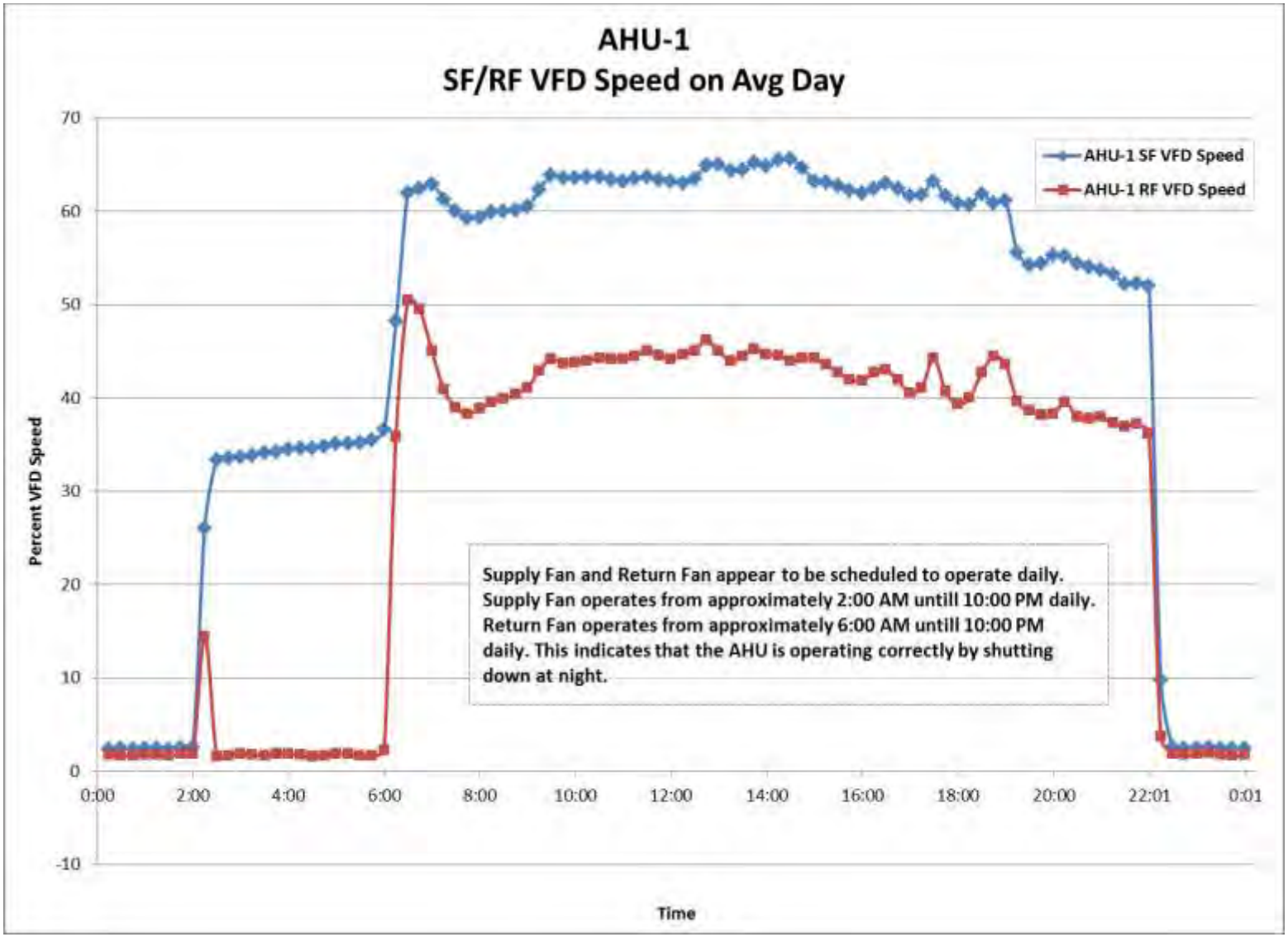

Glycol Temperature and Cooling Valve Position - Avg Winter Day
Deg F
Valve Position
55
50
45
40
35
30
25
20
70
60
50
40
30
20
10
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
GCS Temp
Outside Air Temp
GCS Valve Cmd

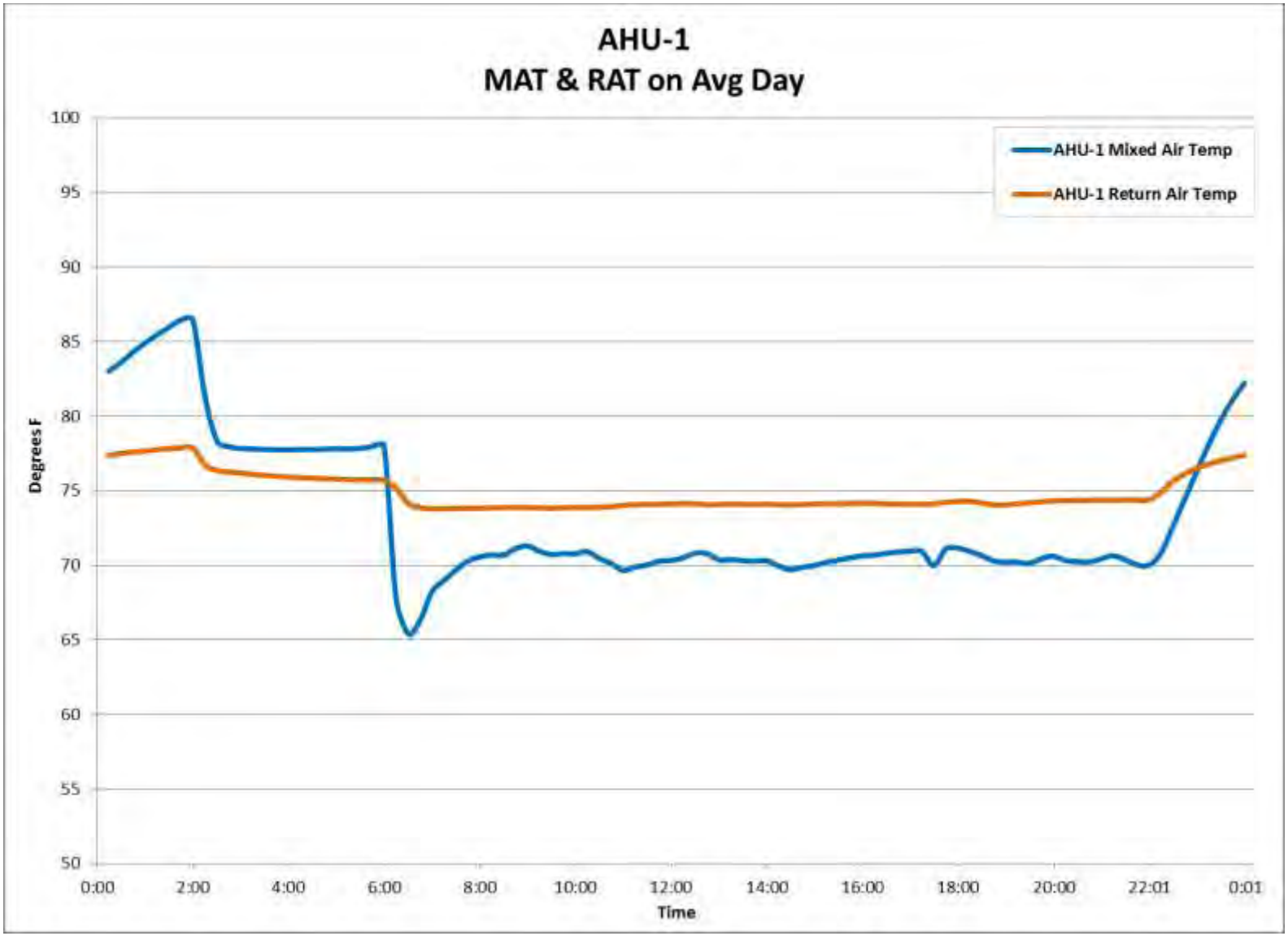
AHU 1 – SUMMER

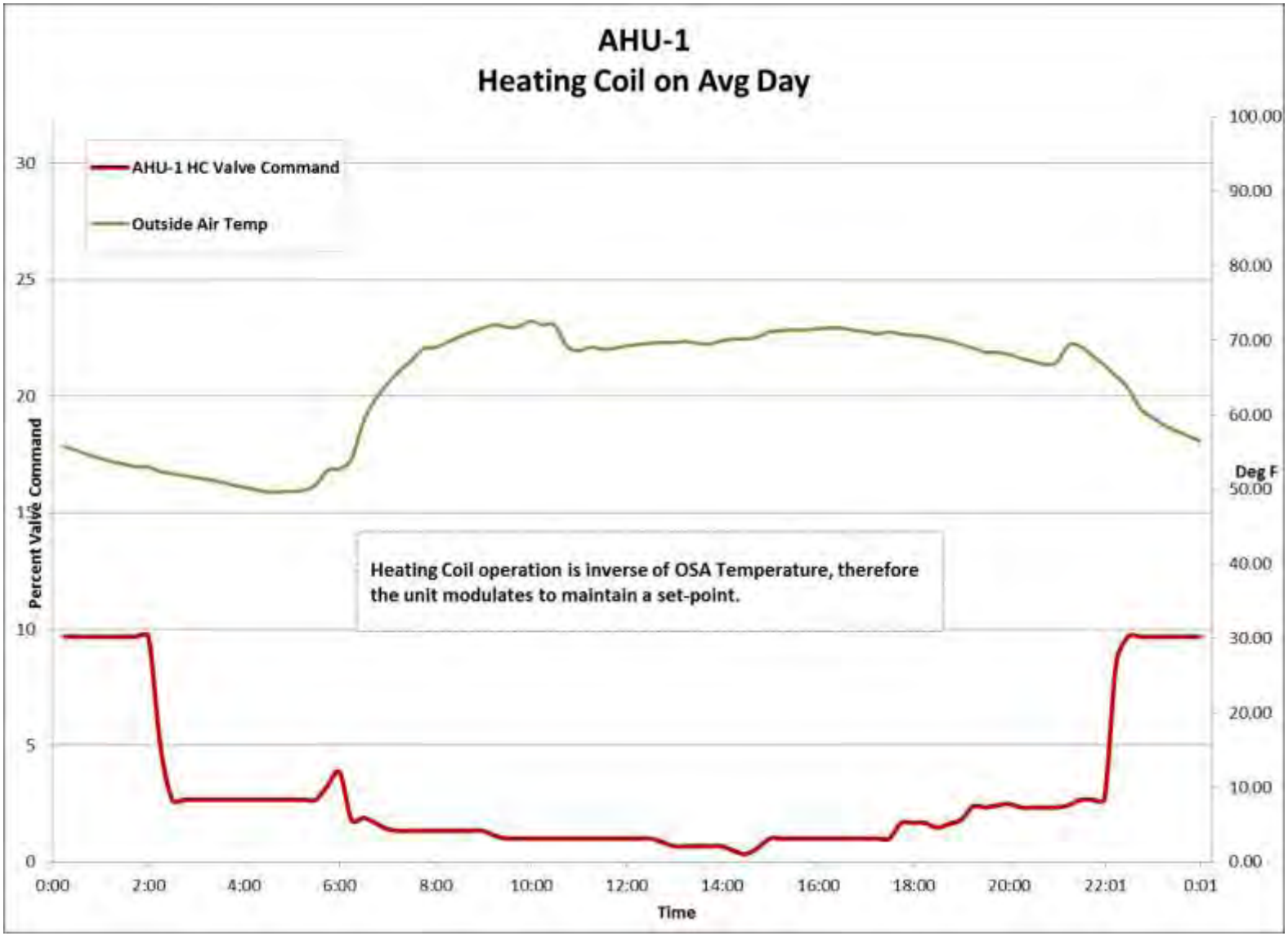

AHU 1 - Economizer Operation
Optimum OSA Conditions
OSA Fraction
80%
60%
40%
20%
0%
-20%
-40%
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
OSA Temp (F)

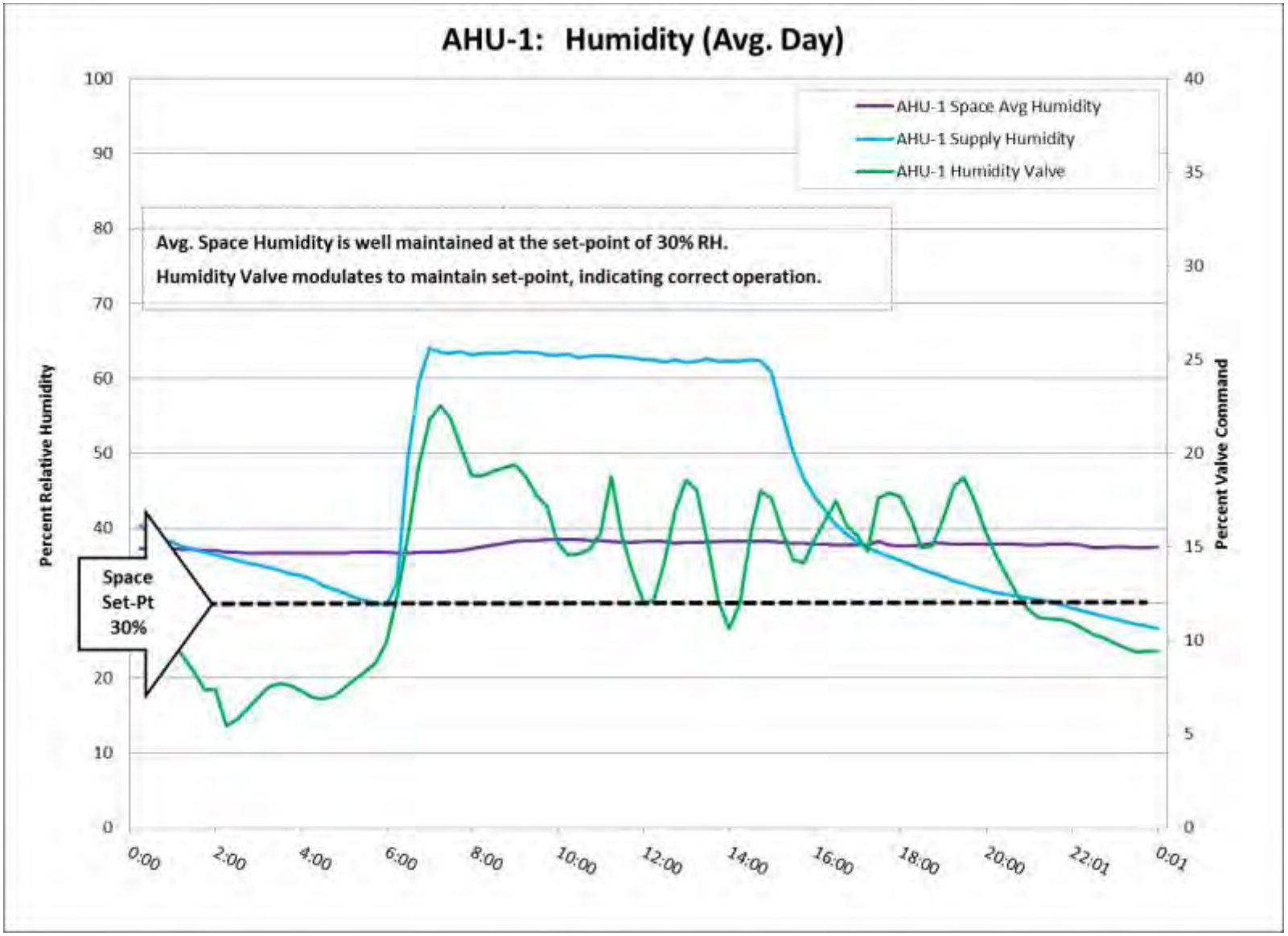

AHU-1
SF VFD Speed
AHU-1 SF VFD Speed
Percent VFD Speed
120
100
80
60
40
20
0
5/26/2013 0:00
5/31/2013 0:00
6/5/2013 0:00
6/10/2013 0:00
6/15/2013 0:00
6/20/2013 0:00
6/25/2013 0:00
6/30/2013 0:00
7/5/2013 0:00

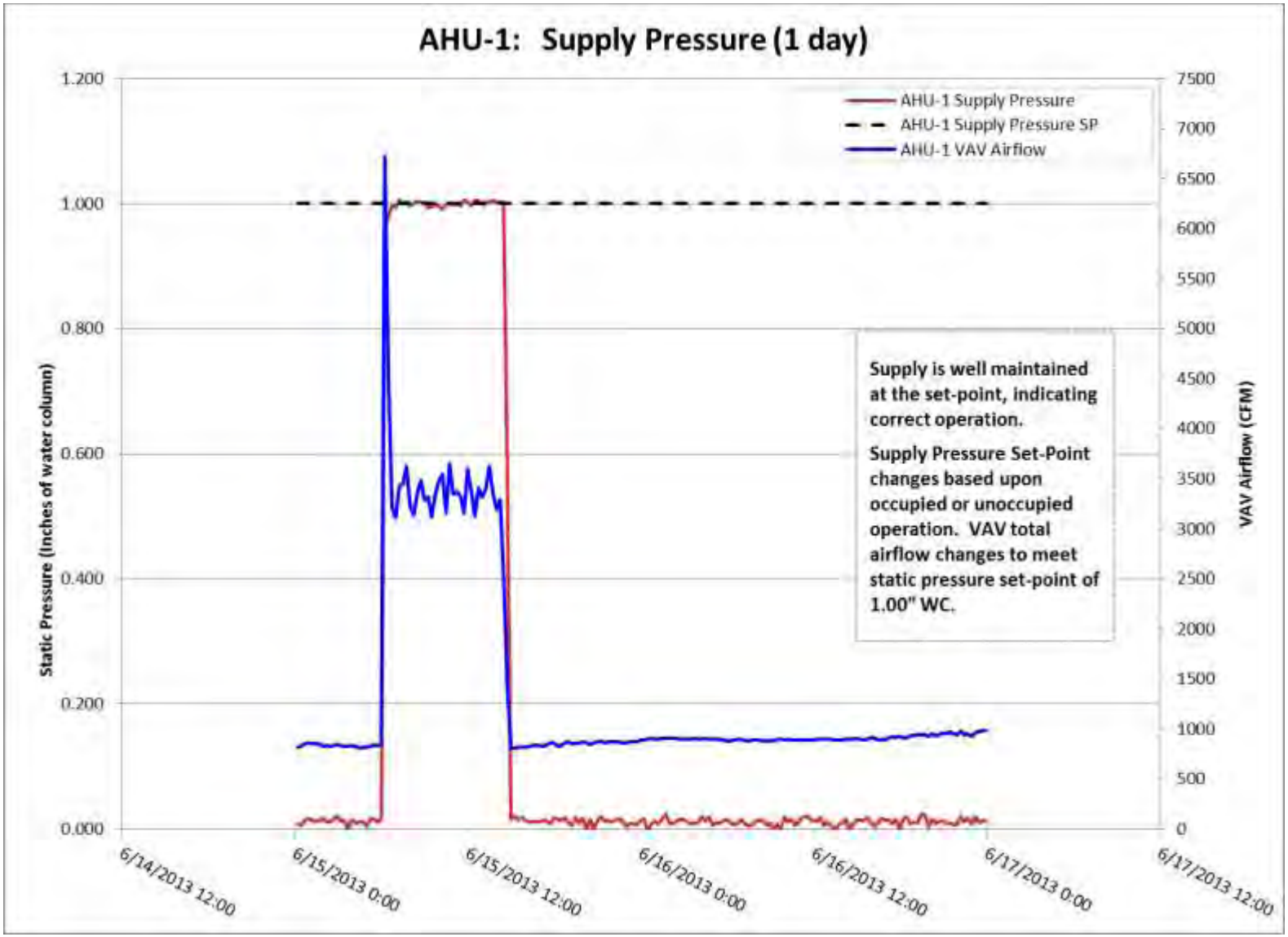

AHU-1
SF VFD Speed vs. OSA T
Unit Supply Fan VFD Speed primarily varies between either (41% - 49%) or (67% - 82%) of full speed, but has capibility to run between 10% and 100% of full speed. The fan can and does shut down at approx 10PM.
AHU-1 SF VFD Speed
Percent VFD Speed
Outside Air Temperature (Deg F)
100
90
80
70
60
50
40
30
20
10
0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0


AHU-1
SF/RF VFD Speed on Avg Day
AHU-1 SF VFD Speed
AHU-1 RF VFD Speed
Percent VFD Speed
70
60
50
40
30
20
10
0
-10
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 10:00 PM daily. Return Fan operates from approximately 6:00 AM untill 10:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

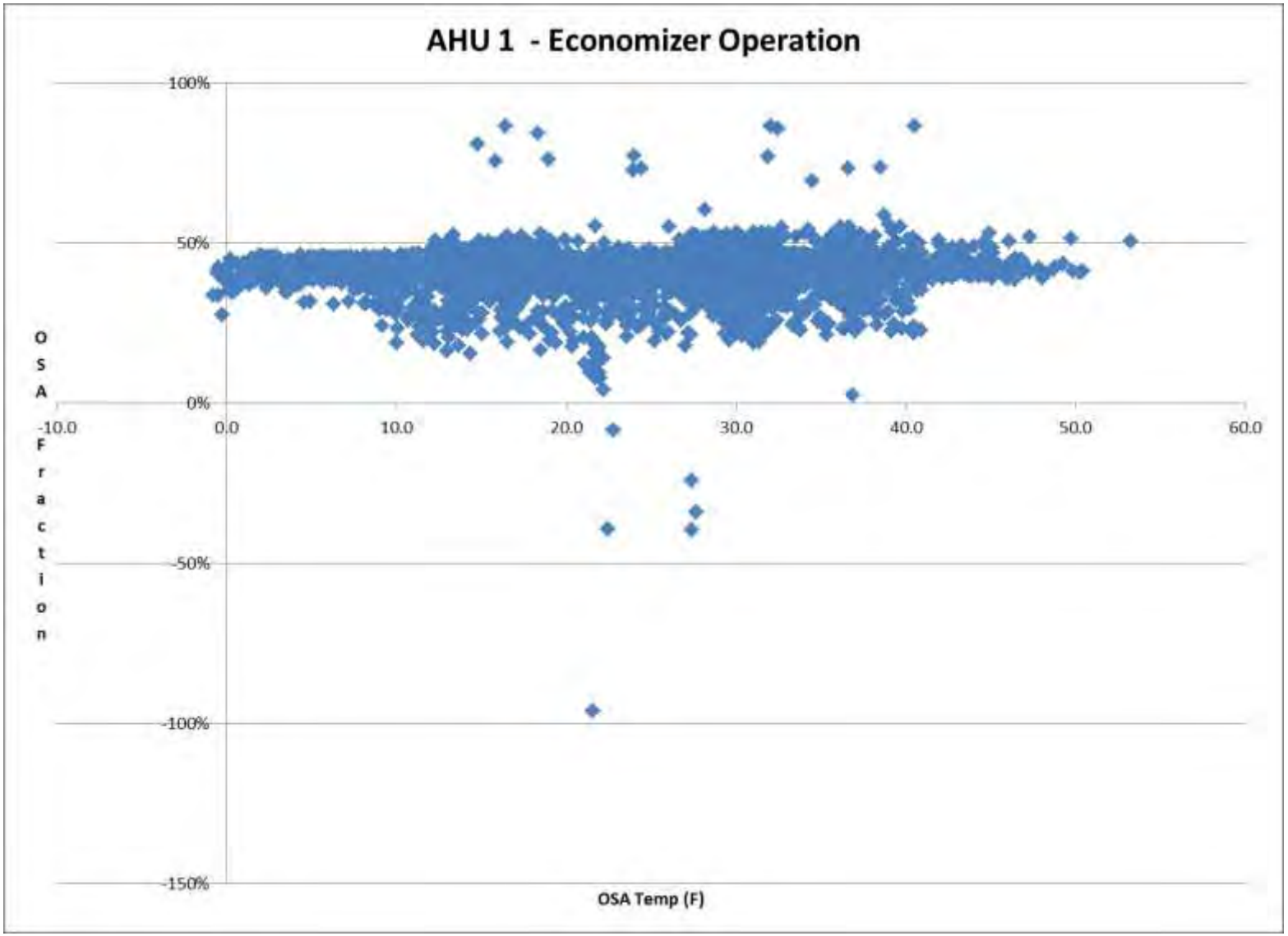

AHU-1
MAT & RAT on Avg Day
AHU-1 Mixed Air Temp
AHU-1 Return Air Temp
Degrees F
100
95
90
85
80
75
70
65
60
55
50
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time

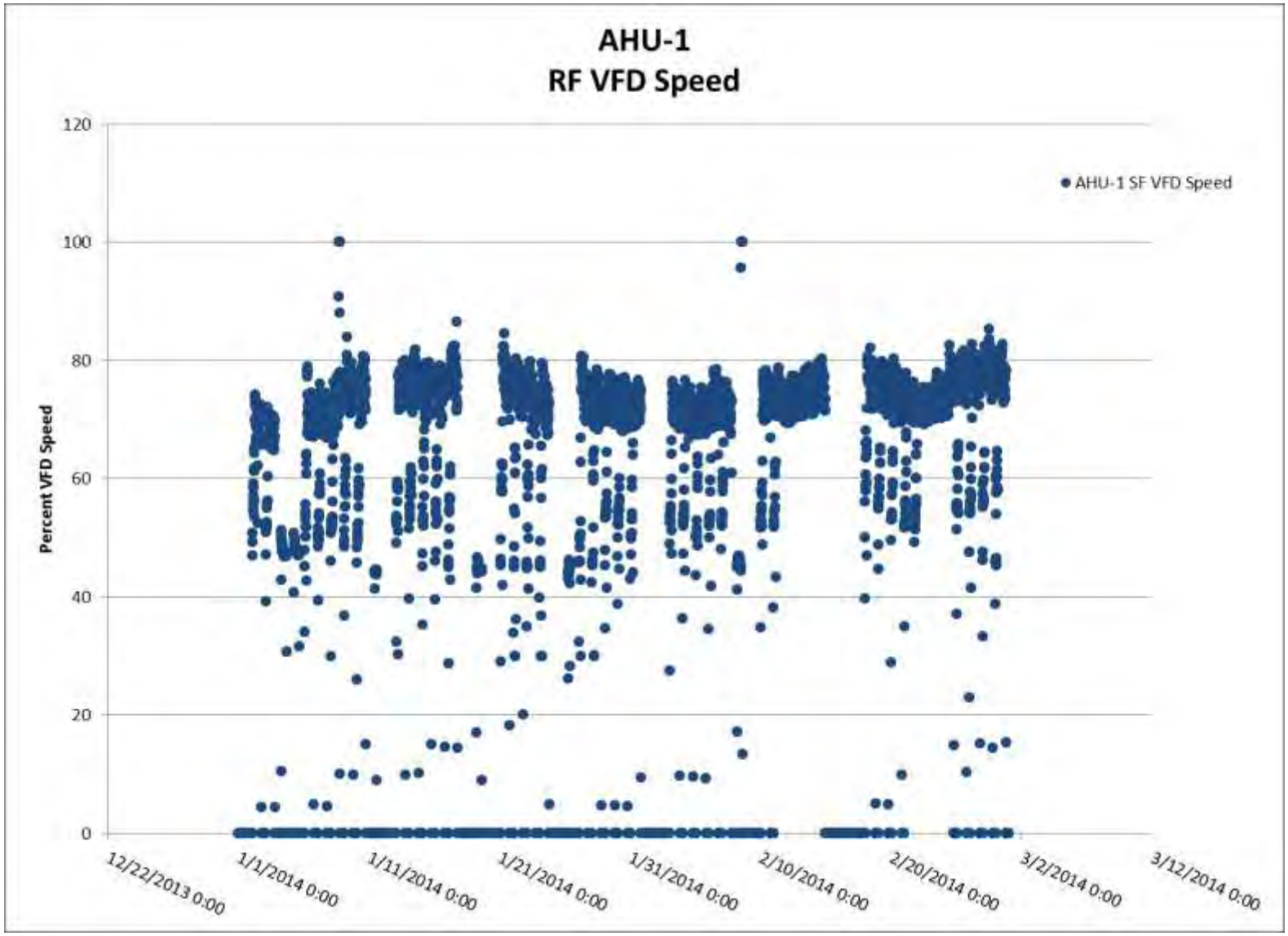

AHU-1
Heating Coil on Avg Day
AHU-1 HC Valve Command
Outside Air Temp
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Percent Valve Command
Deg F
Time
30
25
20
15
10
5
0
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

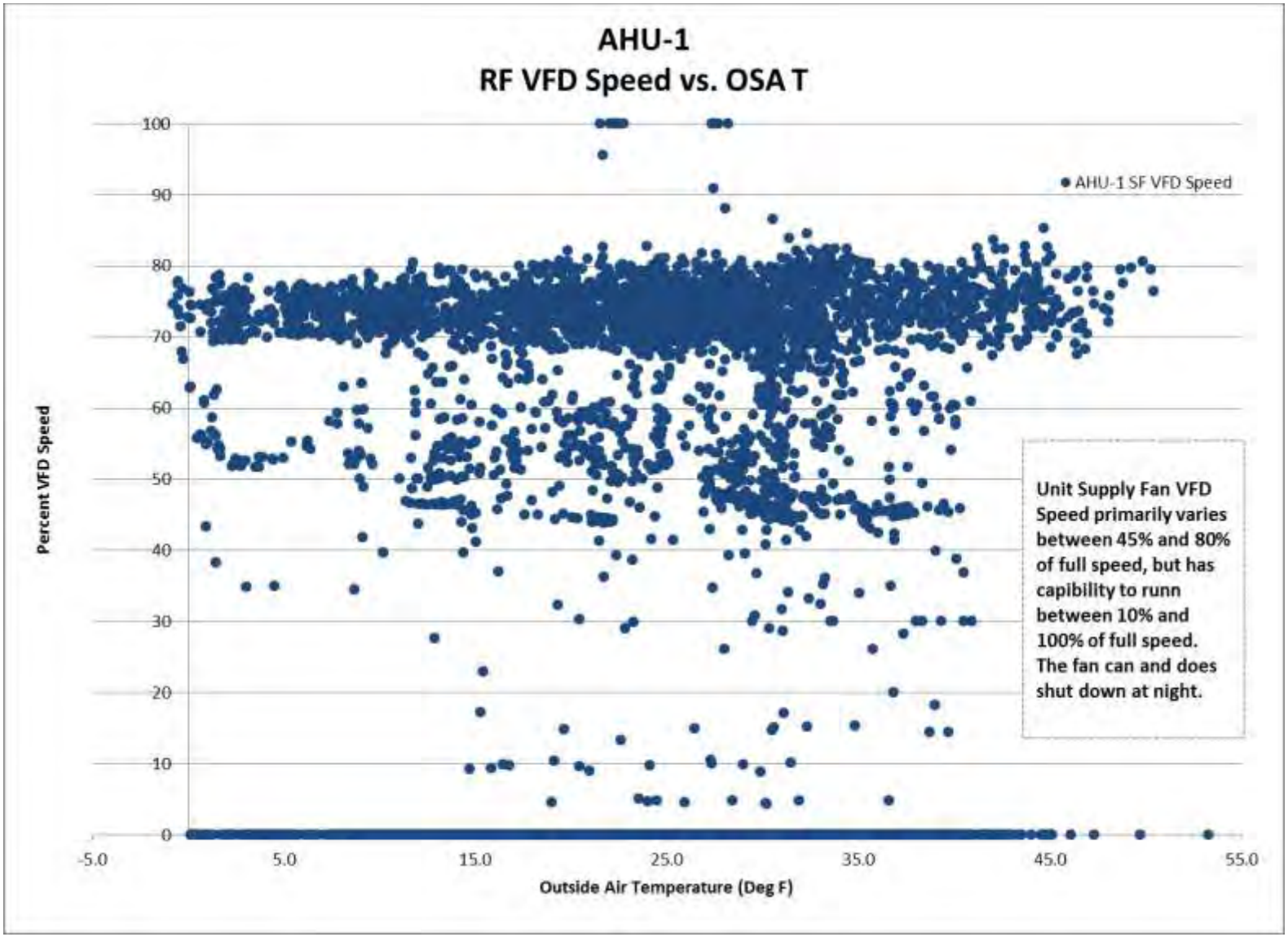

AHU-1: Humidity (Avg. Day)
AHU-1 Space Avg Humidity
AHU-1 Supply Humidity
AHU-1 Humidity Valve
Avg. Space Humidity is well maintained at the set-point of 30% RH.
Humidity Valve modulates to maintain set-point, indicating correct operation.
Space Set-Pt 30%
Percent Relative Humidity
Percent Valve Command
100
90
80
70
60
50
40
20
10
0
40
35
30
25
20
15
10
5
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

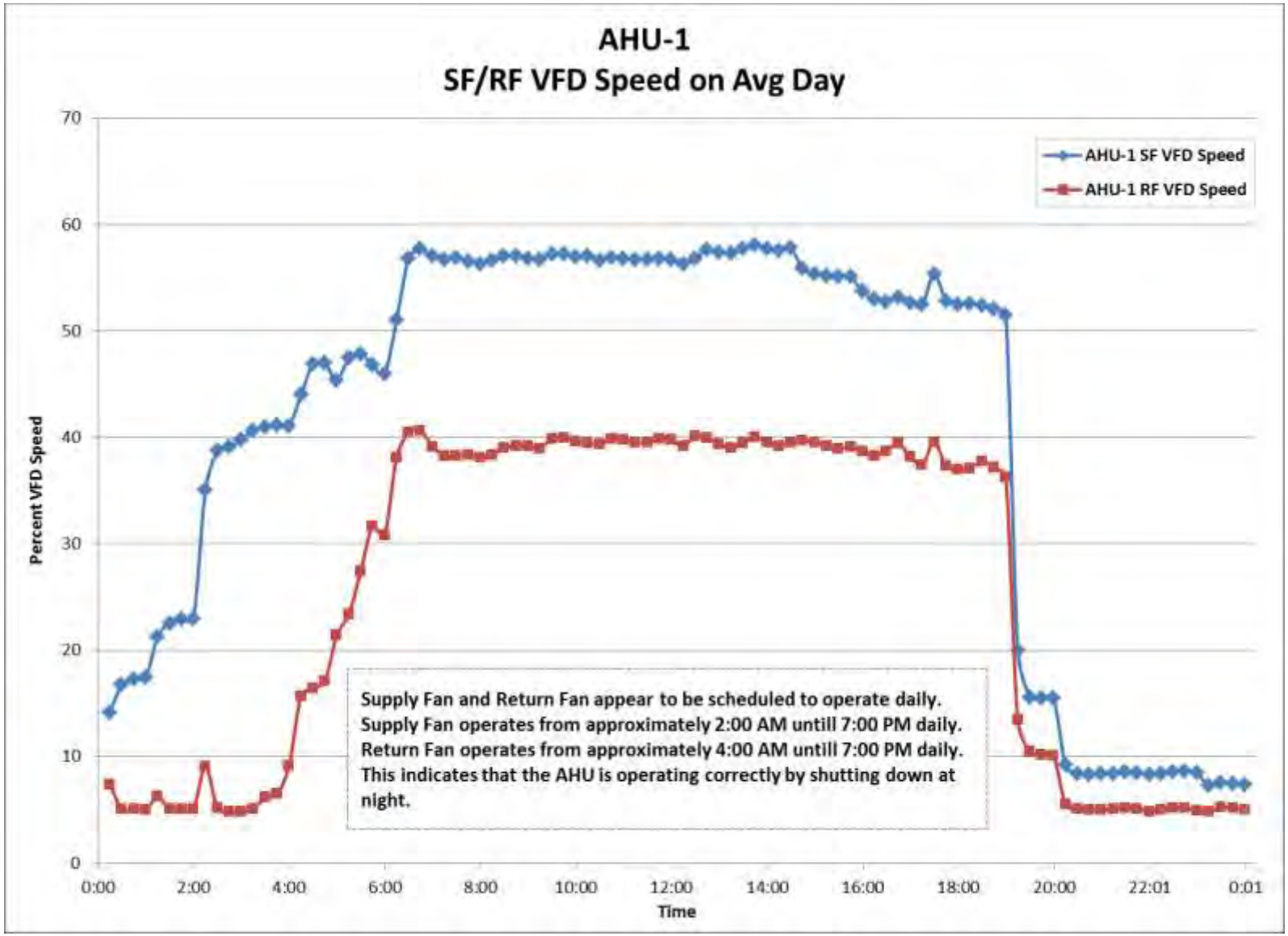

AHU-1: Supply Pressure (1 day)
AHU-1 Supply Pressure
AHU-1 Supply Pressure SP
AHU-1 VAV Airflow
Supply is well maintained at the set-point, indicating correct operation.
Supply Pressure Set-Point changes based upon occupied or unoccupied operation. VAV total airflow changes to meet static pressure set-point of 1.00" WC.
Static Pressure (Inches of water column)
VAV Airflow (CFM)
1.200
1.000
0.800
0.600
0.400
0.200
0.000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
6/14/2013 12:00
6/15/2013 0:00
6/15/2013 12:00
6/16/2013 0:00
6/16/2013 12:00
6/17/2013 0:00
6/17/2013 12:00

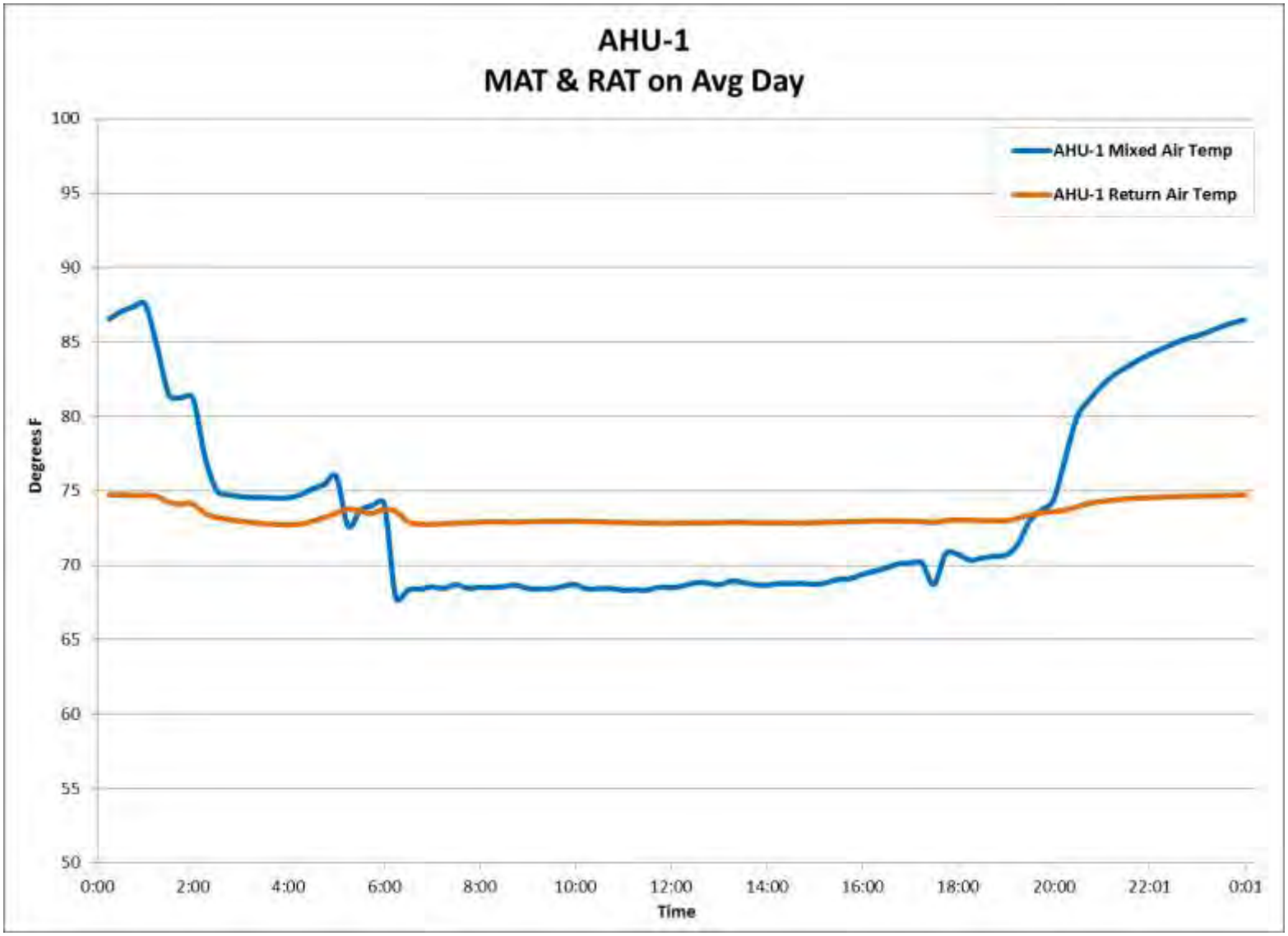
AHU 1 – WINTER

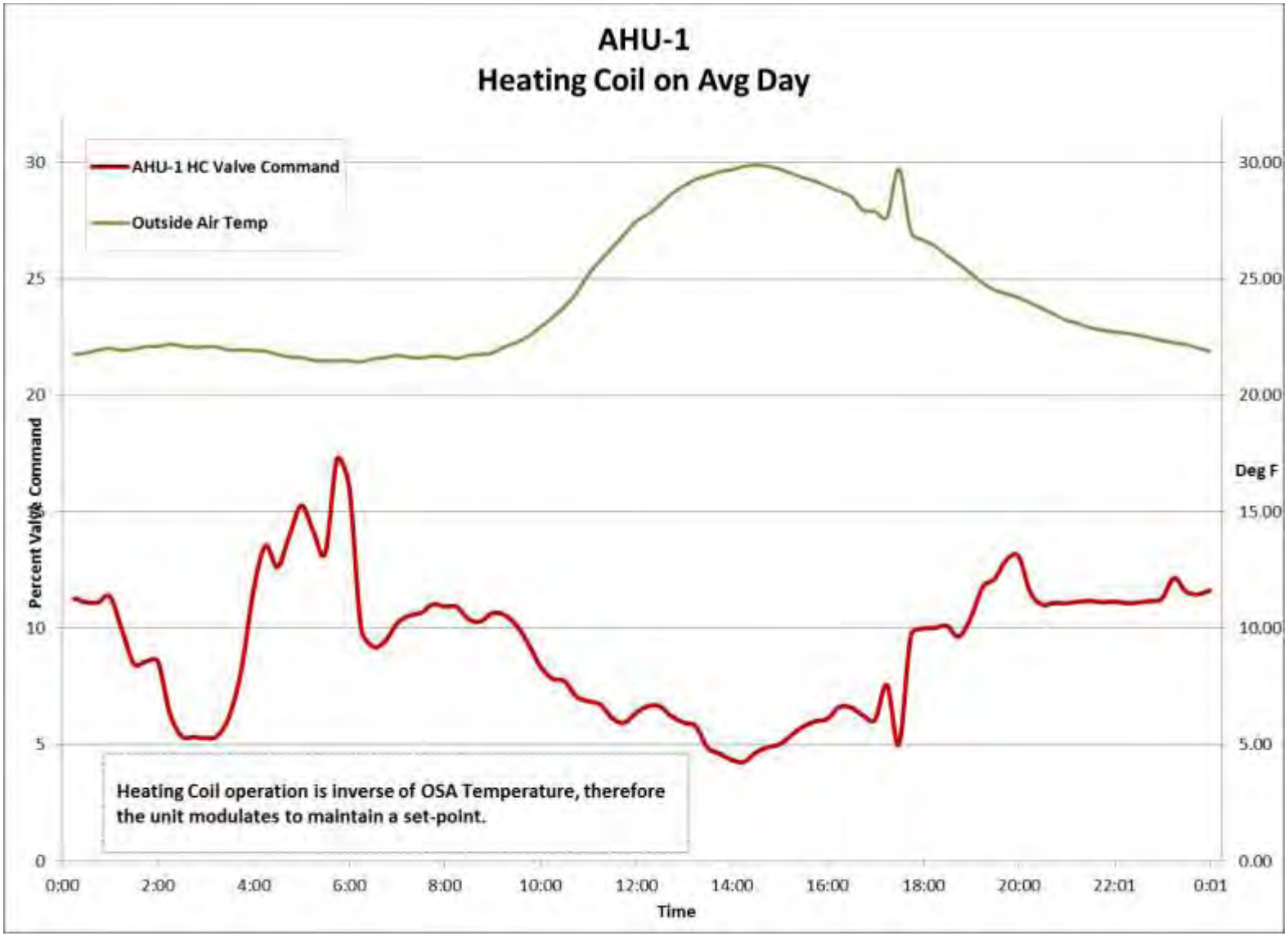

AHU 1 - Economizer Operation
100%
50%
0%
-50%
-100%
-150%
OSA Fraction
-10.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
OSA Temp (F)

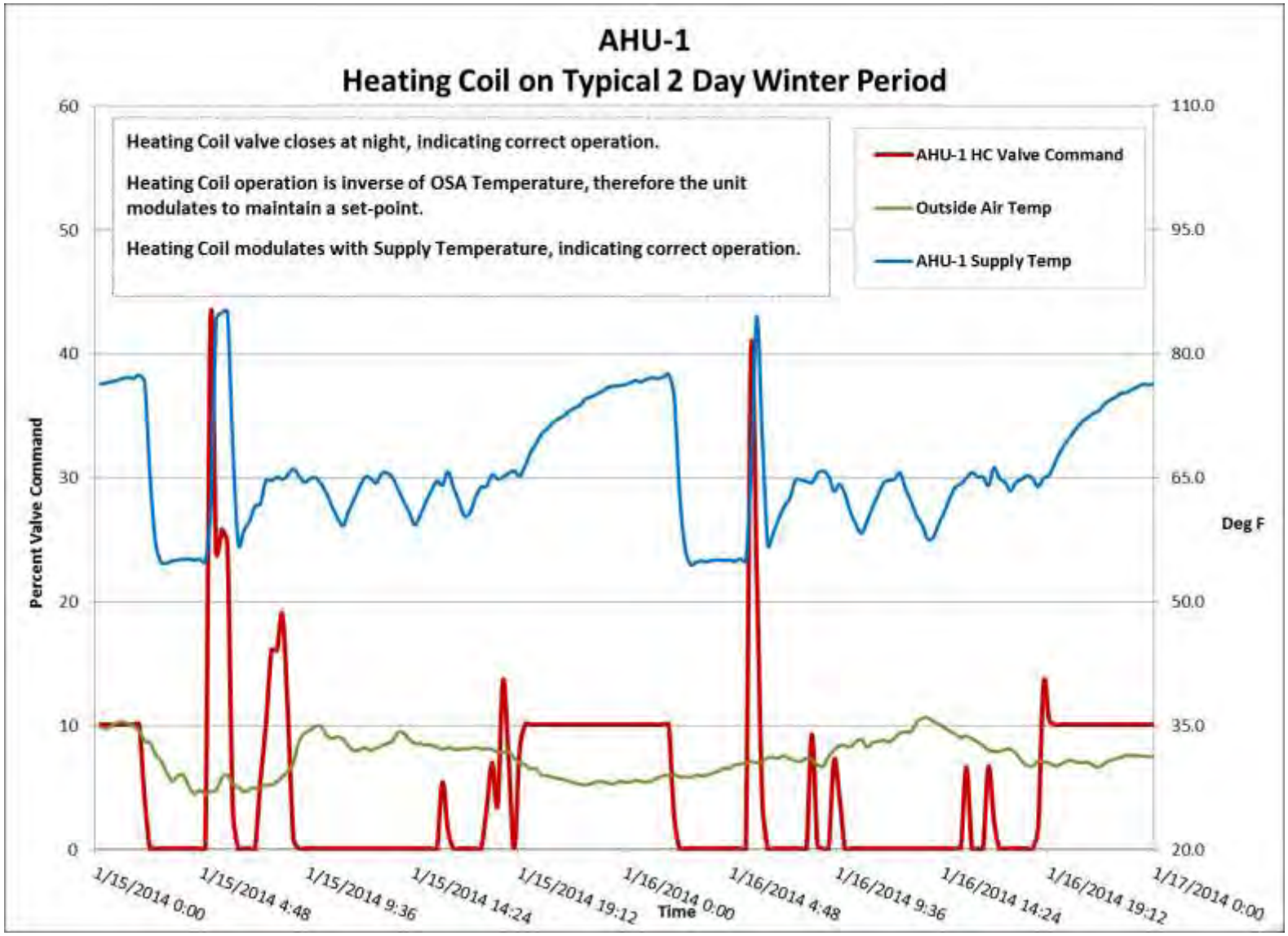

AHU-1
RF VFD Speed
AHU-1 SF VFD Speed
Percent VFD Speed
120
100
80
60
40
20
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00

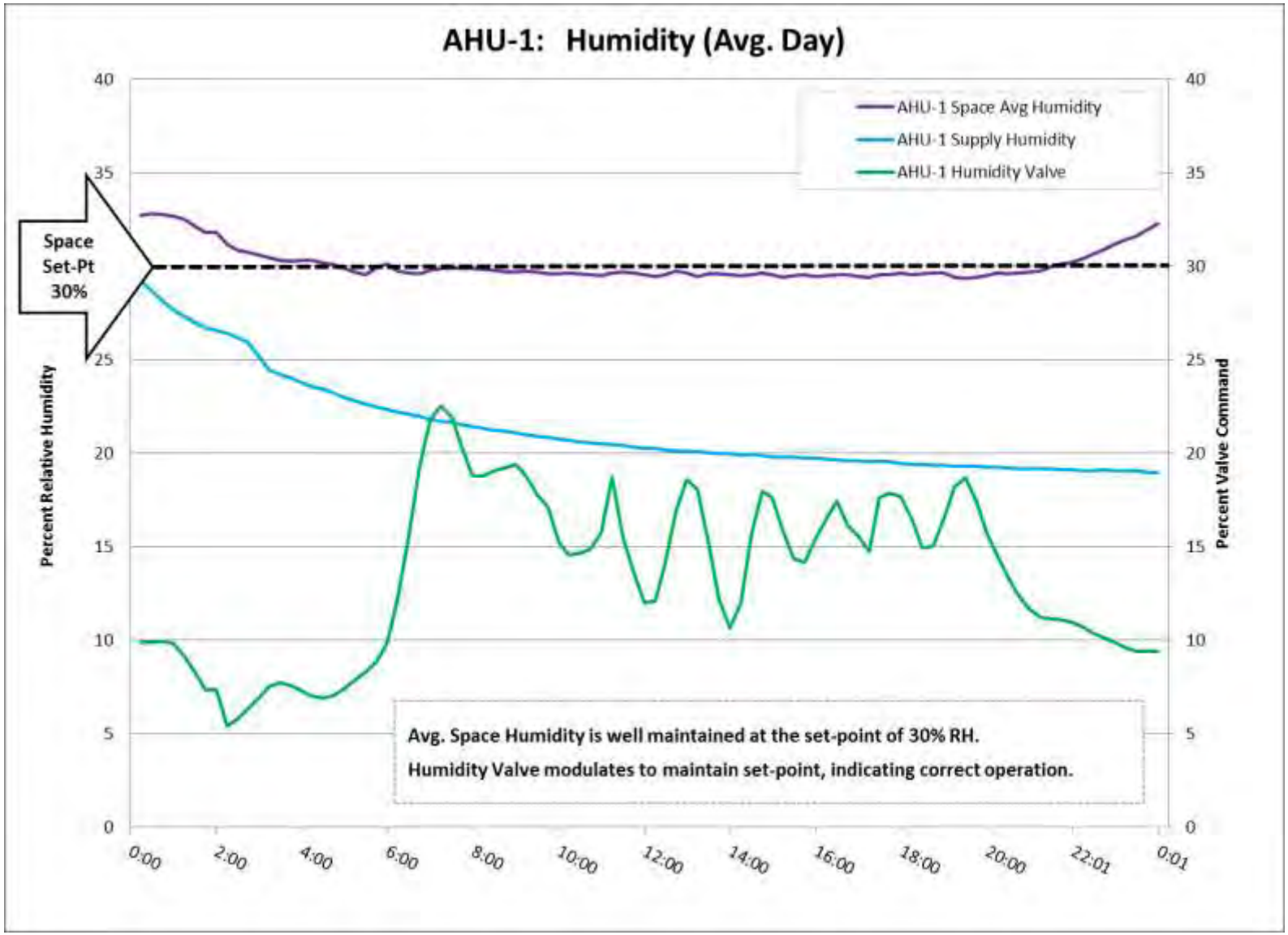

AHU-1
RF VFD Speed vs. OSA T
AHU-1 SF VFD Speed
Percent VFD Speed
Outside Air Temperature (Deg F)
100
90
80
70
60
50
40
30
20
10
0
-5.0
5.0
15.0
25.0
35.0
45.0
55.0
Unit Supply Fan VFD Speed primarily varies between 45% and 80% of full speed, but has capibility to runn between 10% and 100% of full speed. The fan can and does shut down at night.

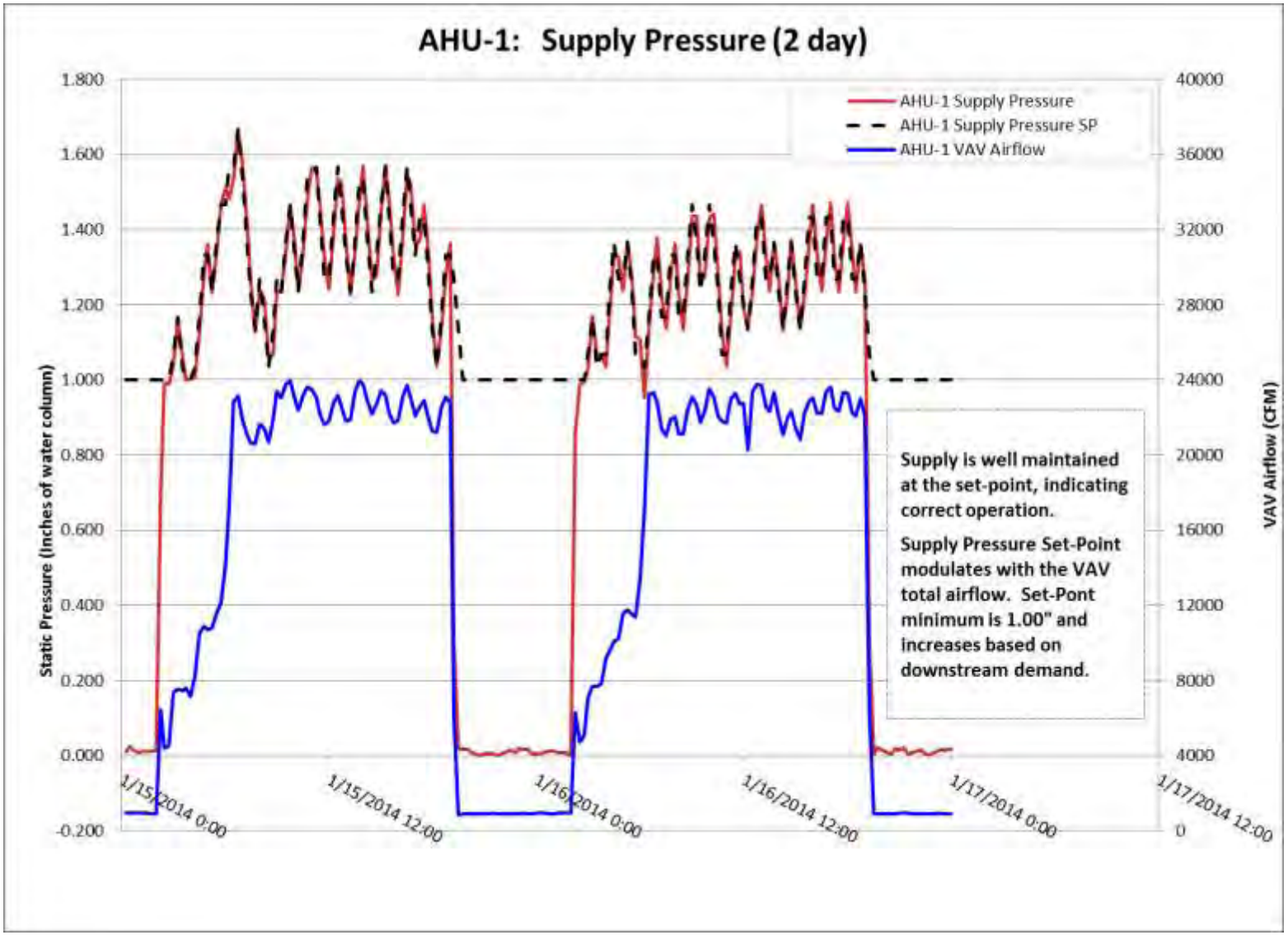

AHU-1
SF/RF VFD Speed on Avg Day
AHU-1 SF VFD Speed
AHU-1 RF VFD Speed
Percent VFD Speed
Time
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Supply Fan and Return Fan appear to be scheduled to operate daily.
Supply Fan operates from approximately 2:00 AM untill 7:00 PM daily.
Return Fan operates from approximately 4:00 AM untill 7:00 PM daily.
This indicates that the AHU is operating correctly by shutting down at night.


AHU-1
MAT & RAT on Avg Day
AHU-1 Mixed Air Temp
AHU-1 Return Air Temp
Degrees F
100
95
90
85
80
75
70
65
60
55
50
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time

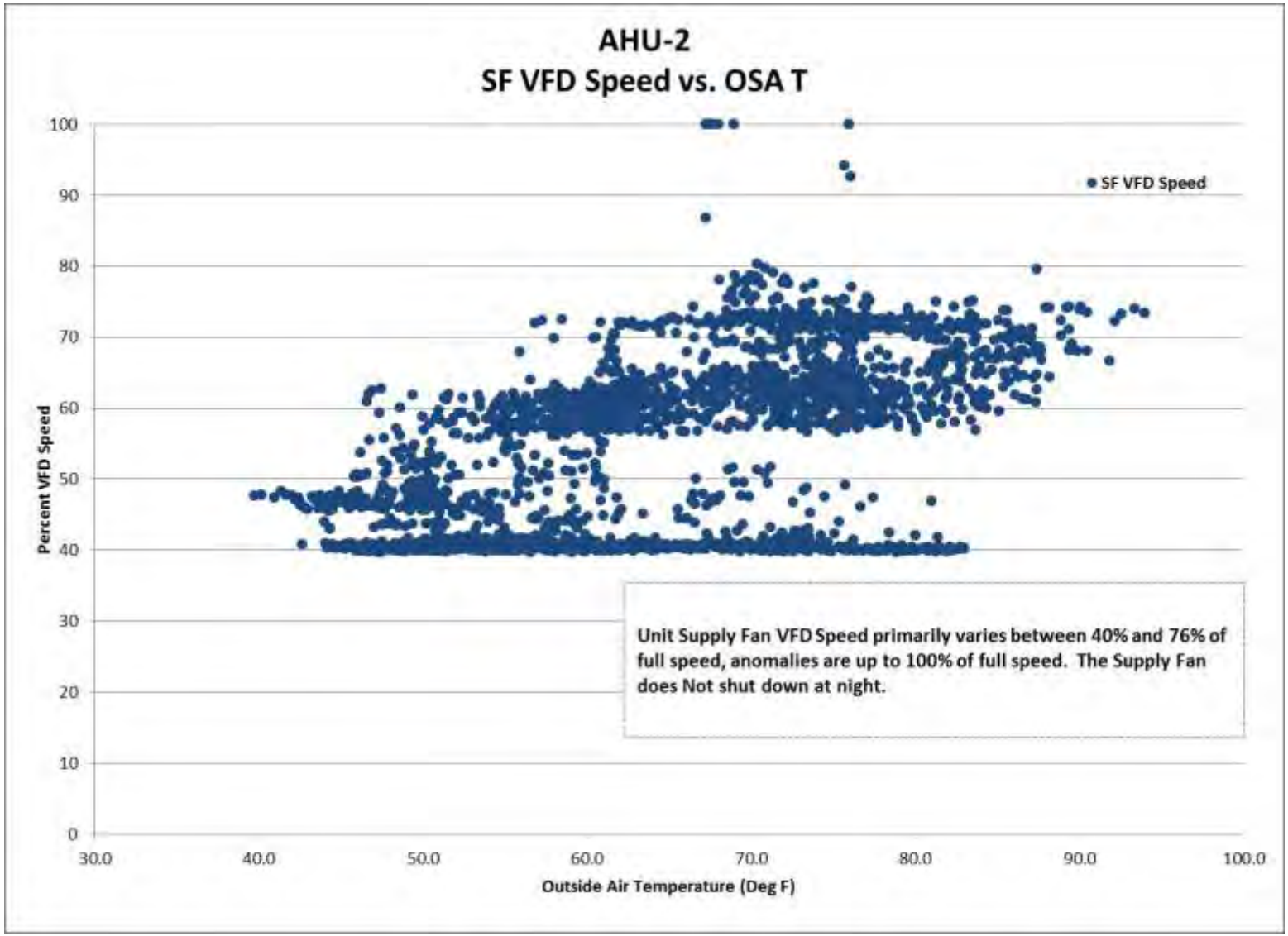

AHU-1
Heating Coil on Avg Day
AHU-1 HC Valve Command
Outside Air Temp
Percent Valve Command
Deg F
30
25
20
15
10
5
0
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.

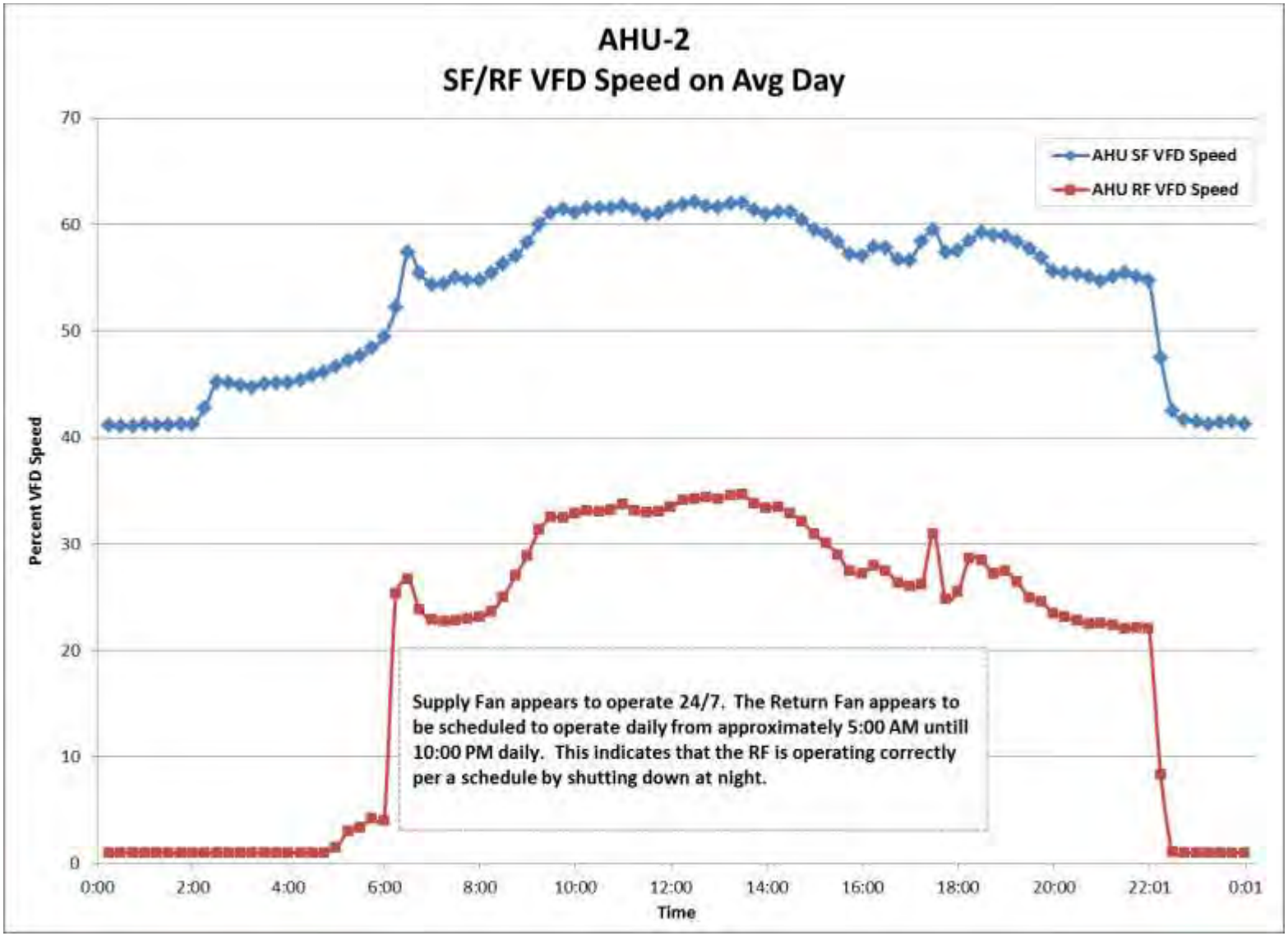

AHU-1
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
AHU-1 HC Valve Command
Outside Air Temp
AHU-1 Supply Temp
Percent Valve Command
Deg F
Time
60
50
40
30
20
10
0
110.0
95.0
80.0
65.0
50.0
35.0
20.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

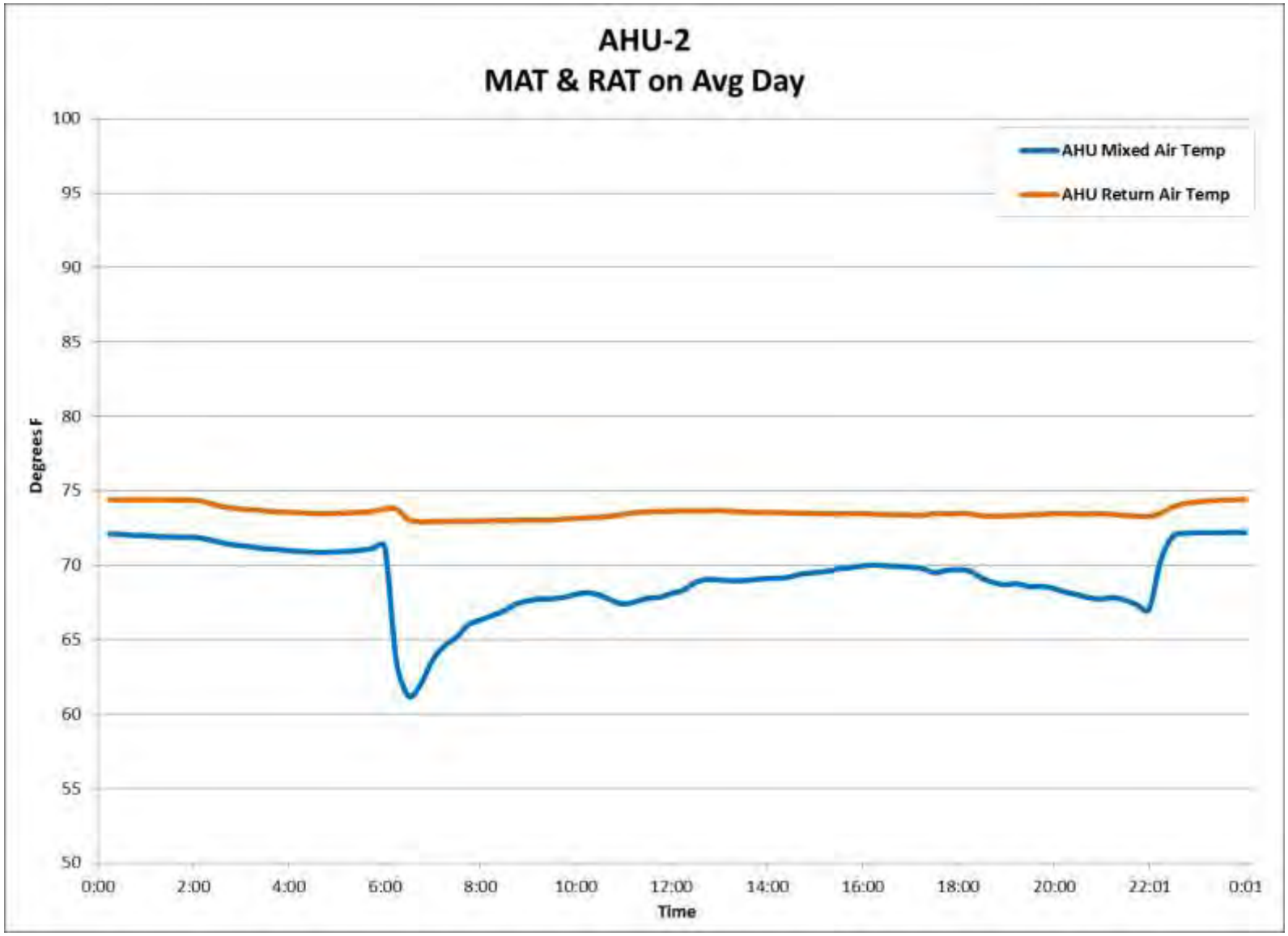

AHU-1: Humidity (Avg. Day)
AHU-1 Space Avg Humidity
AHU-1 Supply Humidity
AHU-1 Humidity Valve
Space Set-Pt 30%
Percent Relative Humidity
Percent Valve Command
Avg. Space Humidity is well maintained at the set-point of 30% RH.
Humidity Valve modulates to maintain set-point, indicating correct operation.
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

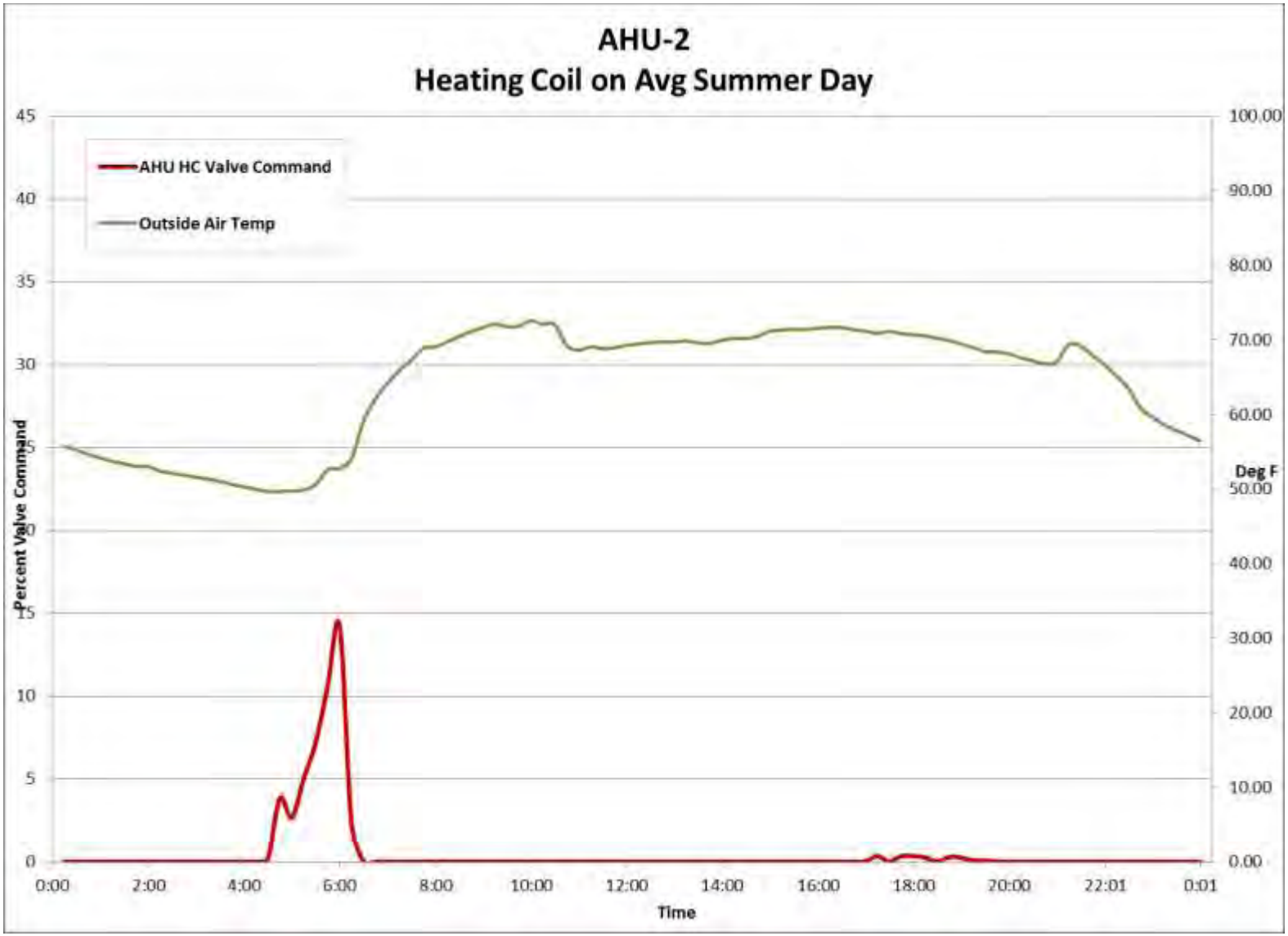

AHU-1: Supply Pressure (2 day)
AHU-1 Supply Pressure
AHU-1 Supply Pressure SP
AHU-1 VAV Airflow
Static Pressure (Inches of water column)
VAV Airflow (CFM)
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
1/15/2014 0:00
1/15/2014 12:00
1/16/2014 0:00
1/16/2014 12:00
1/17/2014 0:00
1/17/2014 12:00
Supply is well maintained at the set-point, indicating correct operation.
Supply Pressure Set-Point modulates with the VAV total airflow. Set-Pont minimum is 1.00" and increases based on downstream demand.

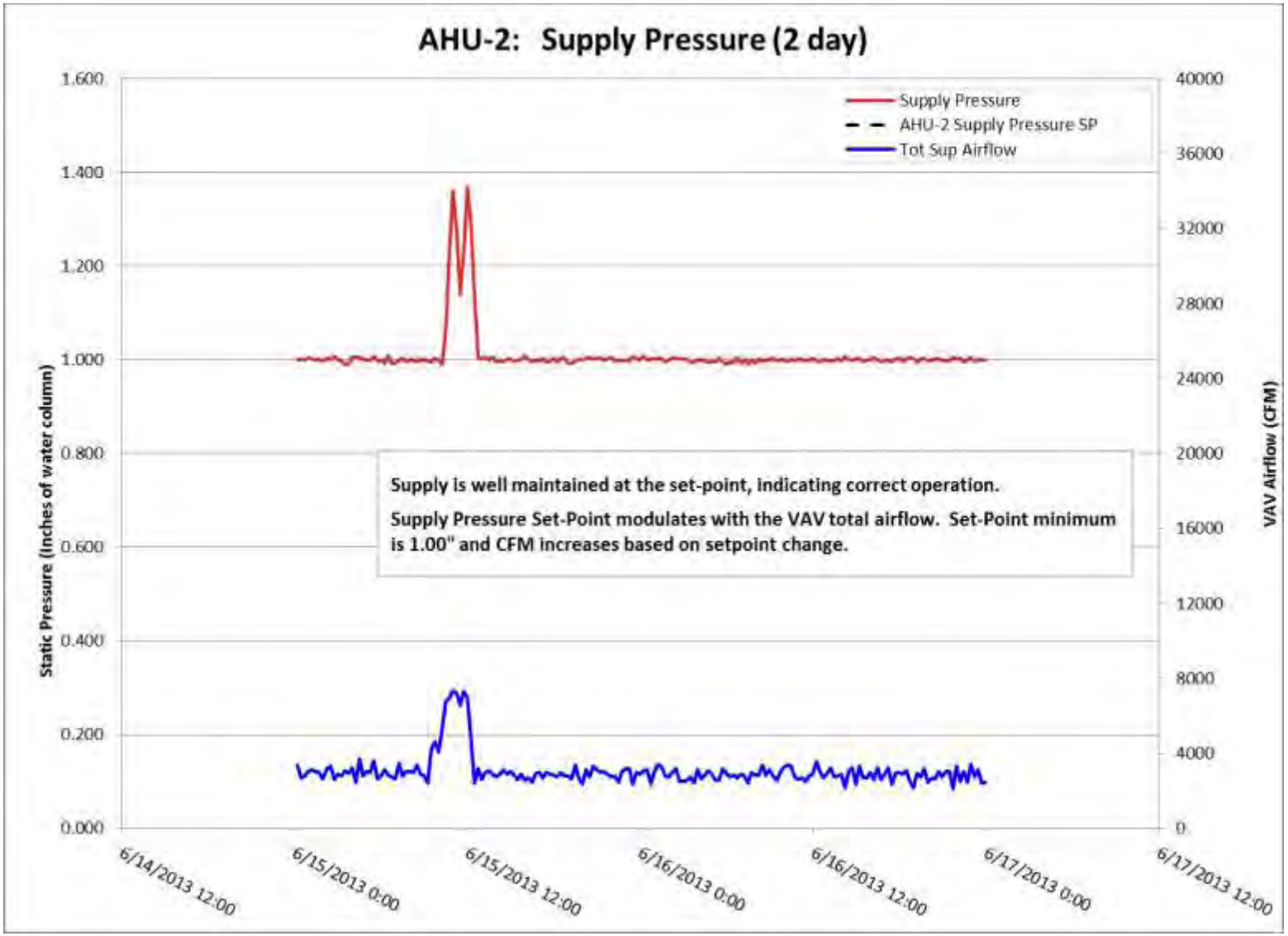
AHU 2 – SUMMER


AHU-2
SF VFD Speed vs. OSA T
SF VFD Speed
Percent VFD Speed
Outside Air Temperature (Deg F)
100
90
80
70
60
50
40
30
20
10
0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
Unit Supply Fan VFD Speed primarily varies between 40% and 76% of full speed, anomalies are up to 100% of full speed. The Supply Fan does Not shut down at night.

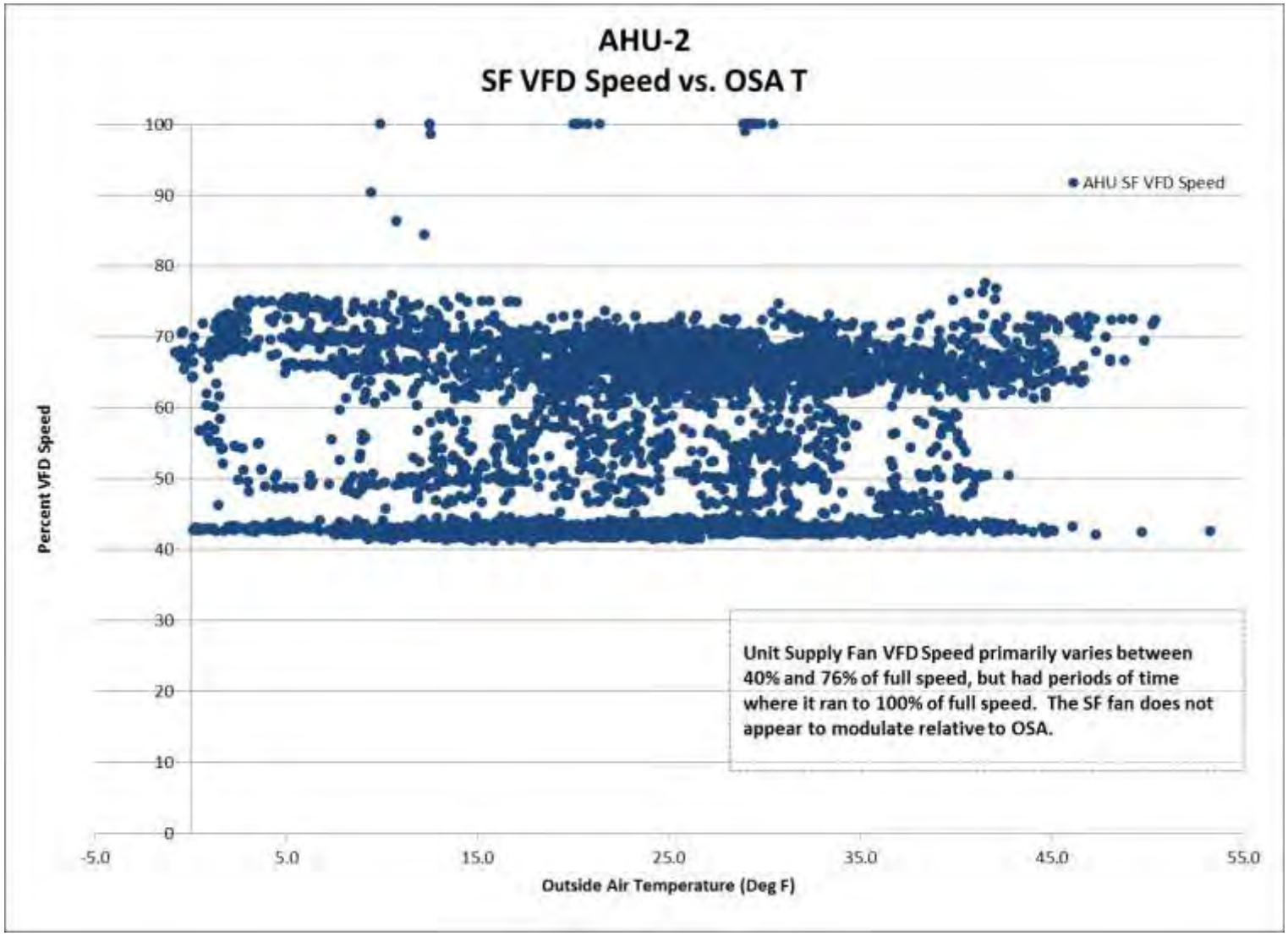

AHU-2
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan appears to operate 24/7. The Return Fan appears to be scheduled to operate daily from approximately 5:00 AM untill 10:00 PM daily. This indicates that the RF is operating correctly per a schedule by shutting down at night.

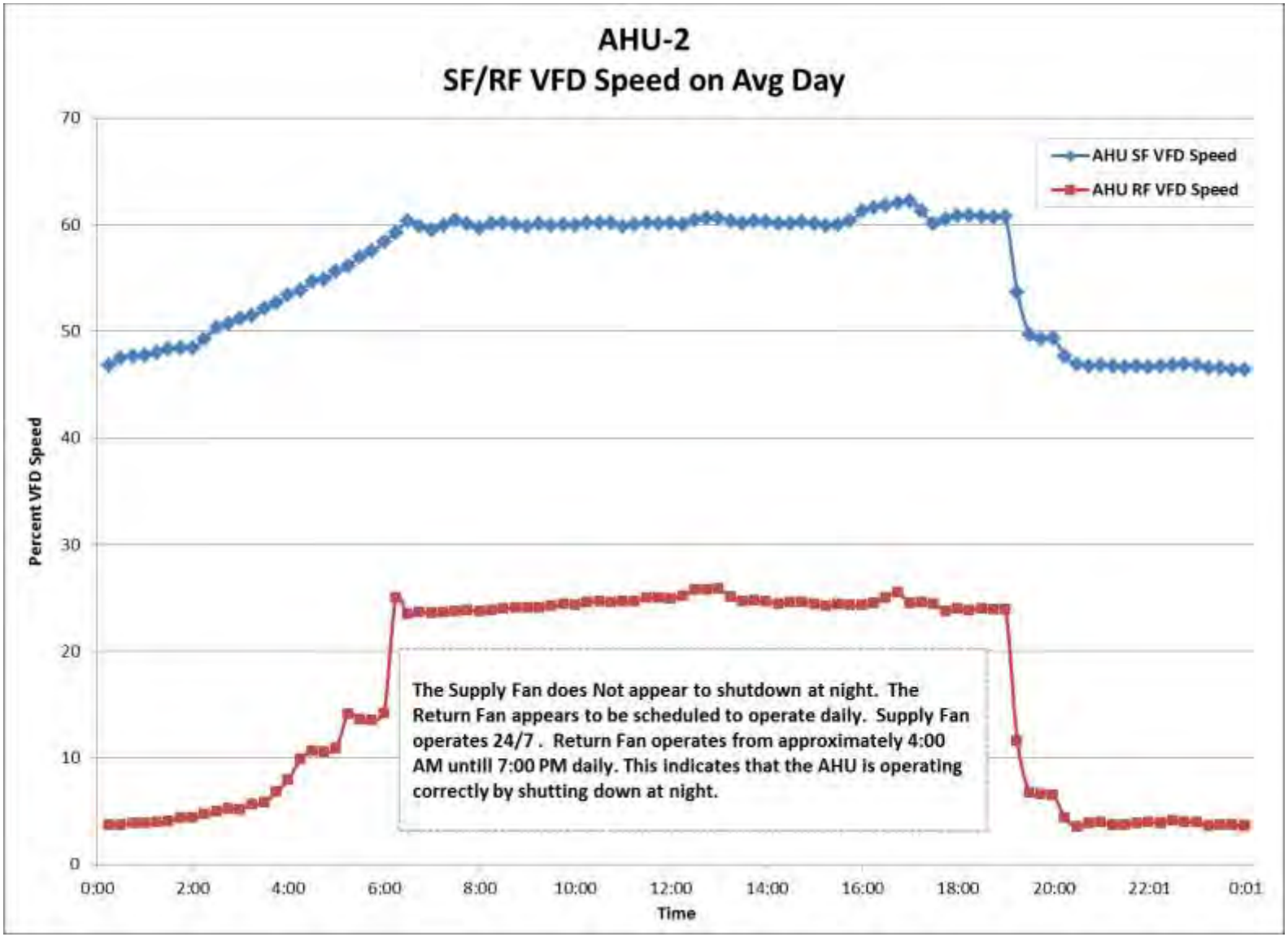

AHU-2
MAT & RAT on Avg Day
AHU Mixed Air Temp
AHU Return Air Temp
Degrees F
100
95
90
85
80
75
70
65
60
55
50
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time

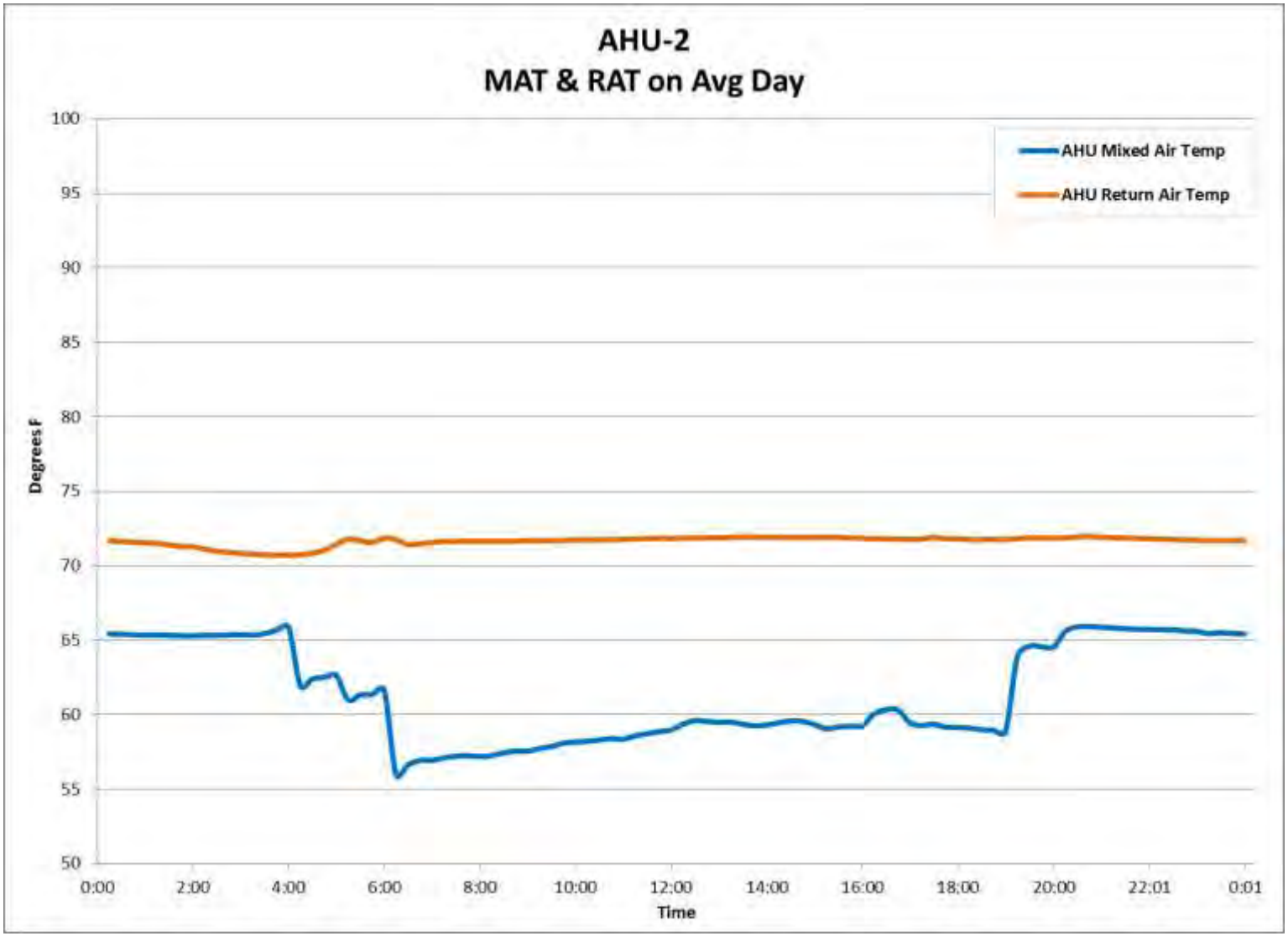

AHU-2
Heating Coil on Avg Summer Day
AHU HC Valve Command
Outside Air Temp
Percent Valve Command
Deg F
Time
45
40
35
30
25
20
15
10
5
0
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

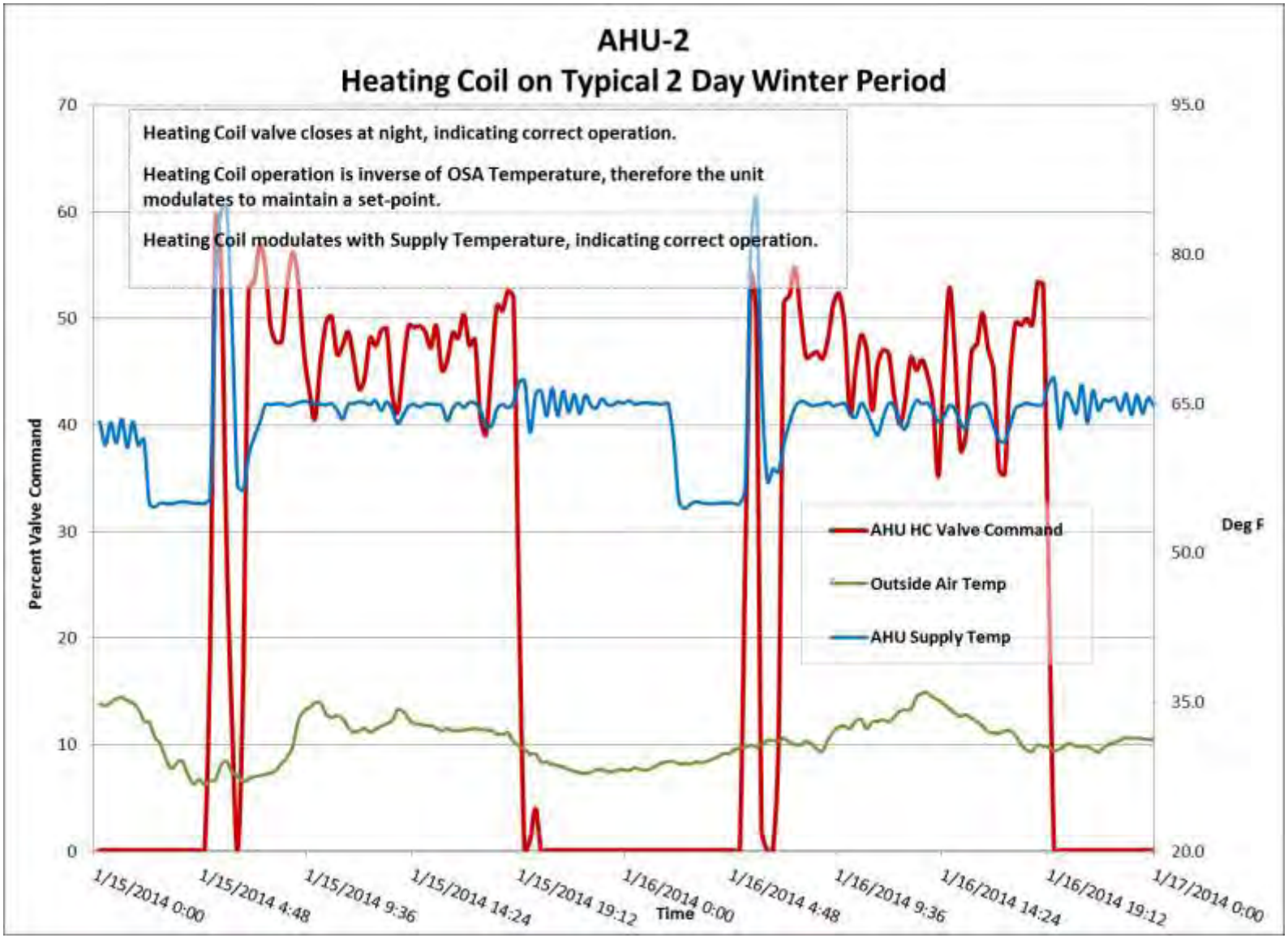

AHU-2: Supply Pressure (2 day)
Supply Pressure
AHU-2 Supply Pressure SP
Tot Sup Airflow
Supply is well maintained at the set-point, indicating correct operation.
Supply Pressure Set-Point modulates with the VAV total airflow. Set-Point minimum is 1.00" and CFM increases based on setpoint change.
Static Pressure (Inches of water column)
VAV Airflow (CFM)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
6/14/2013 12:00
6/15/2013 0:00
6/15/2013 12:00
6/16/2013 0:00
6/16/2013 12:00
6/17/2013 0:00
6/17/2013 12:00

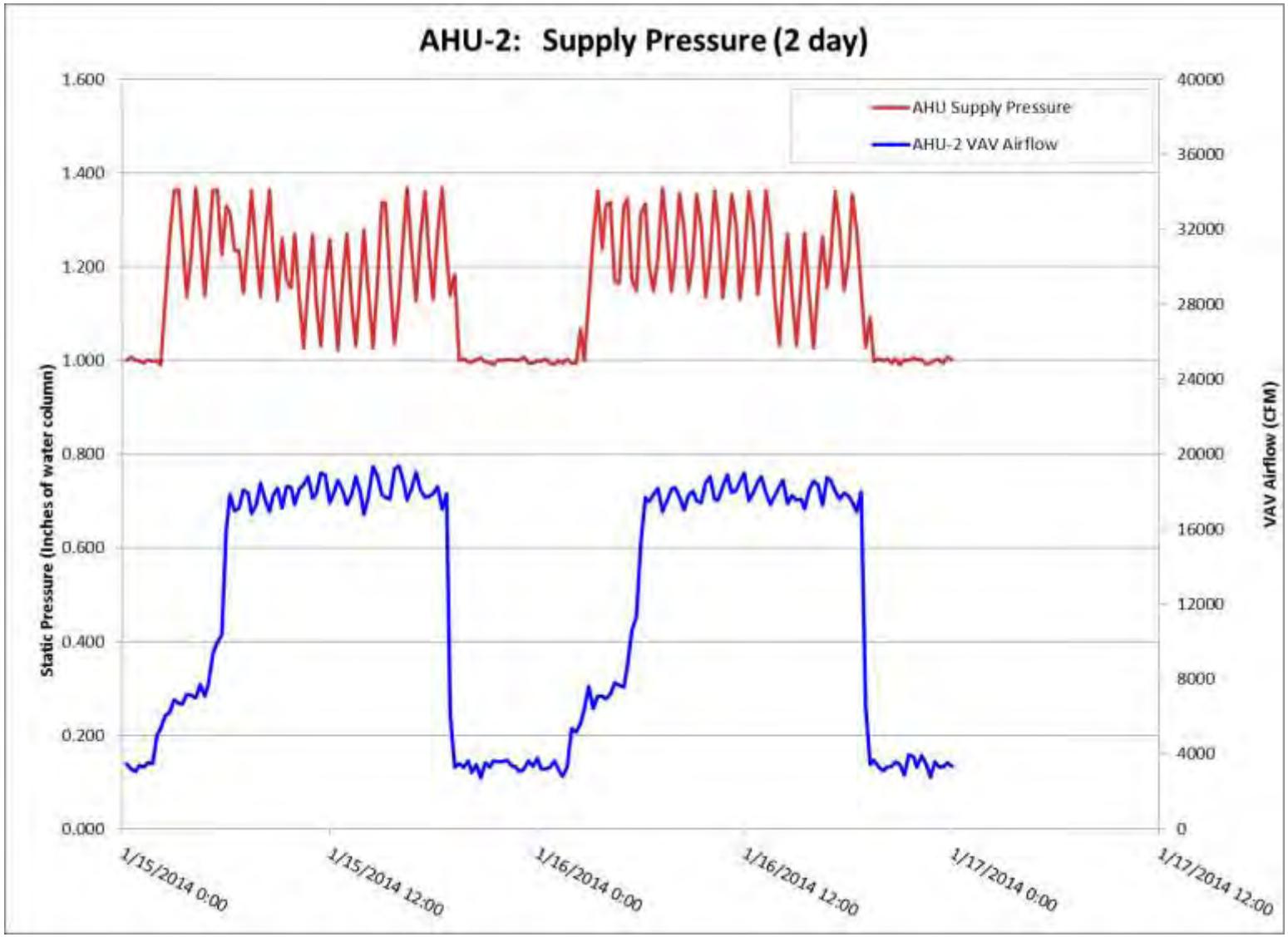
AHU 2 – WINTER


AHU-2
SF VFD Speed vs. OSA T
AHU SF VFD Speed
Percent VFD Speed
100
90
80
70
60
50
40
30
20
10
0
-5.0
5.0
15.0
25.0
35.0
45.0
55.0
Outside Air Temperature (Deg F)
Unit Supply Fan VFD Speed primarily varies between 40% and 76% of full speed, but had periods of time where it ran to 100% of full speed. The SF fan does not appear to modulate relative to OSA.

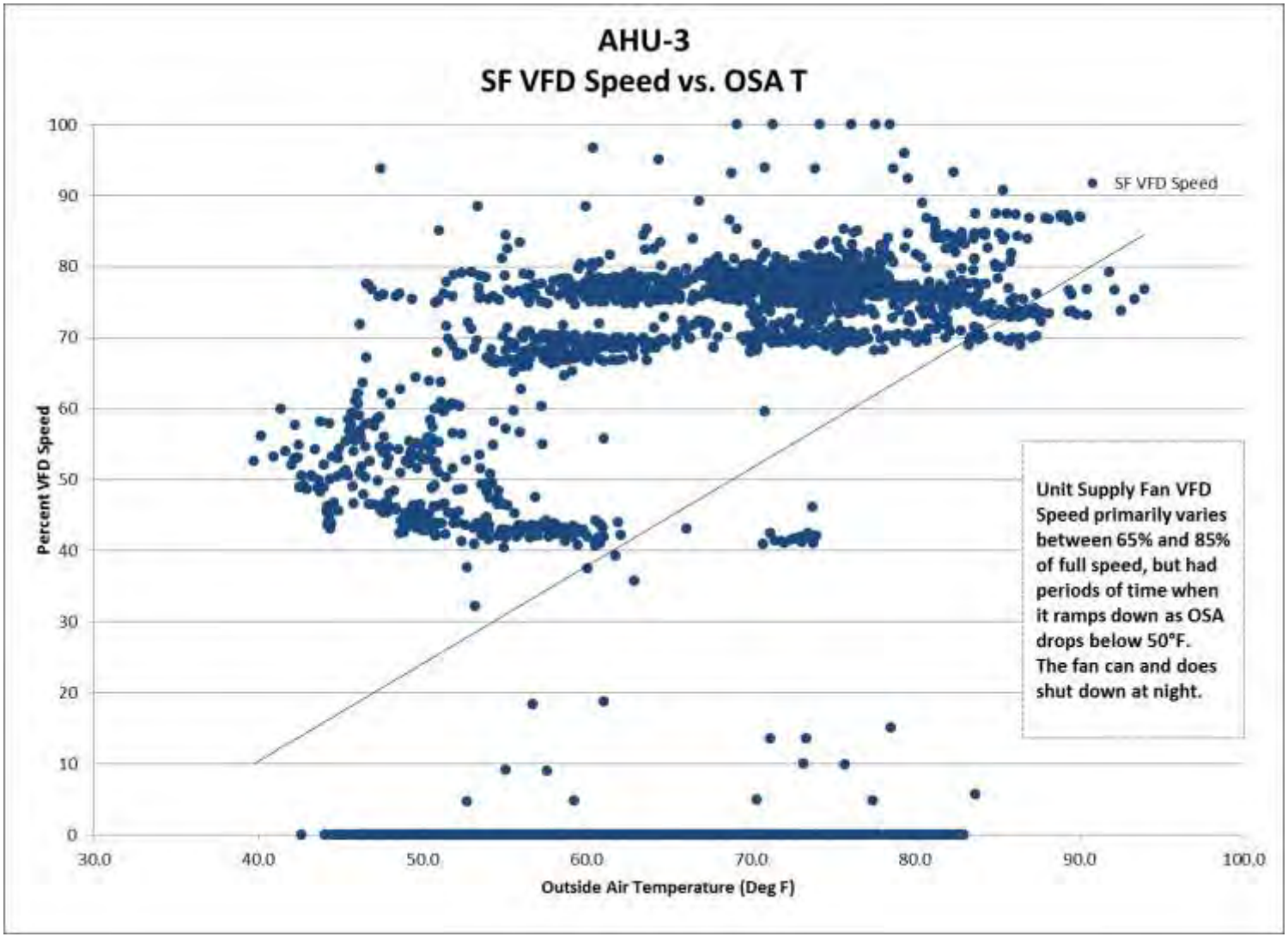

AHU-2
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
The Supply Fan does Not appear to shutdown at night. The Return Fan appears to be scheduled to operate daily. Supply Fan operates 24/7 . Return Fan operates from approximately 4:00 AM untill 7:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

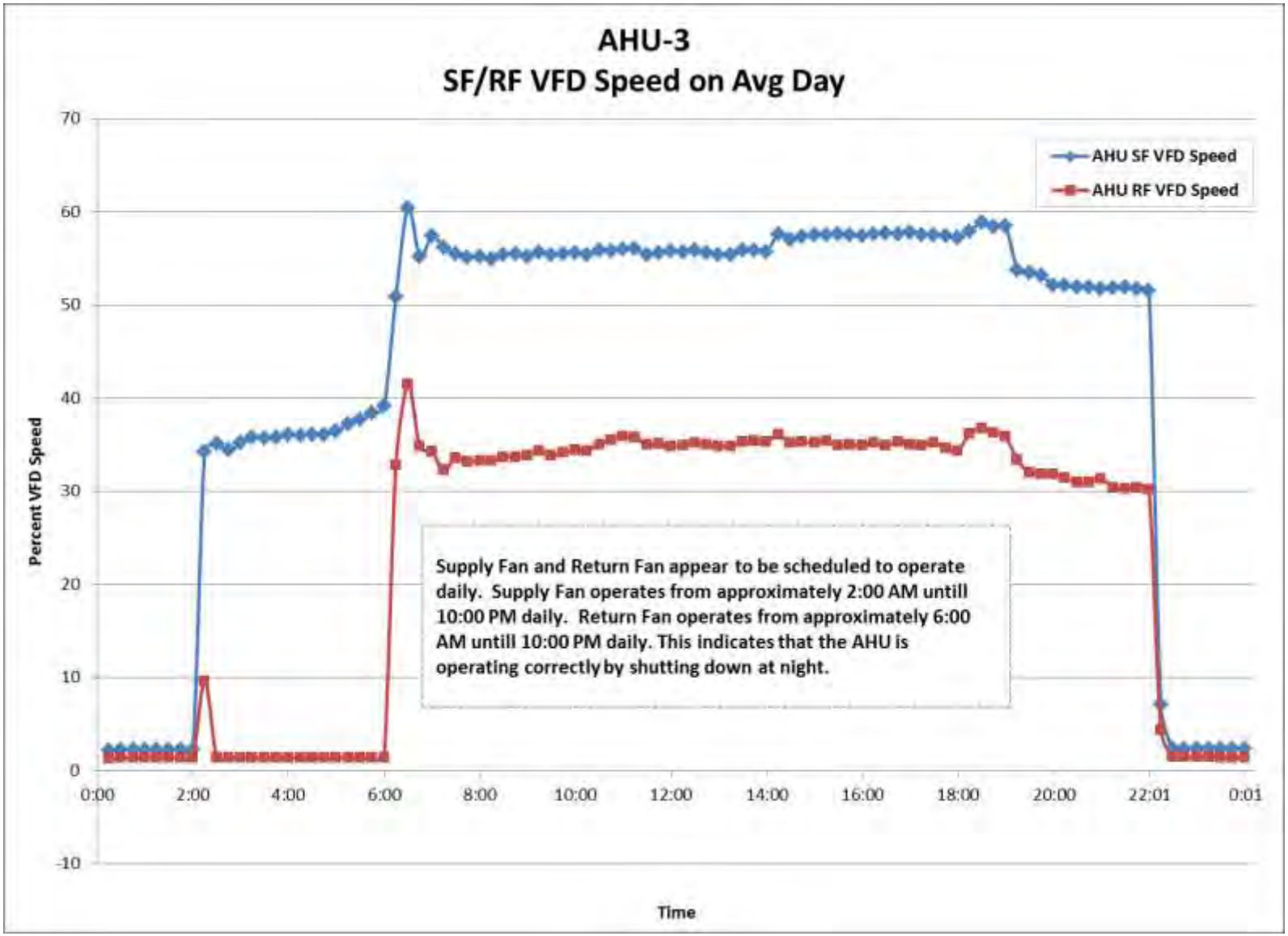

AHU-2
MAT & RAT on Avg Day
AHU Mixed Air Temp
AHU Return Air Temp
Degrees F
100
95
90
85
80
75
70
65
60
55
50
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time

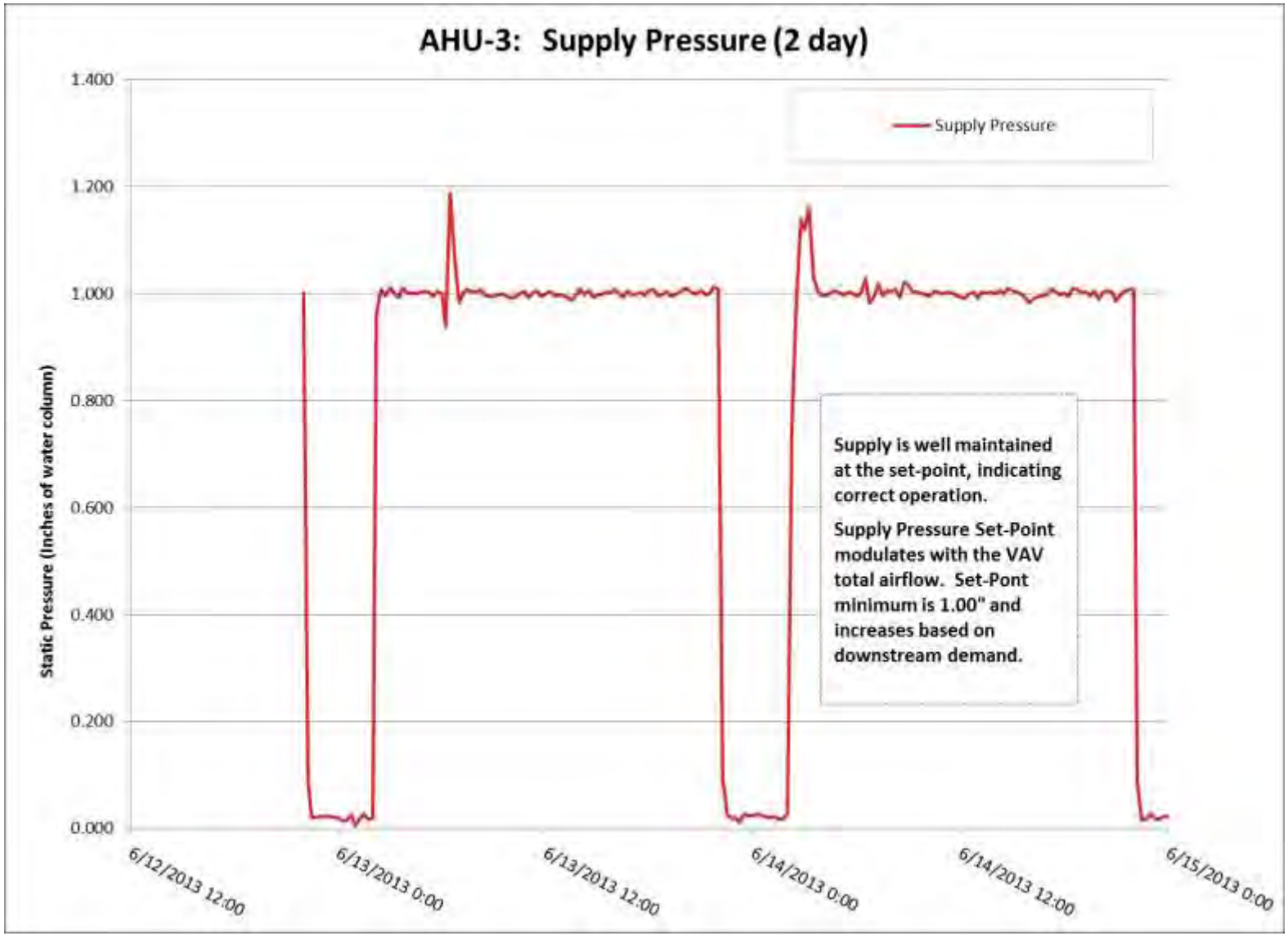

AHU-2
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
Time
AHU HC Valve Command
Outside Air Temp
AHU Supply Temp
70
60
50
40
30
20
10
0
95.0
80.0
65.0
50.0
35.0
20.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00


AHU-2: Supply Pressure (2 day)
AHU Supply Pressure
AHU-2 VAV Airflow
Static Pressure (Inches of water column)
VAV Airflow (CFM)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
1/15/2014 0:00
1/15/2014 12:00
1/16/2014 0:00
1/16/2014 12:00
1/17/2014 0:00
1/17/2014 12:00

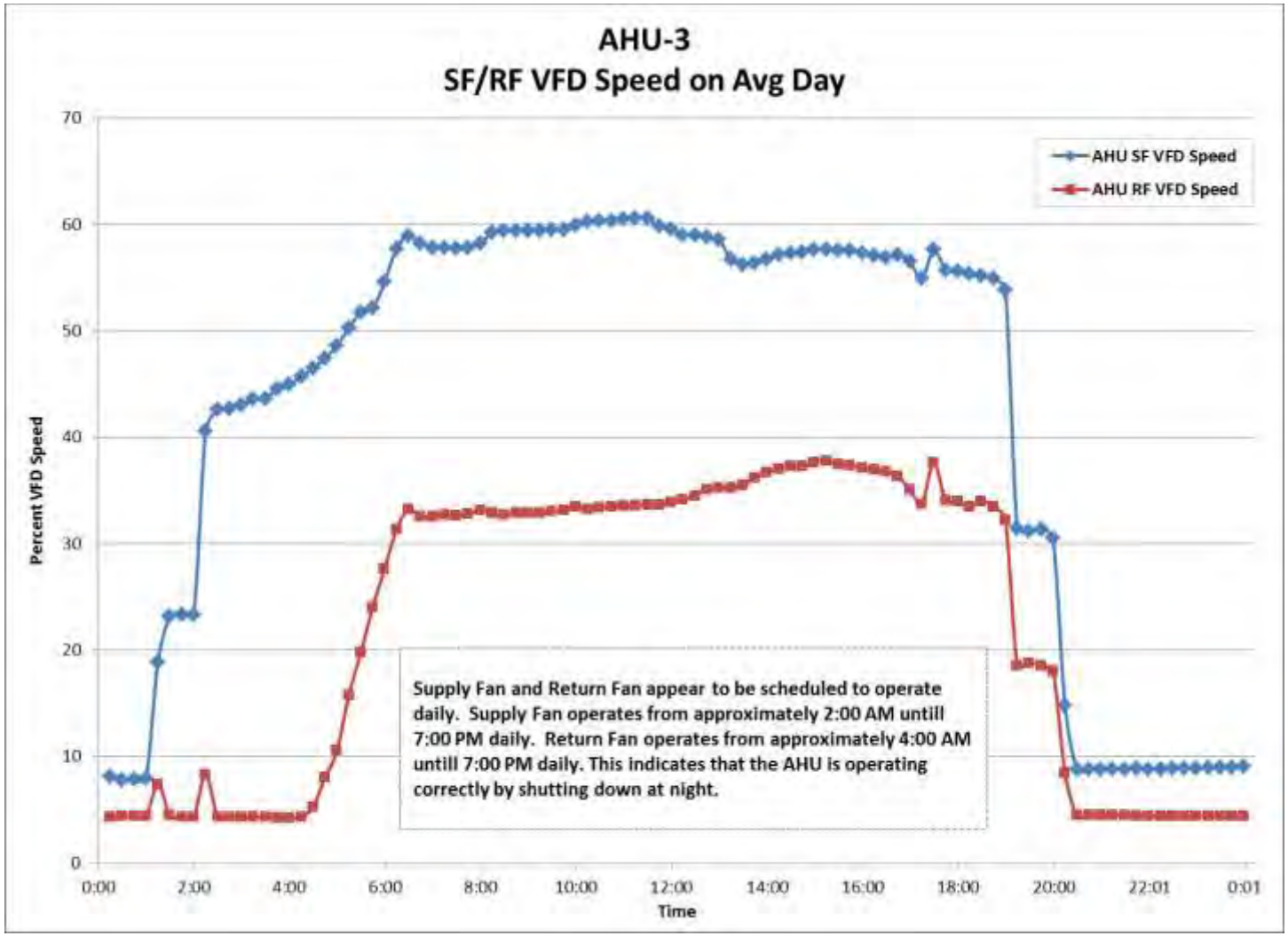
AHU 3 – SUMMER

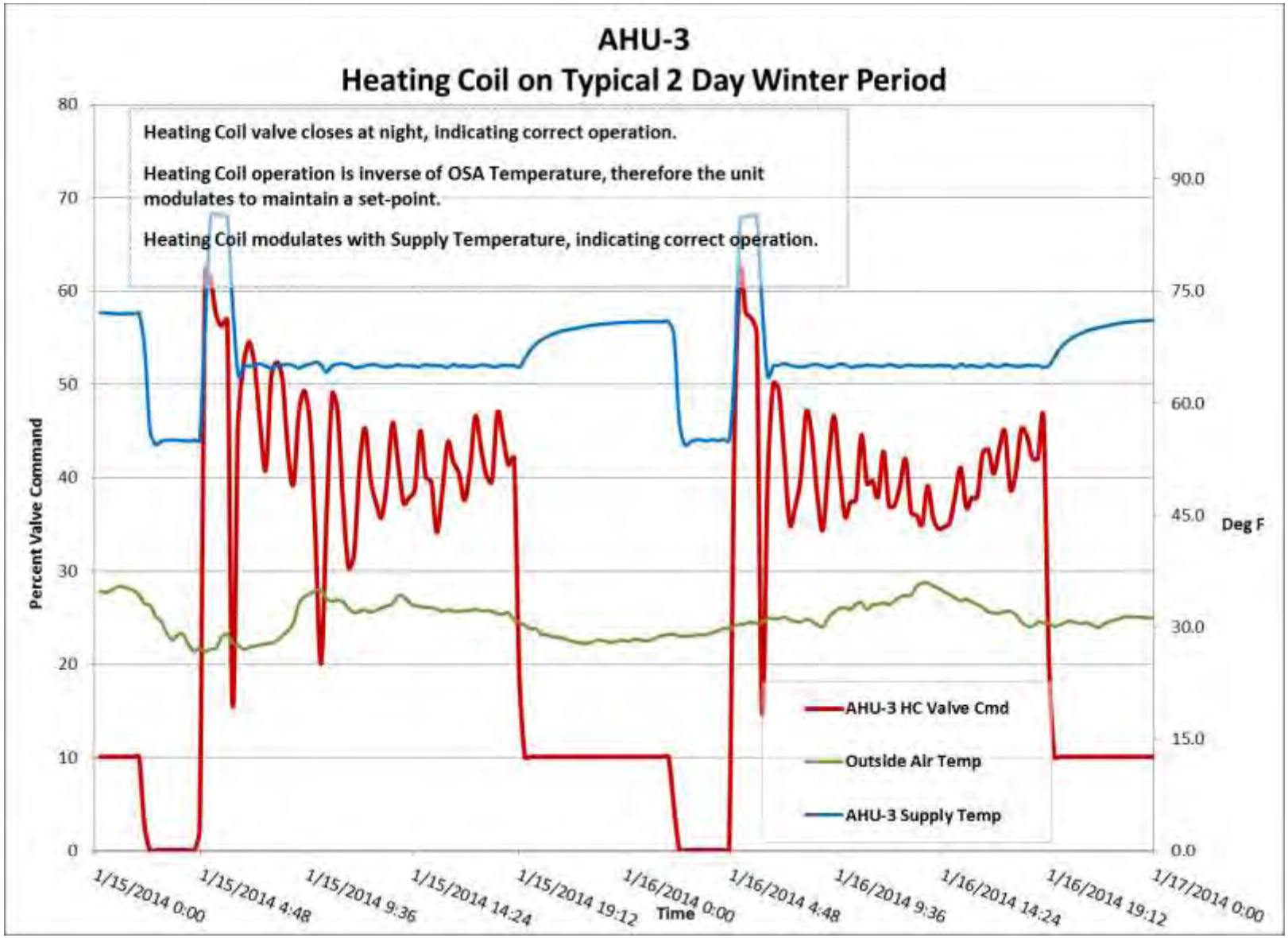

AHU-3
SF VFD Speed vs. OSA T
Percent VFD Speed
Outside Air Temperature (Deg F)
SF VFD Speed
100
90
80
70
60
50
40
30
20
10
0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
Unit Supply Fan VFD Speed primarily varies between 65% and 85% of full speed, but had periods of time when it ramps down as OSA drops below 50°F. The fan can and does shut down at night.


AHU-3
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
70
60
50
40
30
20
10
0
-10
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 10:00 PM daily. Return Fan operates from approximately 6:00 AM untill 10:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

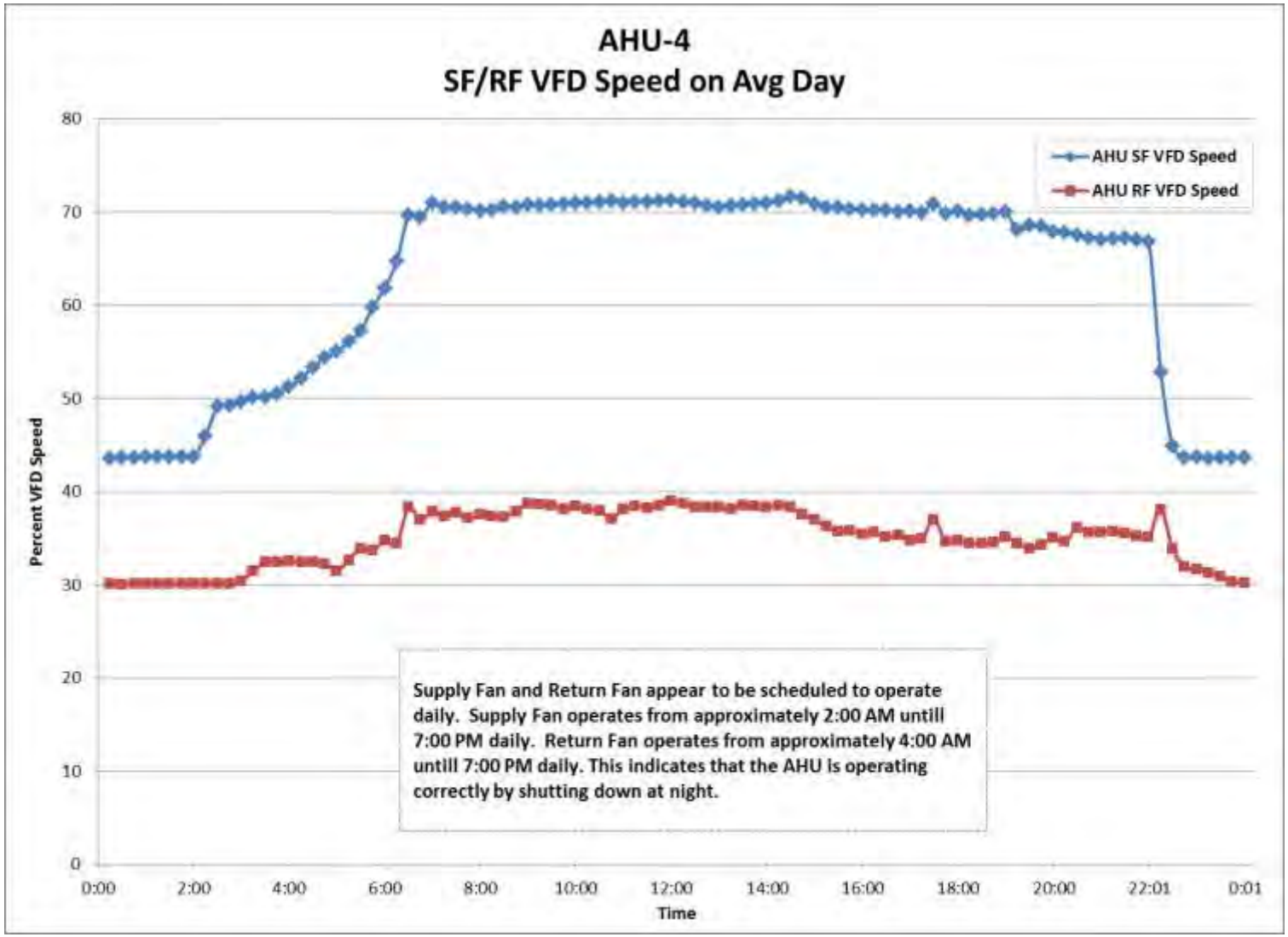

AHU-3: Supply Pressure (2 day)
Static Pressure (Inches of water column)
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Supply Pressure
Supply is well maintained at the set-point, indicating correct operation.
Supply Pressure Set-Point modulates with the VAV total airflow. Set-Pont minimum is 1.00" and increases based on downstream demand.
6/12/2013 12:00
6/13/2013 0:00
6/13/2013 12:00
6/14/2013 0:00
6/14/2013 12:00
6/15/2013 0:00

AHU 3 – Winter

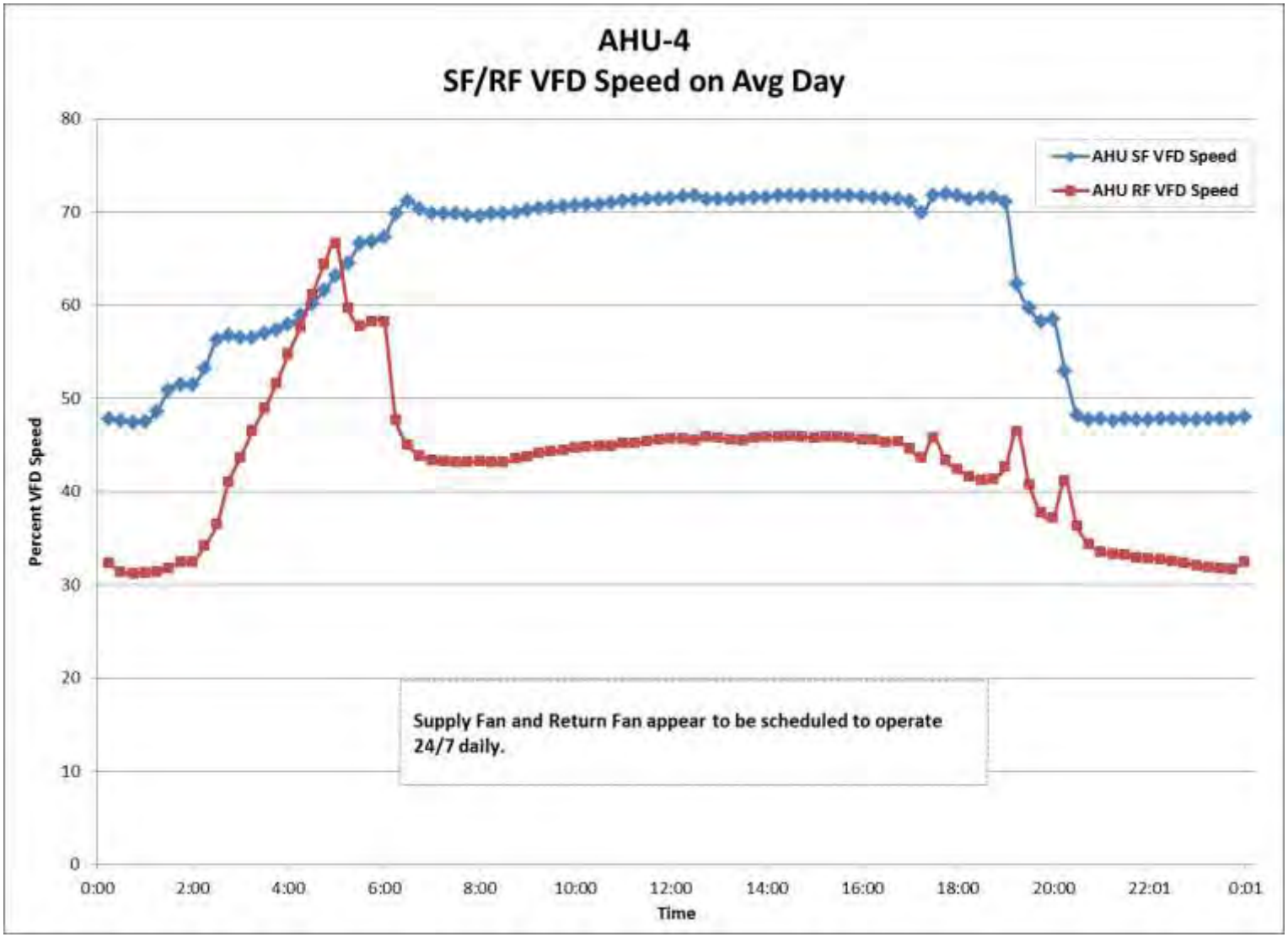

AHU-3
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 7:00 PM daily. Return Fan operates from approximately 4:00 AM untill 7:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

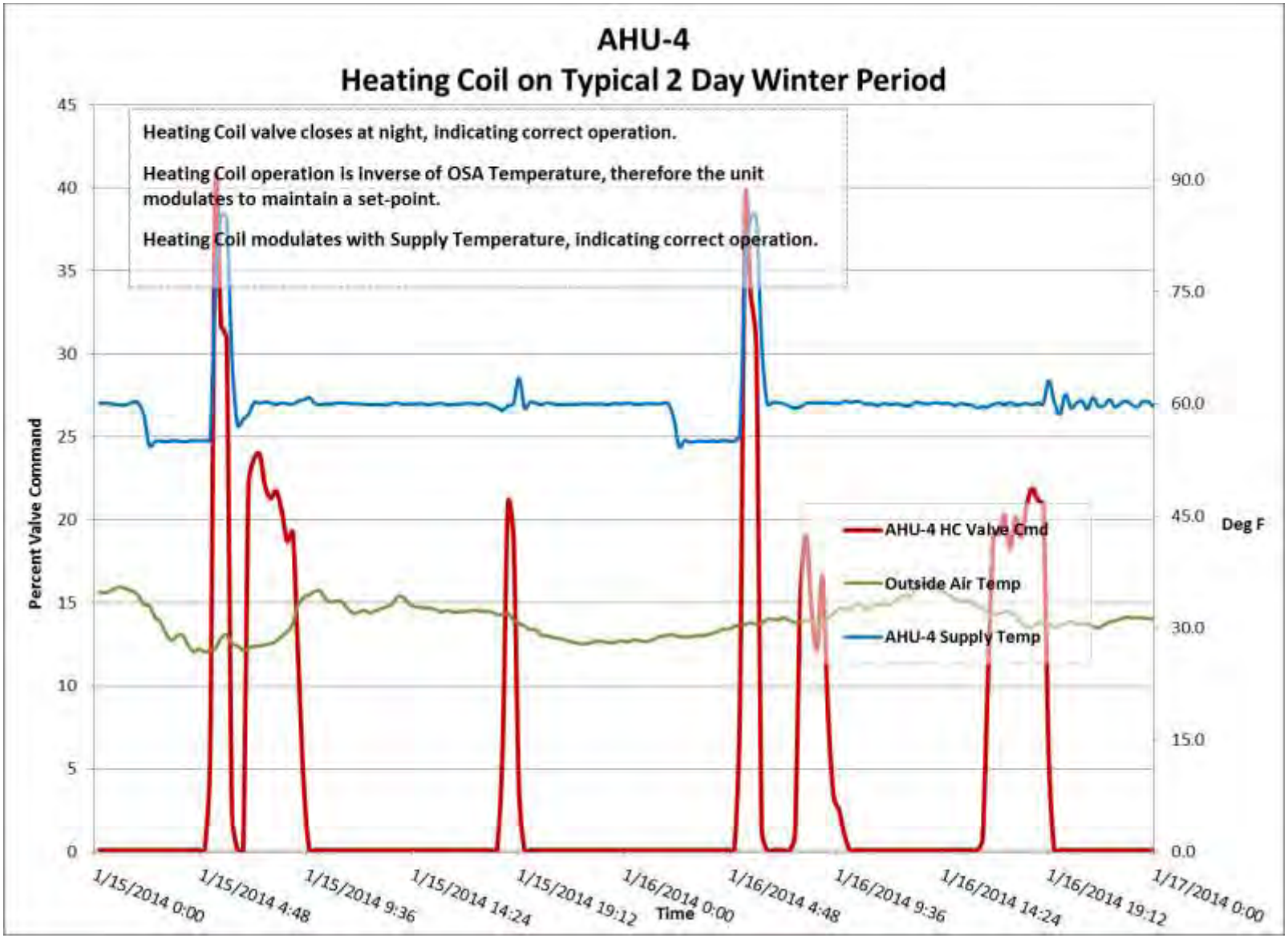

AHU-3
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
Time
AHU-3 HC Valve Cmd
Outside Air Temp
AHU-3 Supply Temp
80
70
60
50
40
30
20
10
0
90.0
75.0
60.0
45.0
30.0
15.0
0.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

AHU 4 – Summer

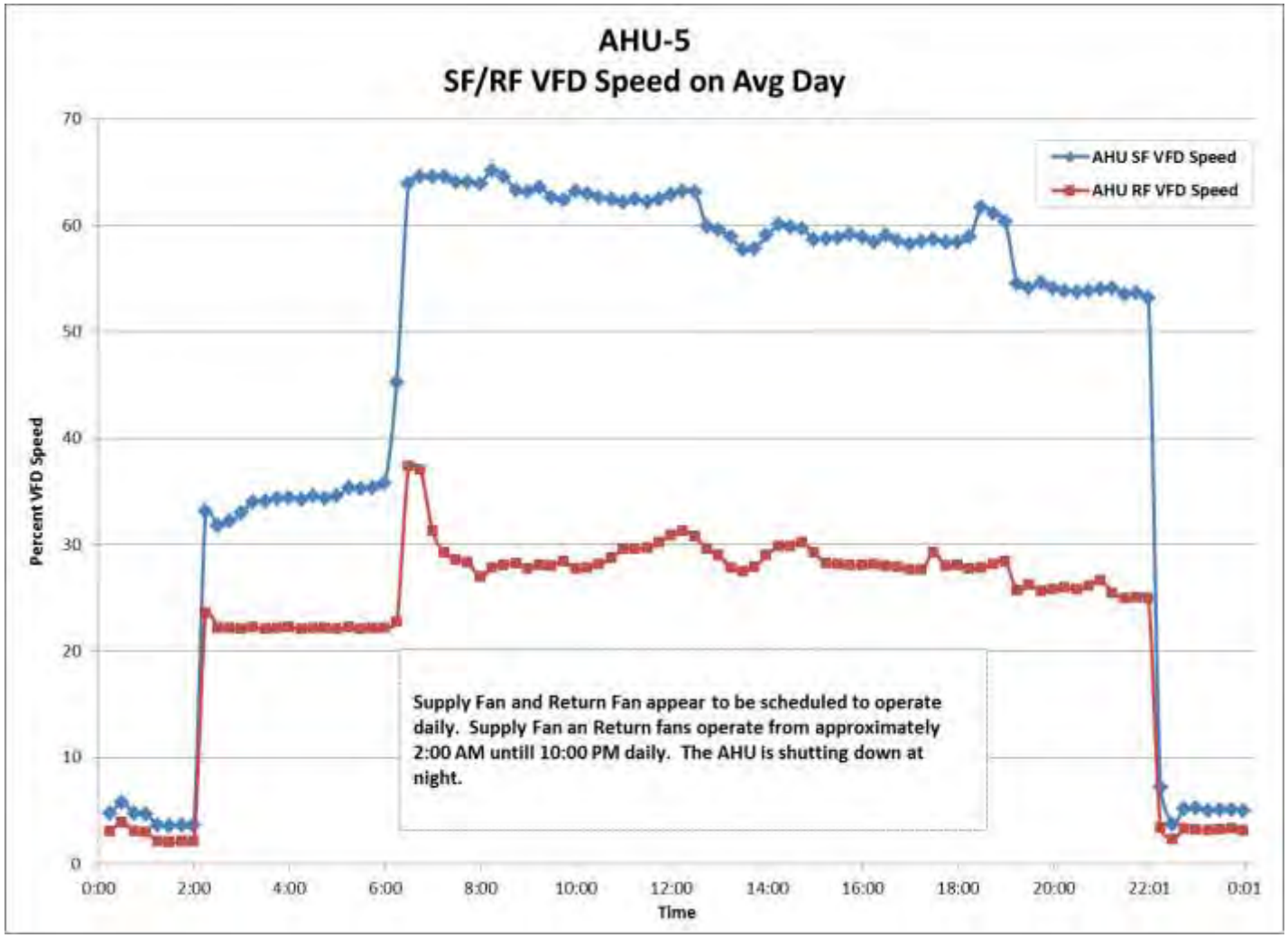

AHU-4
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
80
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 7:00 PM daily. Return Fan operates from approximately 4:00 AM untill 7:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

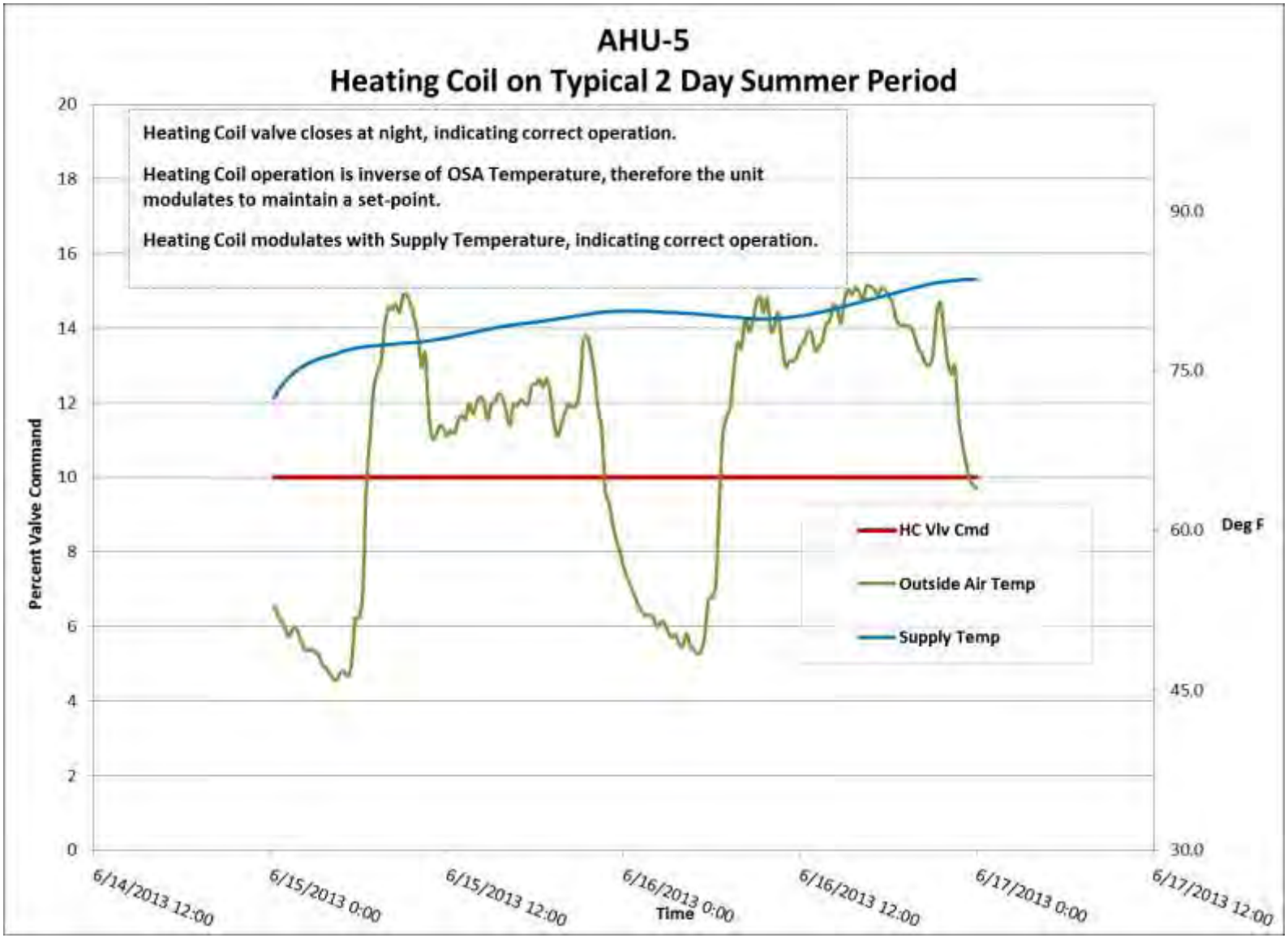
AHU 4 - Winter


AHU-4
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
80
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate 24/7 daily.

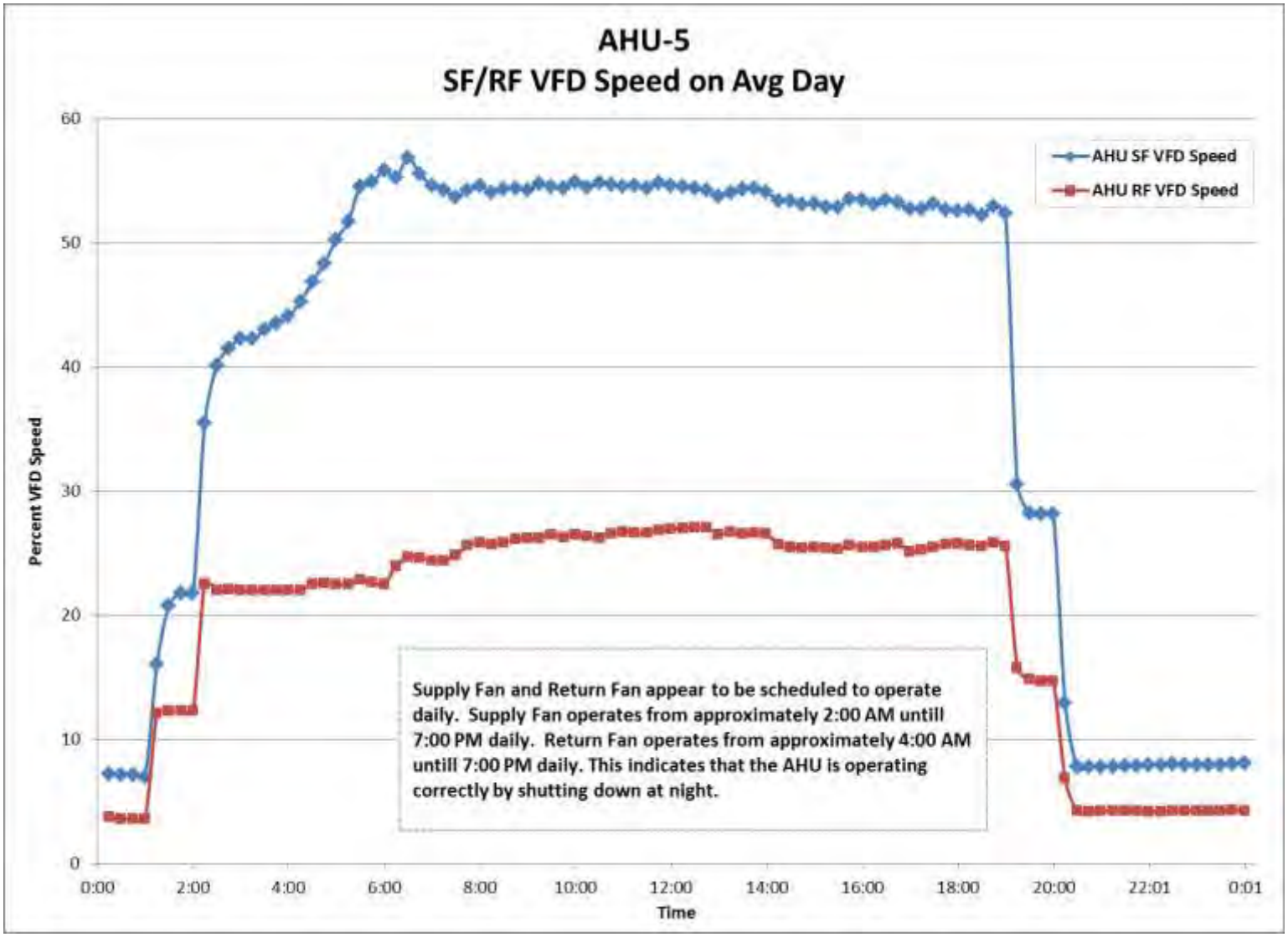

AHU-4
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
AHU-4 HC Valve Cmd
Outside Air Temp
AHU-4 Supply Temp
Time
45
40
35
30
25
20
15
10
5
0
90.0
75.0
60.0
45.0
30.0
15.0
0.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

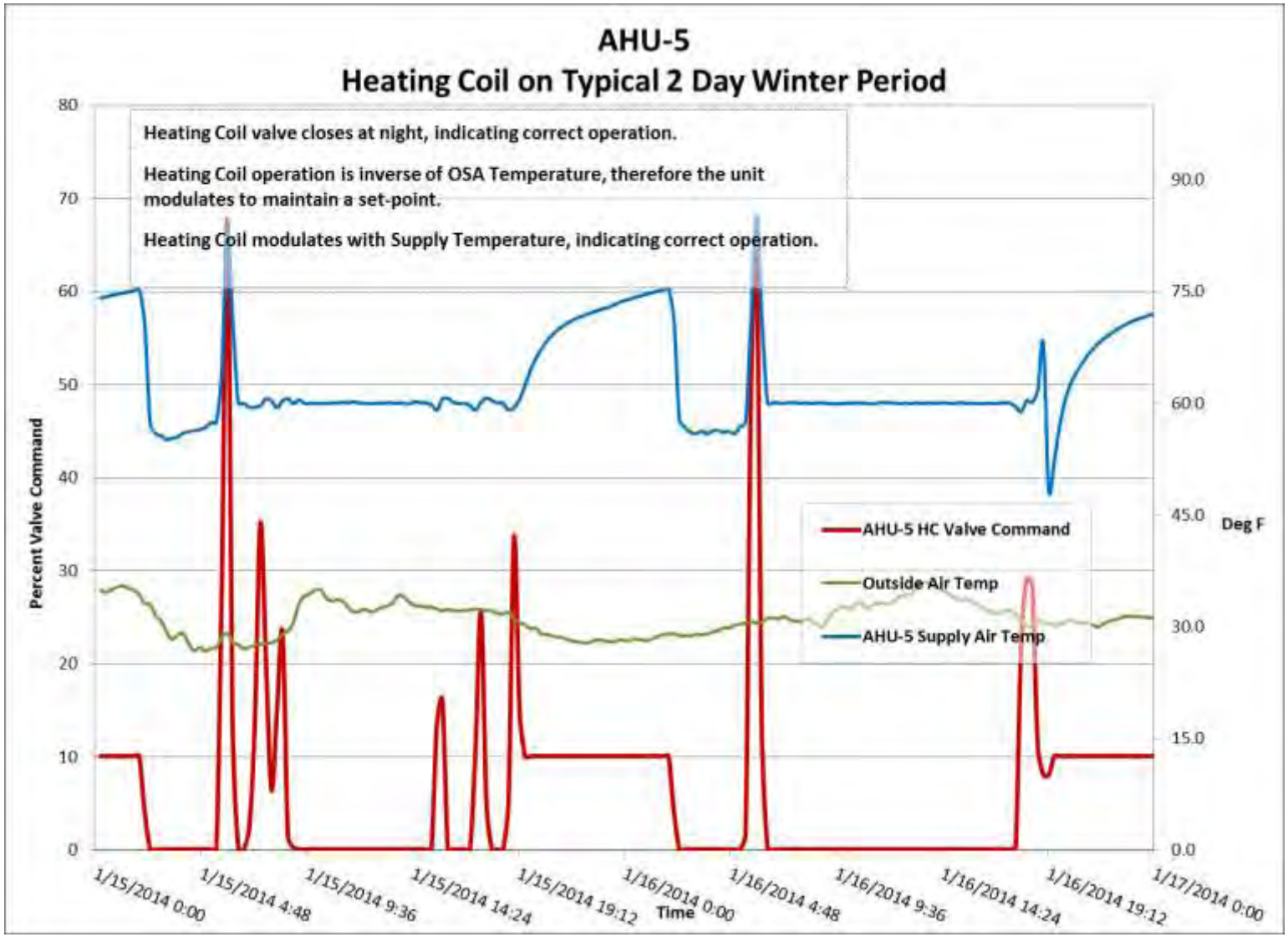
AHU 5 – Summer


AHU-5
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan an Return fans operate from approximately 2:00 AM untill 10:00 PM daily. The AHU is shutting down at night.

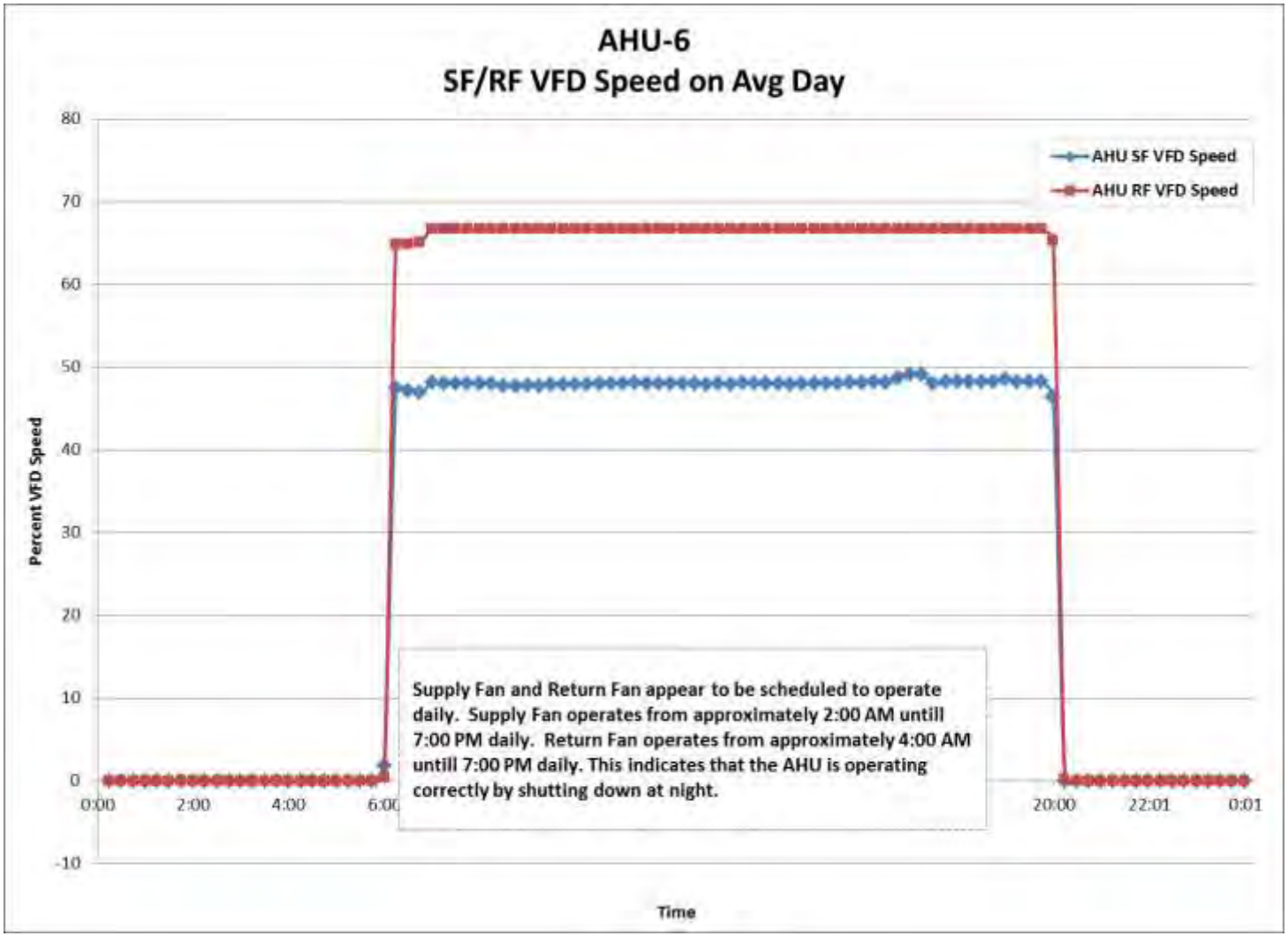

AHU-5
Heating Coil on Typical 2 Day Summer Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
Time
HC Vlv Cmd
Outside Air Temp
Supply Temp
20
18
16
14
12
10
8
6
4
2
0
90.0
75.0
60.0
45.0
30.0
6/14/2013 12:00
6/15/2013 0:00
6/15/2013 12:00
6/16/2013 0:00
6/16/2013 12:00
6/17/2013 0:00
6/17/2013 12:00

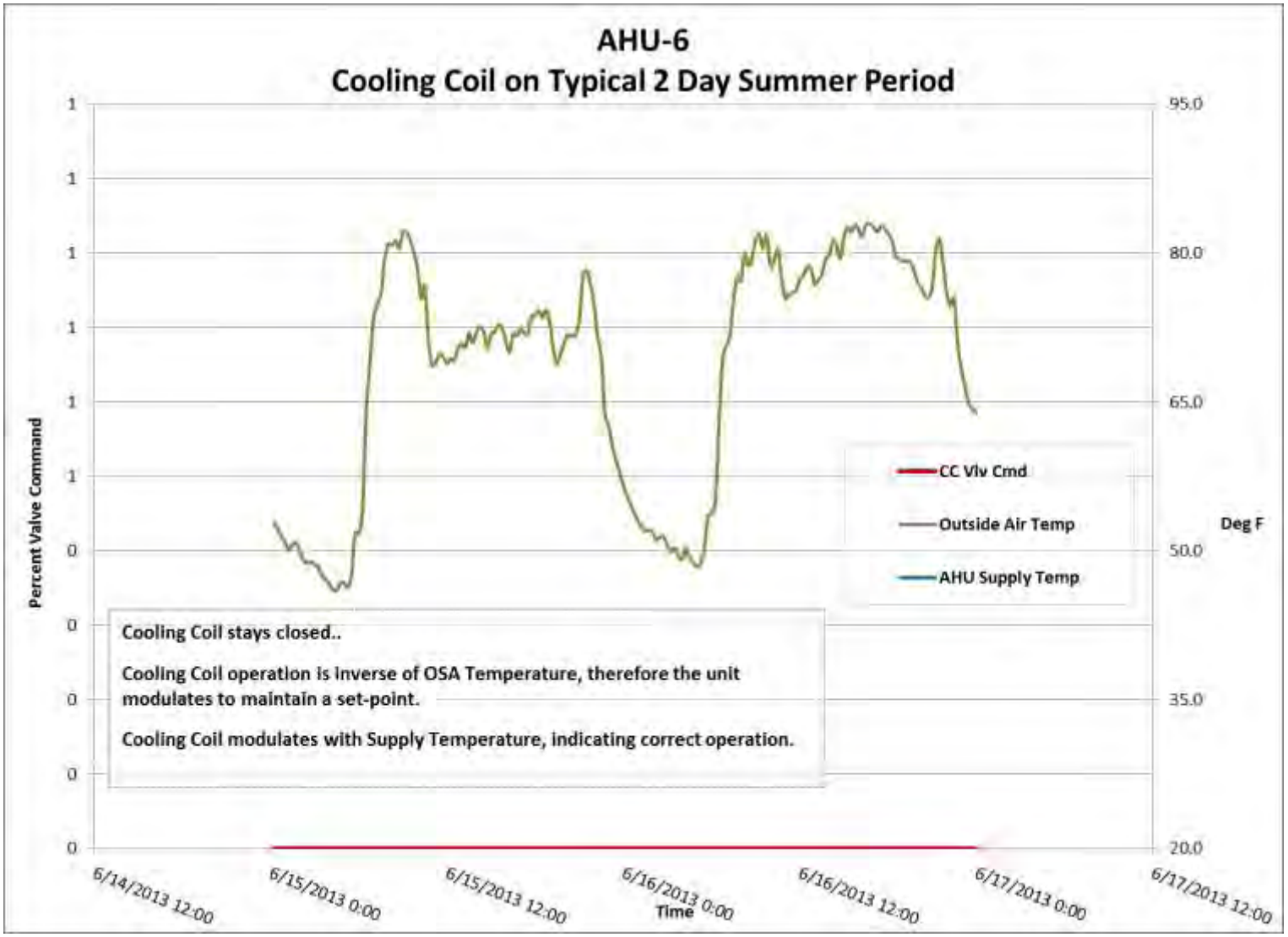
AHU 5 –Winter


AHU-5
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 7:00 PM daily. Return Fan operates from approximately 4:00 AM untill 7:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

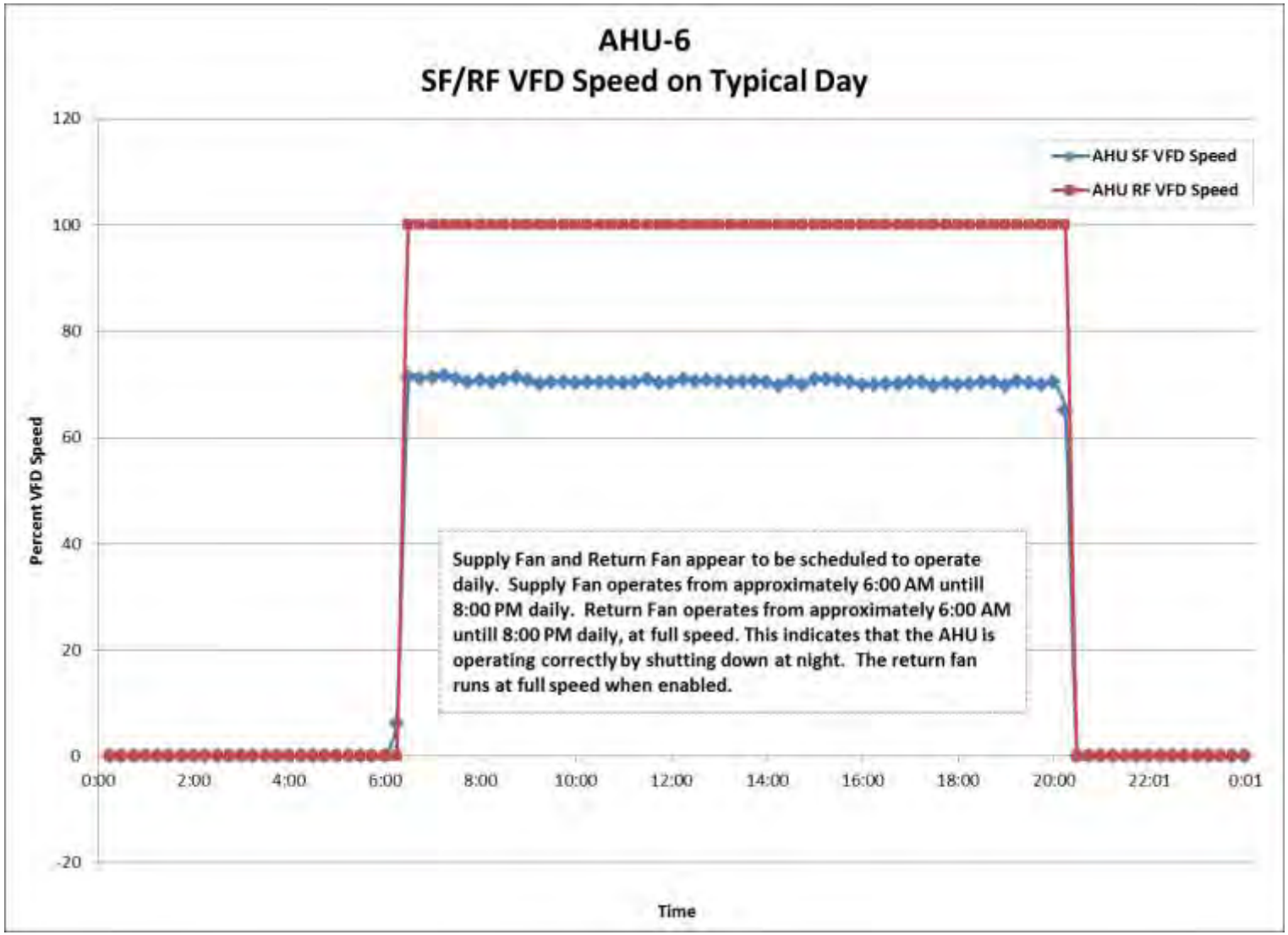

AHU-5
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
AHU-5 HC Valve Command
Outside Air Temp
AHU-5 Supply Air Temp
Time
80
70
60
50
40
30
20
10
0
90.0
75.0
60.0
45.0
30.0
15.0
0.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

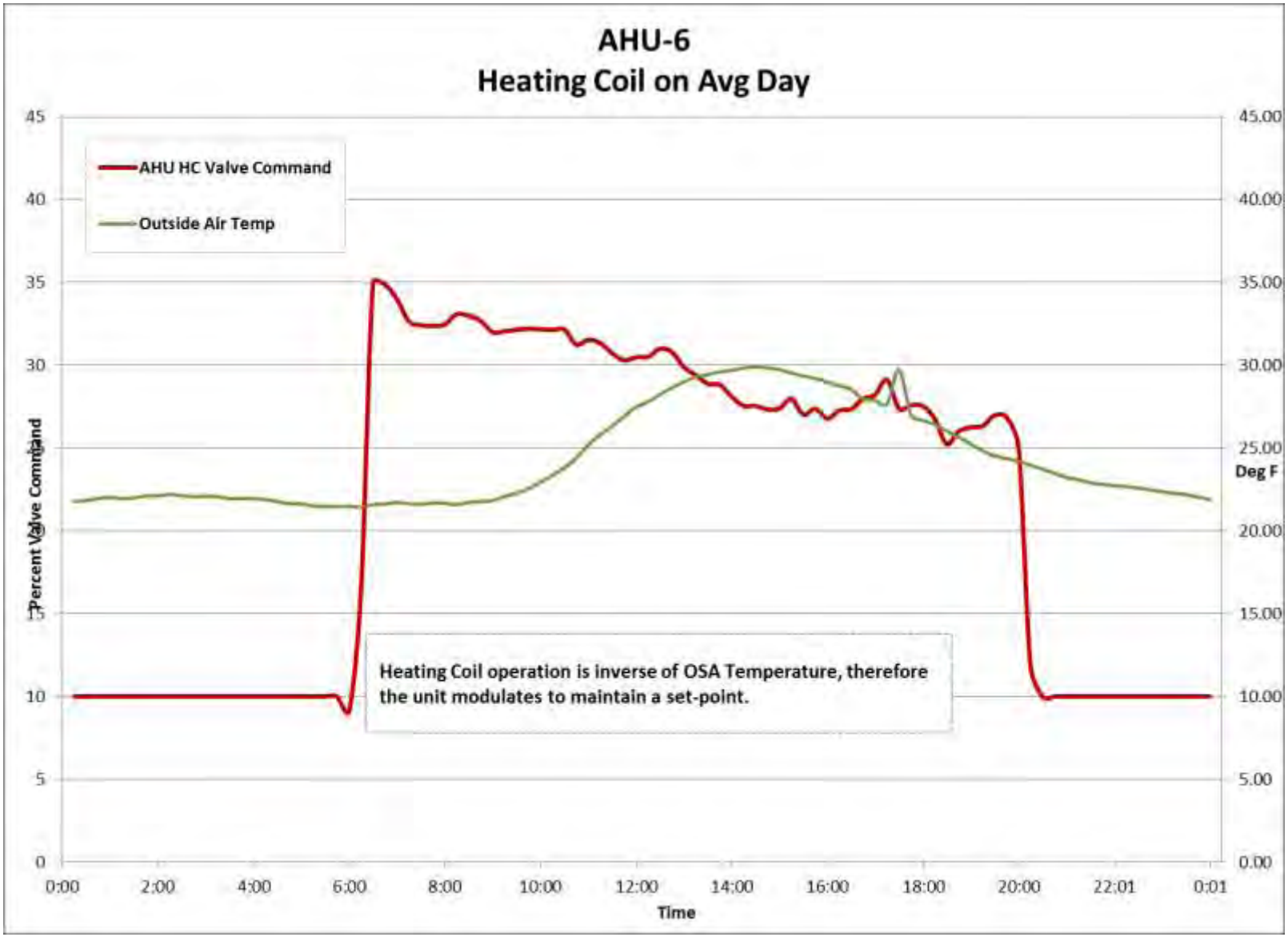
AHU 6 – Summer


AHU-6
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
80
70
60
50
40
30
20
10
0
-10
0:00
2:00
4:00
6:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 7:00 PM daily. Return Fan operates from approximately 4:00 AM untill 7:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

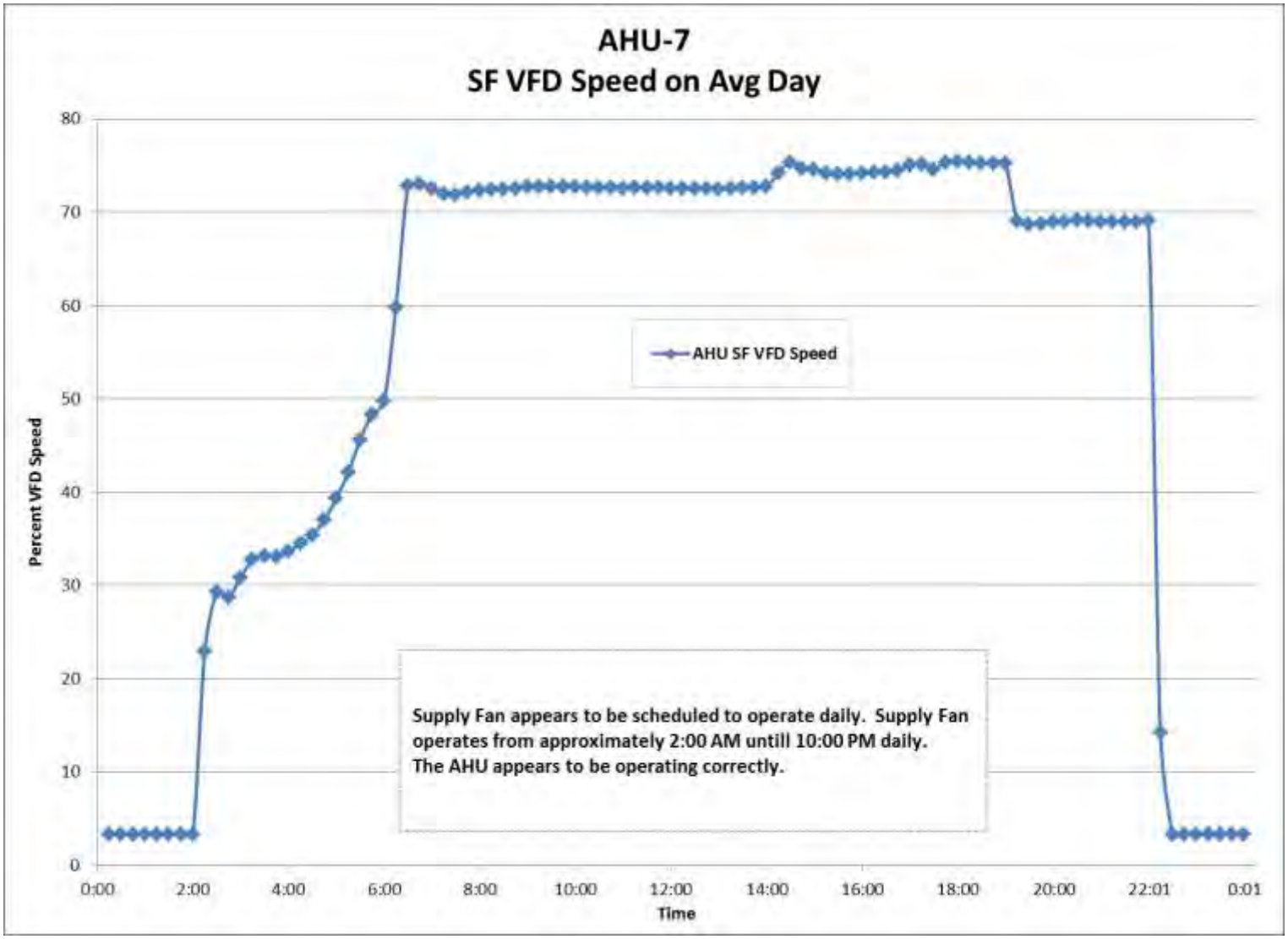

AHU-6
Cooling Coil on Typical 2 Day Summer Period
Percent Valve Command
Deg F
Time
CC Vlv Cmd
Outside Air Temp
AHU Supply Temp
Cooling Coil stays closed..
Cooling Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Cooling Coil modulates with Supply Temperature, indicating correct operation.
95.0
80.0
65.0
50.0
35.0
20.0
6/14/2013 12:00
6/15/2013 0:00
6/15/2013 12:00
6/16/2013 0:00
6/16/2013 12:00
6/17/2013 0:00
6/17/2013 12:00

AHU 6 – Winter

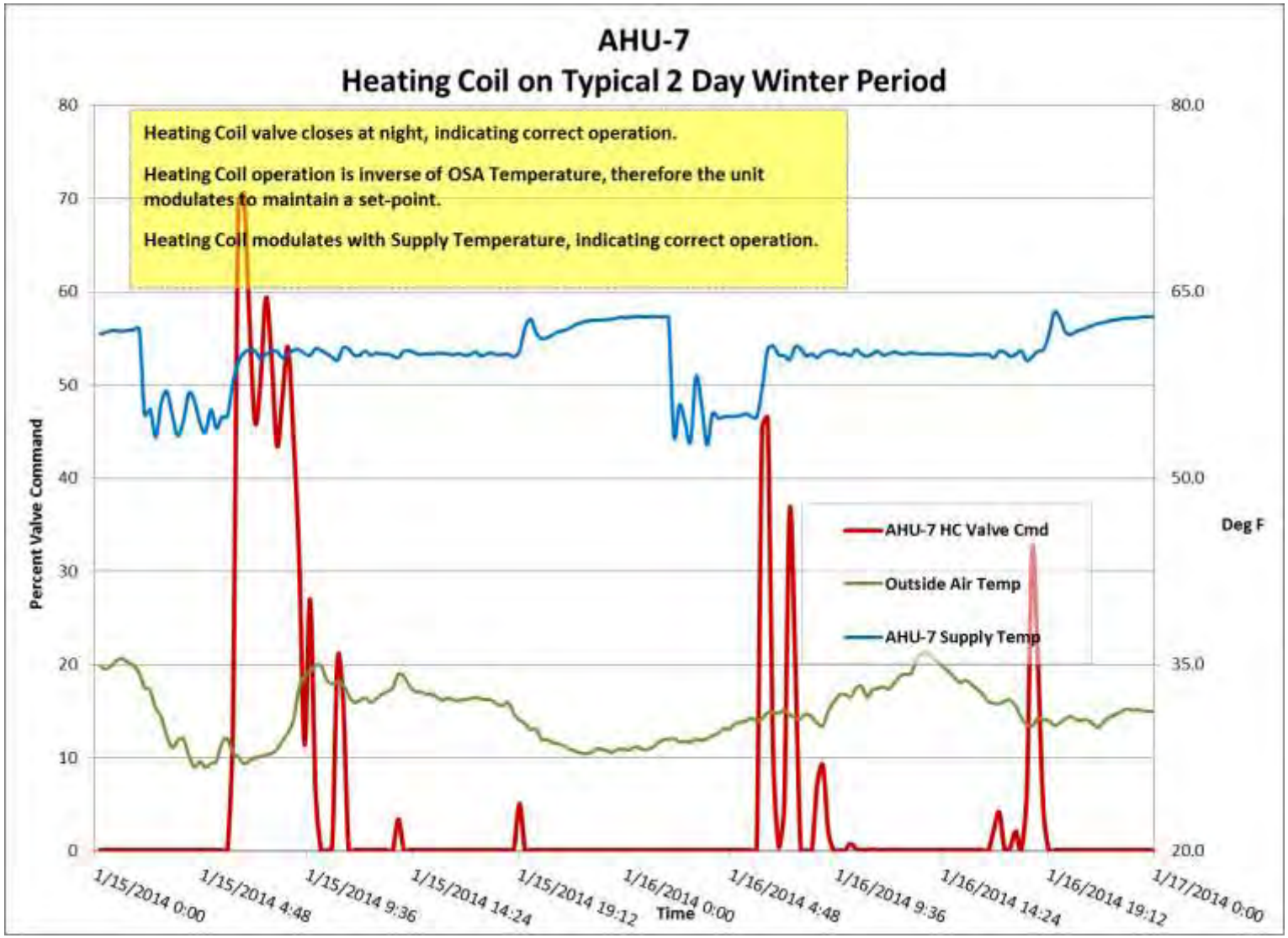

AHU-6
SF/RF VFD Speed on Typical Day
AHU SF VFD Speed
AHU RF VFD Speed
Percent VFD Speed
120
100
80
60
40
20
0
-20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 6:00 AM untill 8:00 PM daily. Return Fan operates from approximately 6:00 AM untill 8:00 PM daily, at full speed. This indicates that the AHU is operating correctly by shutting down at night. The return fan runs at full speed when enabled.


AHU-6
Heating Coil on Avg Day
AHU HC Valve Command
Outside Air Temp
Percent Valve Command
Deg F
Time
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
45
40
35
30
25
20
15
10
5
0
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

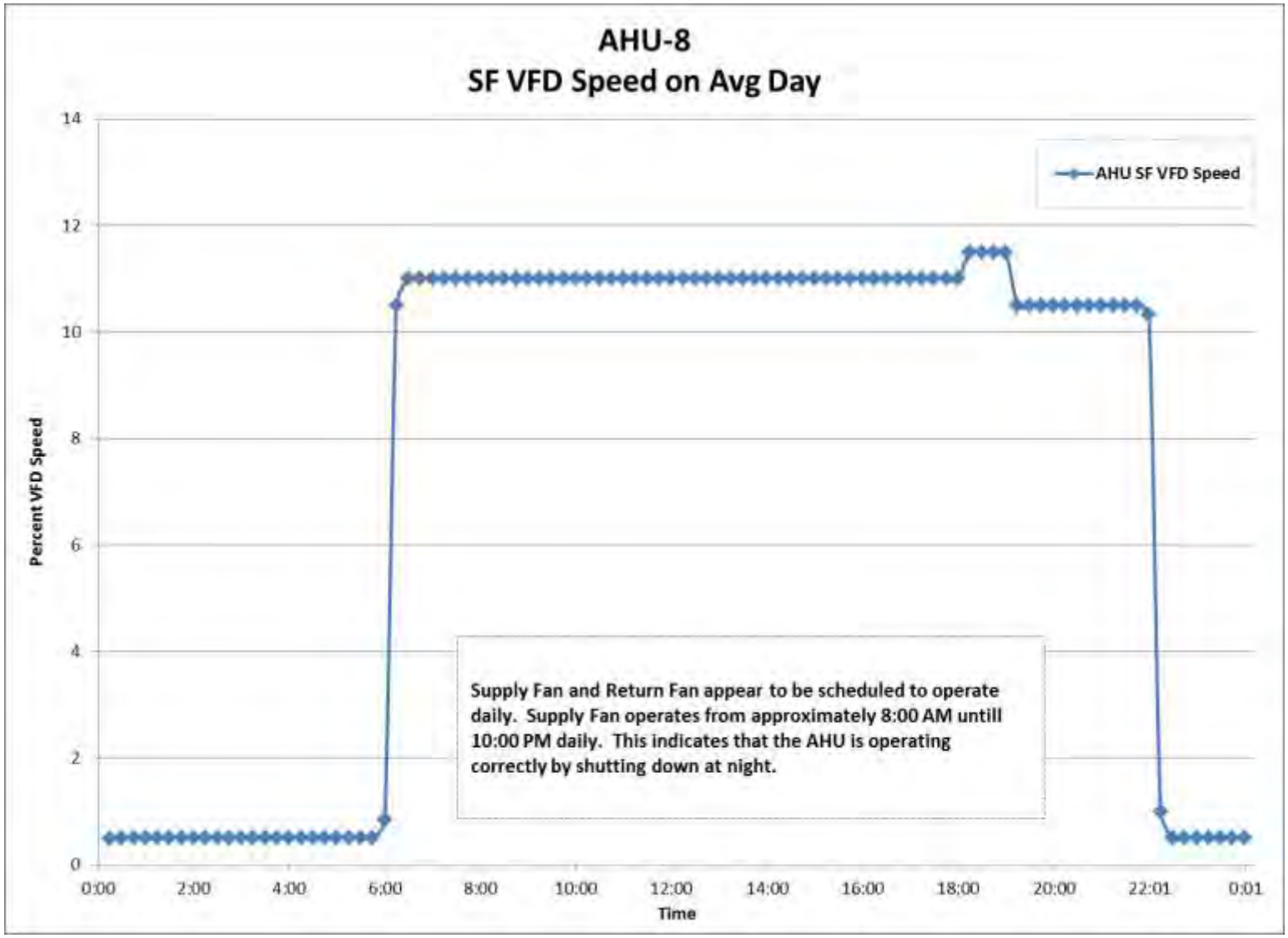
AHU 7 – Summer


AHU-7
SF VFD Speed on Avg Day
Percent VFD Speed
80
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
AHU SF VFD Speed
Supply Fan appears to be scheduled to operate daily. Supply Fan operates from approximately 2:00 AM untill 10:00 PM daily.
The AHU appears to be operating correctly.

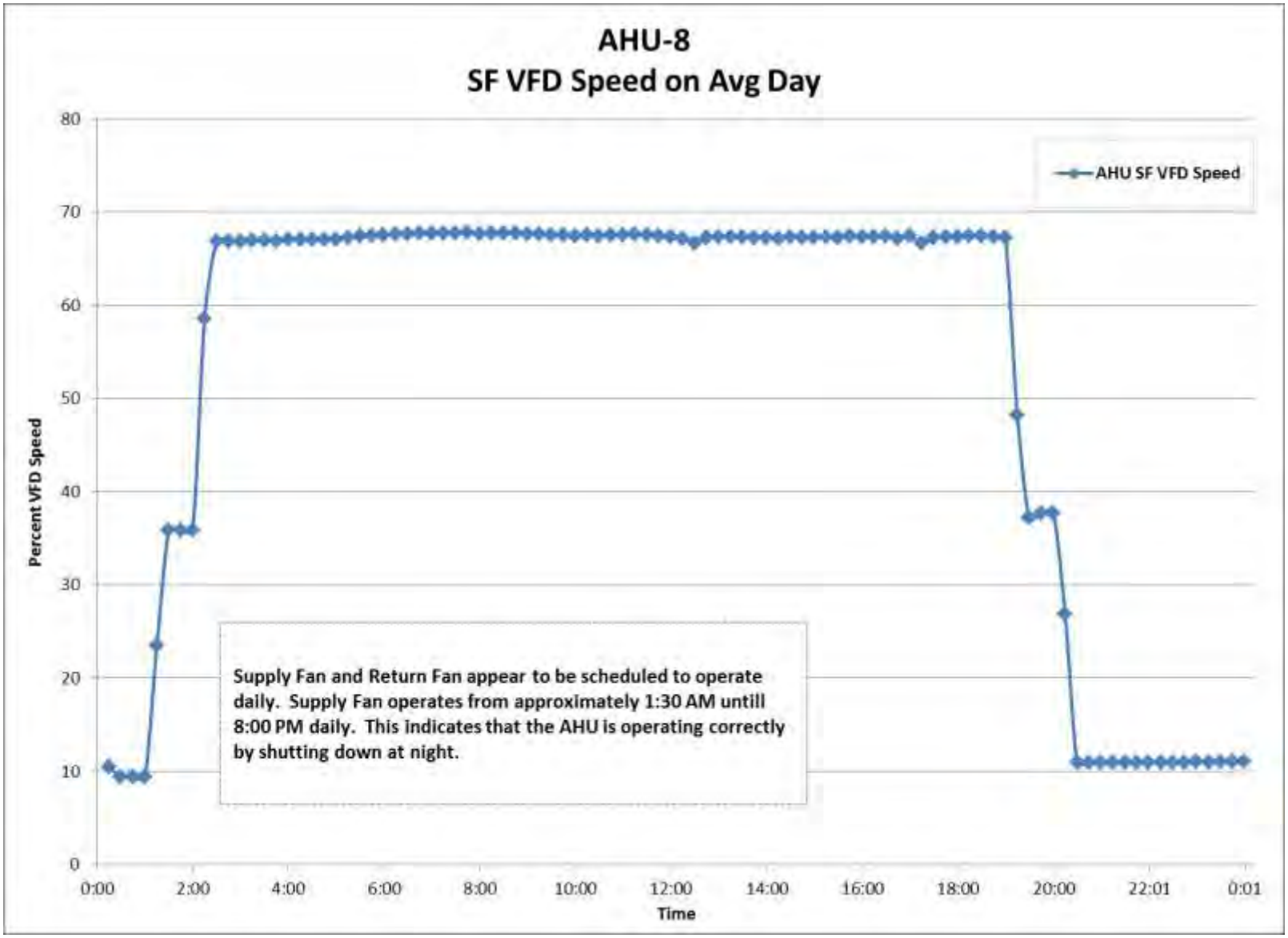
AHU 7 – Winter

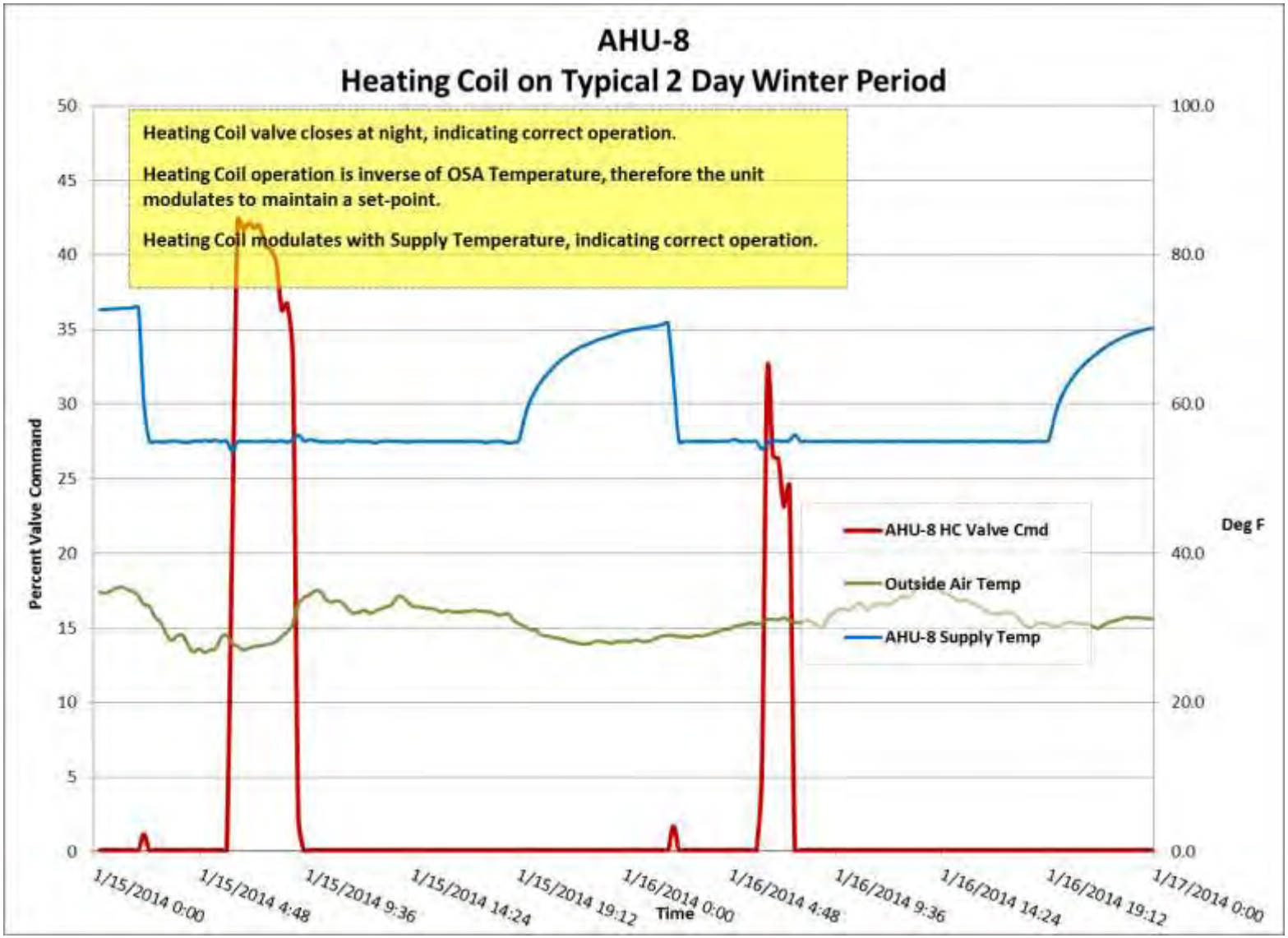

AHU-7
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
AHU-7 HC Valve Cmd
Outside Air Temp
AHU-7 Supply Temp
Time
80
70
60
50
40
30
20
10
0
80.0
65.0
50.0
35.0
20.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

AHU 8 – Summer

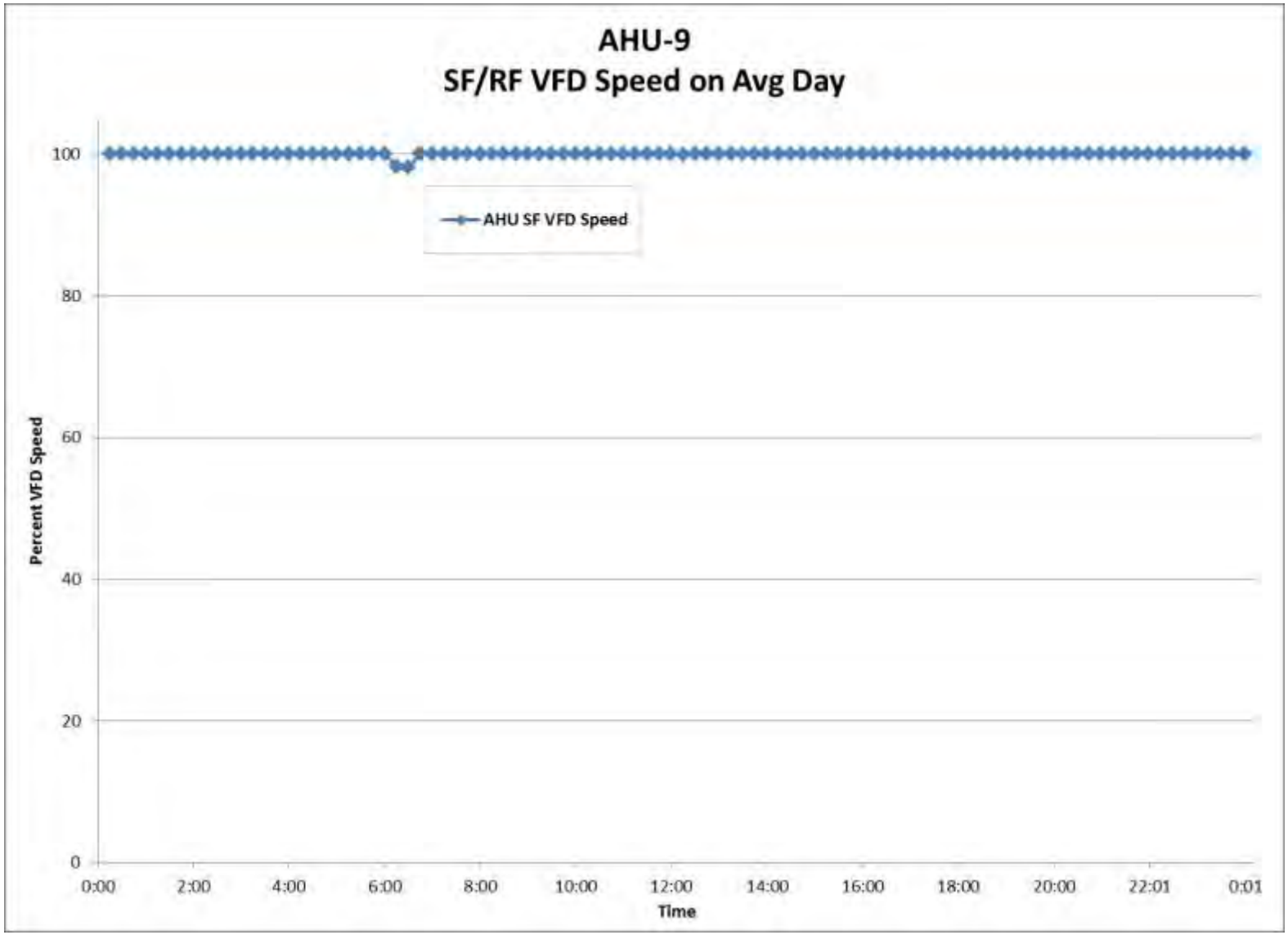

AHU-8
SF VFD Speed on Avg Day
AHU SF VFD Speed
Percent VFD Speed
14
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 8:00 AM untill 10:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

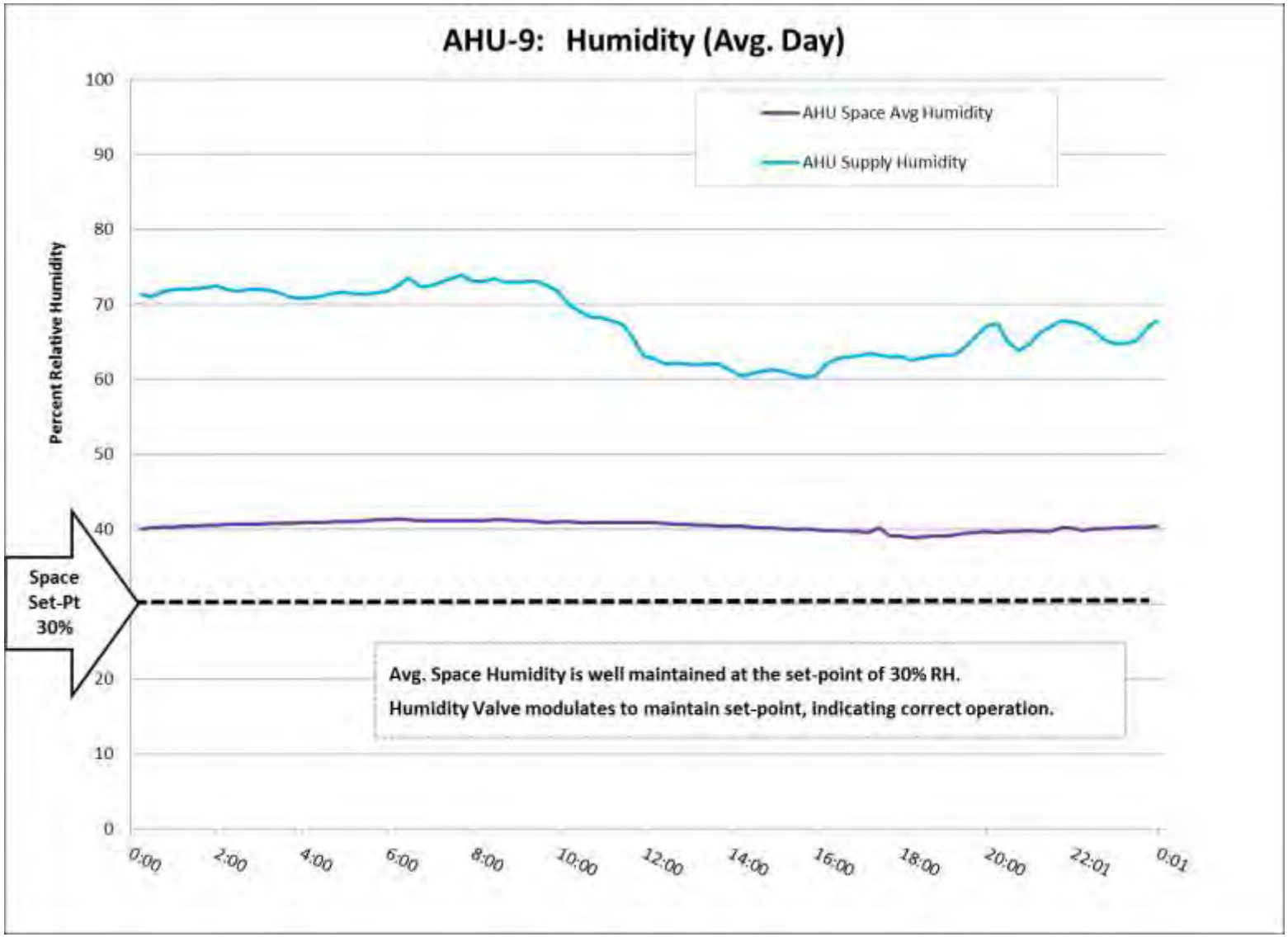
AHU 8 – Winter


AHU-8
SF VFD Speed on Avg Day
AHU SF VFD Speed
Percent VFD Speed
80
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time
Supply Fan and Return Fan appear to be scheduled to operate daily. Supply Fan operates from approximately 1:30 AM untill 8:00 PM daily. This indicates that the AHU is operating correctly by shutting down at night.

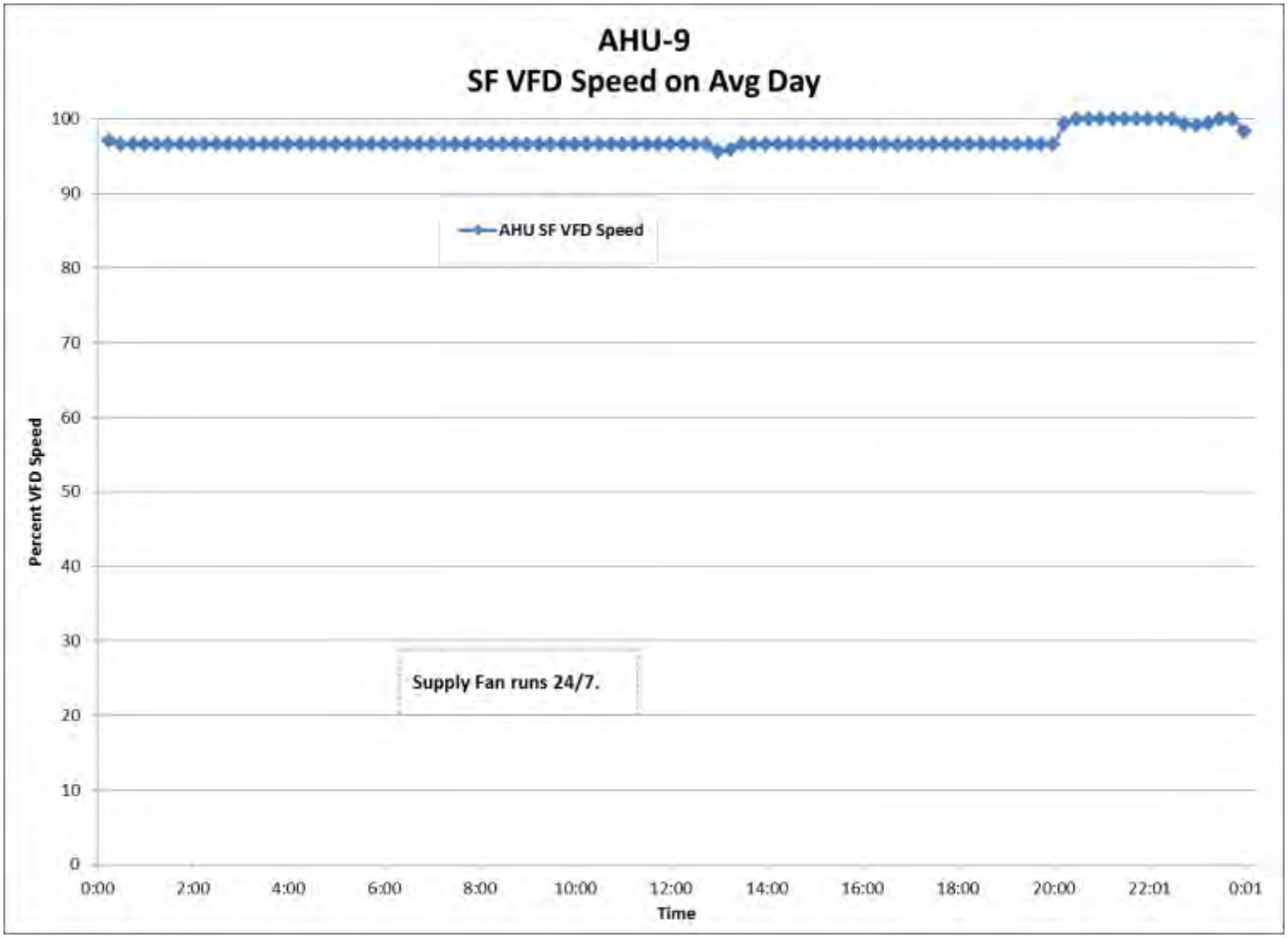

AHU-8
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
AHU-8 HC Valve Cmd
Outside Air Temp
AHU-8 Supply Temp
Time
50
45
40
35
30
25
20
15
10
5
0
100.0
80.0
60.0
40.0
20.0
0.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

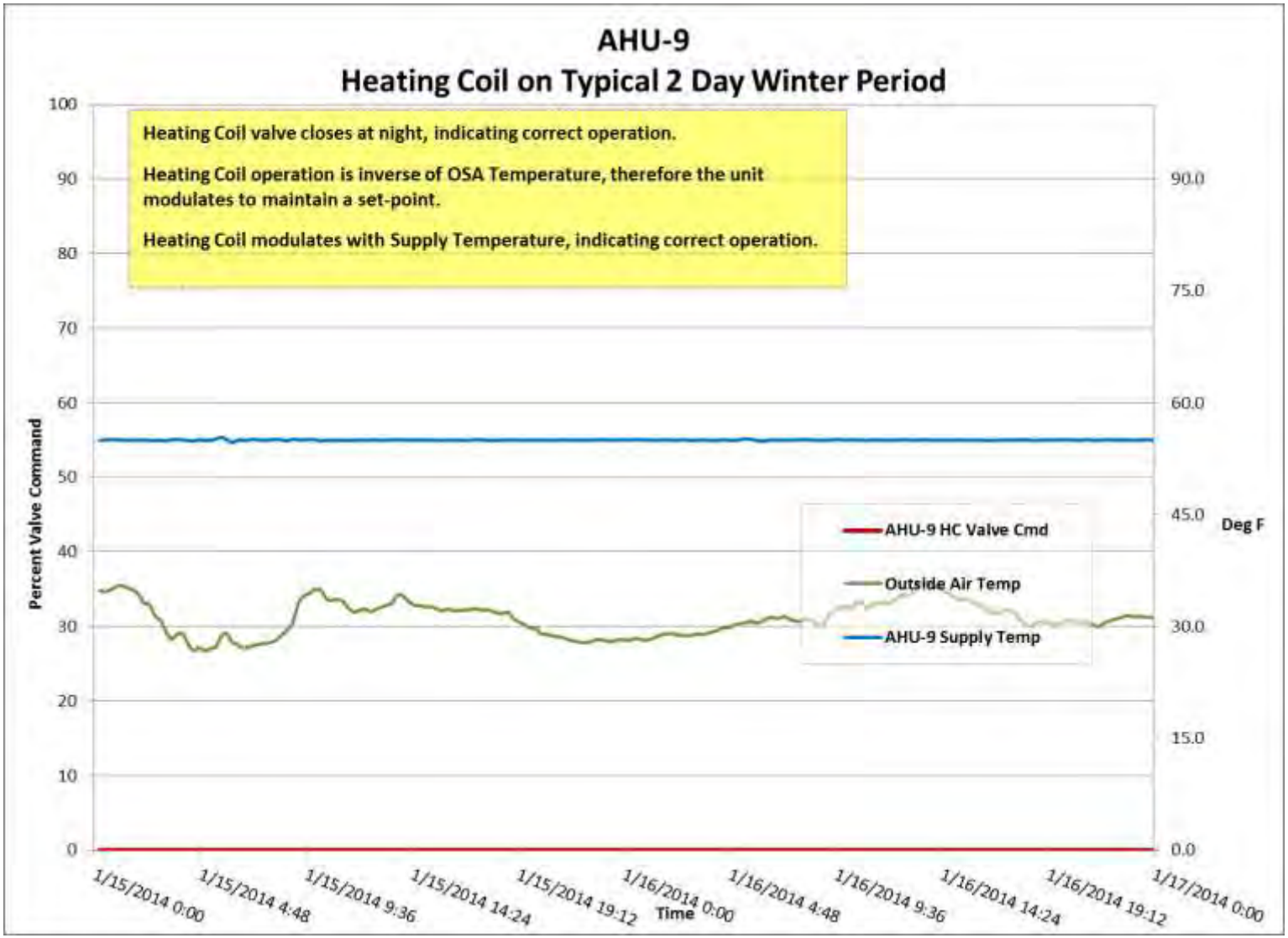
AHU 9 – Summer

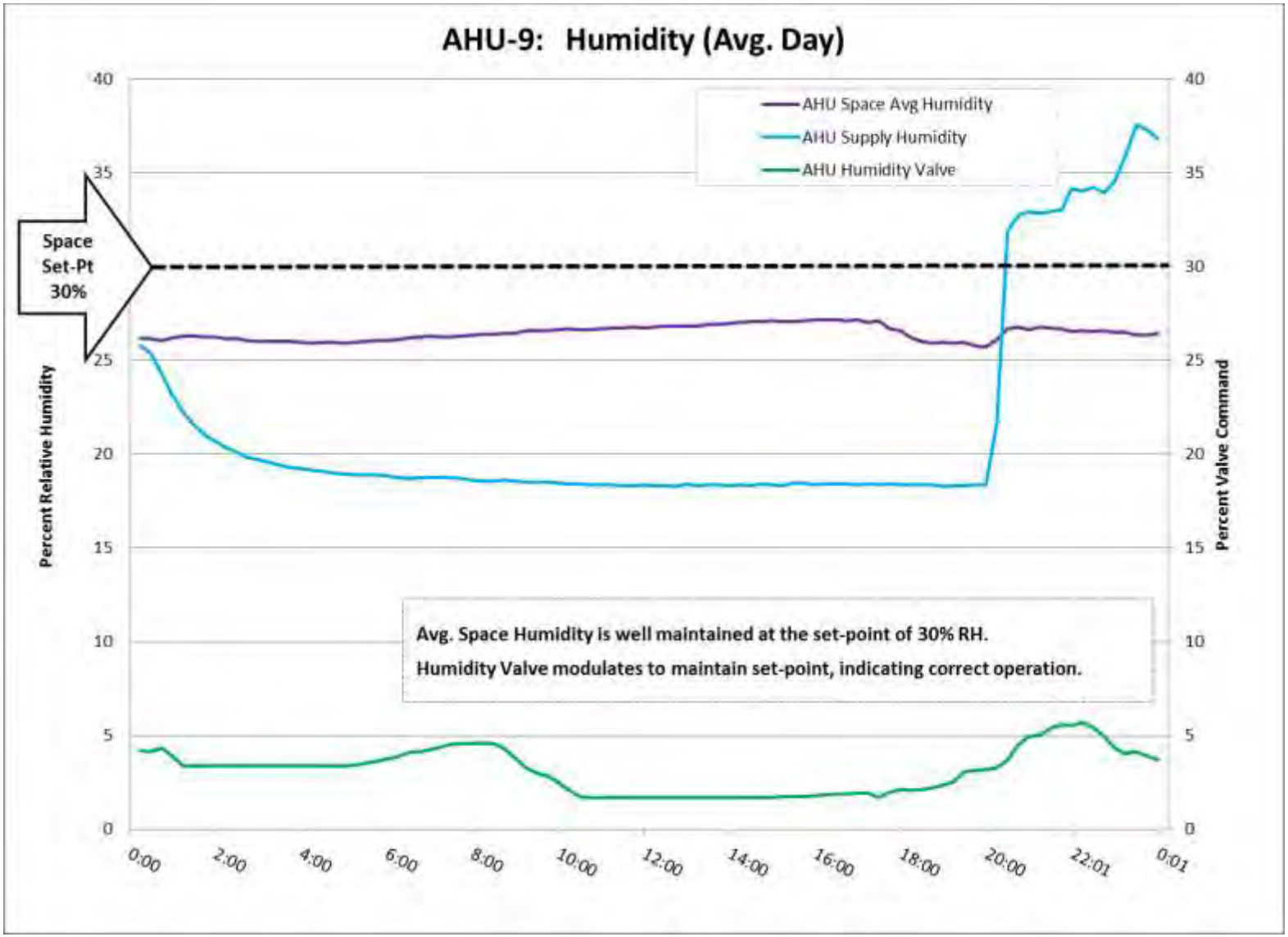

AHU-9
SF/RF VFD Speed on Avg Day
AHU SF VFD Speed
Percent VFD Speed
100
80
60
40
20
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time


AHU-9: Humidity (Avg. Day)
AHU Space Avg Humidity
AHU Supply Humidity
Percent Relative Humidity
100
90
80
70
60
50
40
20
10
0
Space Set-Pt 30%
Avg. Space Humidity is well maintained at the set-point of 30% RH.
Humidity Valve modulates to maintain set-point, indicating correct operation.
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

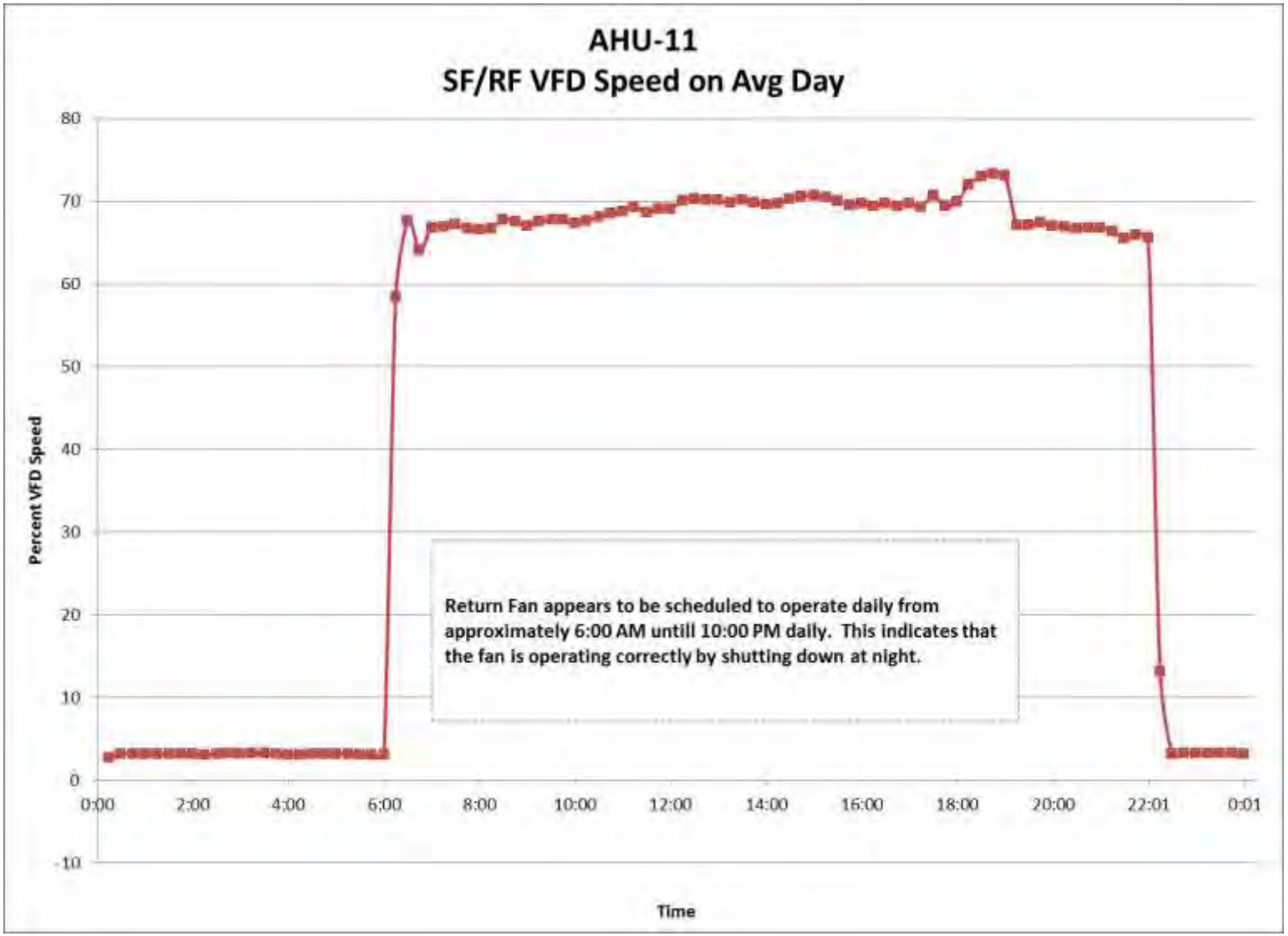
AHU 9 – Winter

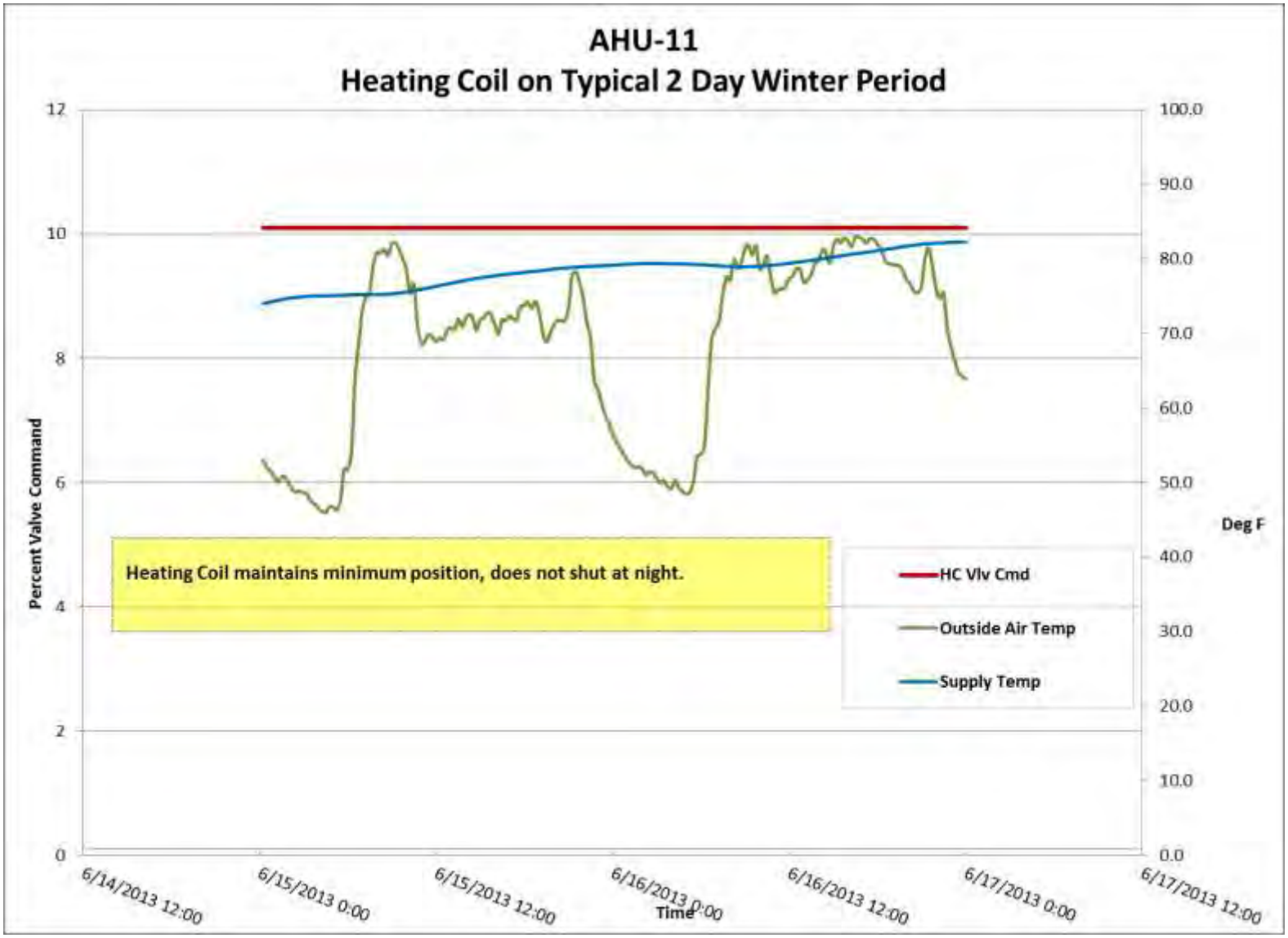

AHU-9
SF VFD Speed on Avg Day
AHU SF VFD Speed
Supply Fan runs 24/7.
Percent VFD Speed
100
90
80
70
60
50
40
30
20
10
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01
Time


AHU-9
Heating Coil on Typical 2 Day Winter Period
Heating Coil valve closes at night, indicating correct operation.
Heating Coil operation is inverse of OSA Temperature, therefore the unit modulates to maintain a set-point.
Heating Coil modulates with Supply Temperature, indicating correct operation.
Percent Valve Command
Deg F
AHU-9 HC Valve Cmd
Outside Air Temp
AHU-9 Supply Temp
Time
100
90
80
70
60
50
40
30
20
10
0
90.0
75.0
60.0
45.0
30.0
15.0
0.0
1/15/2014 0:00
1/15/2014 4:48
1/15/2014 9:36
1/15/2014 14:24
1/15/2014 19:12
1/16/2014 0:00
1/16/2014 4:48
1/16/2014 9:36
1/16/2014 14:24
1/16/2014 19:12
1/17/2014 0:00

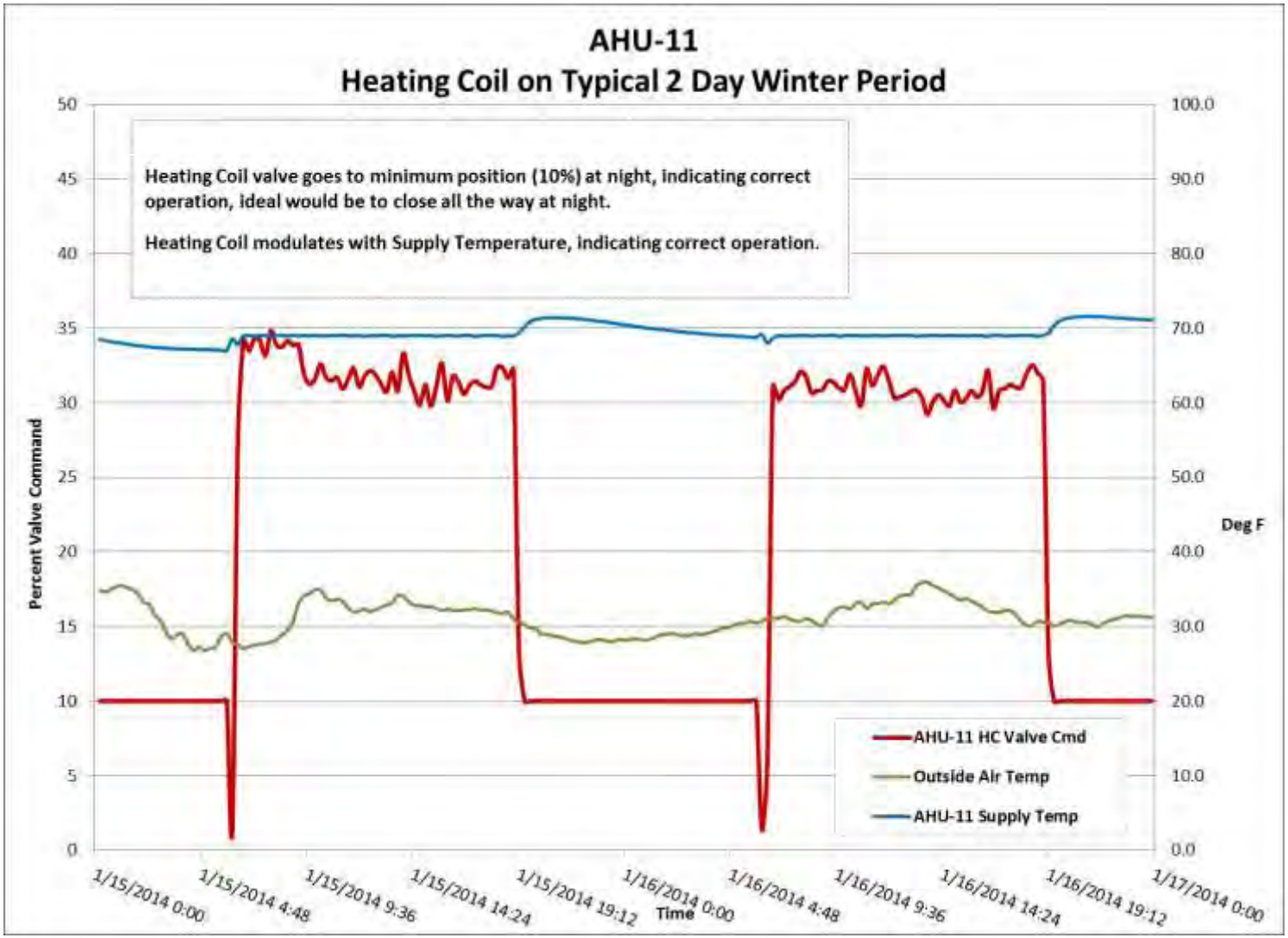

AHU-9: Humidity (Avg. Day)
AHU Space Avg Humidity
AHU Supply Humidity
AHU Humidity Valve
Space Set-Pt 30%
Percent Relative Humidity
Percent Valve Command
Avg. Space Humidity is well maintained at the set-point of 30% RH.
Humidity Valve modulates to maintain set-point, indicating correct operation.
40
35
30
25
20
15
10
5
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01
0:01

AHU 11 – Summer

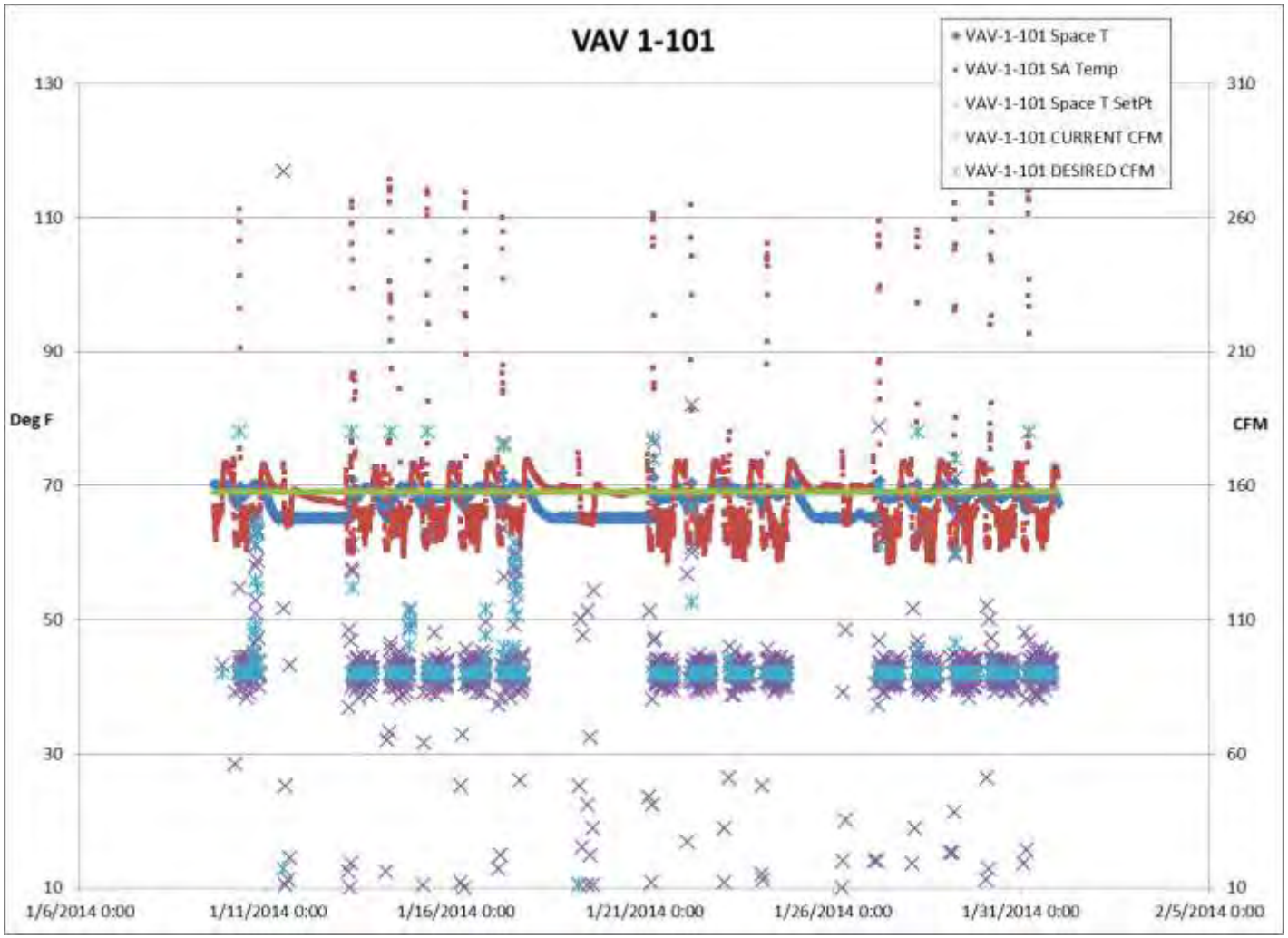


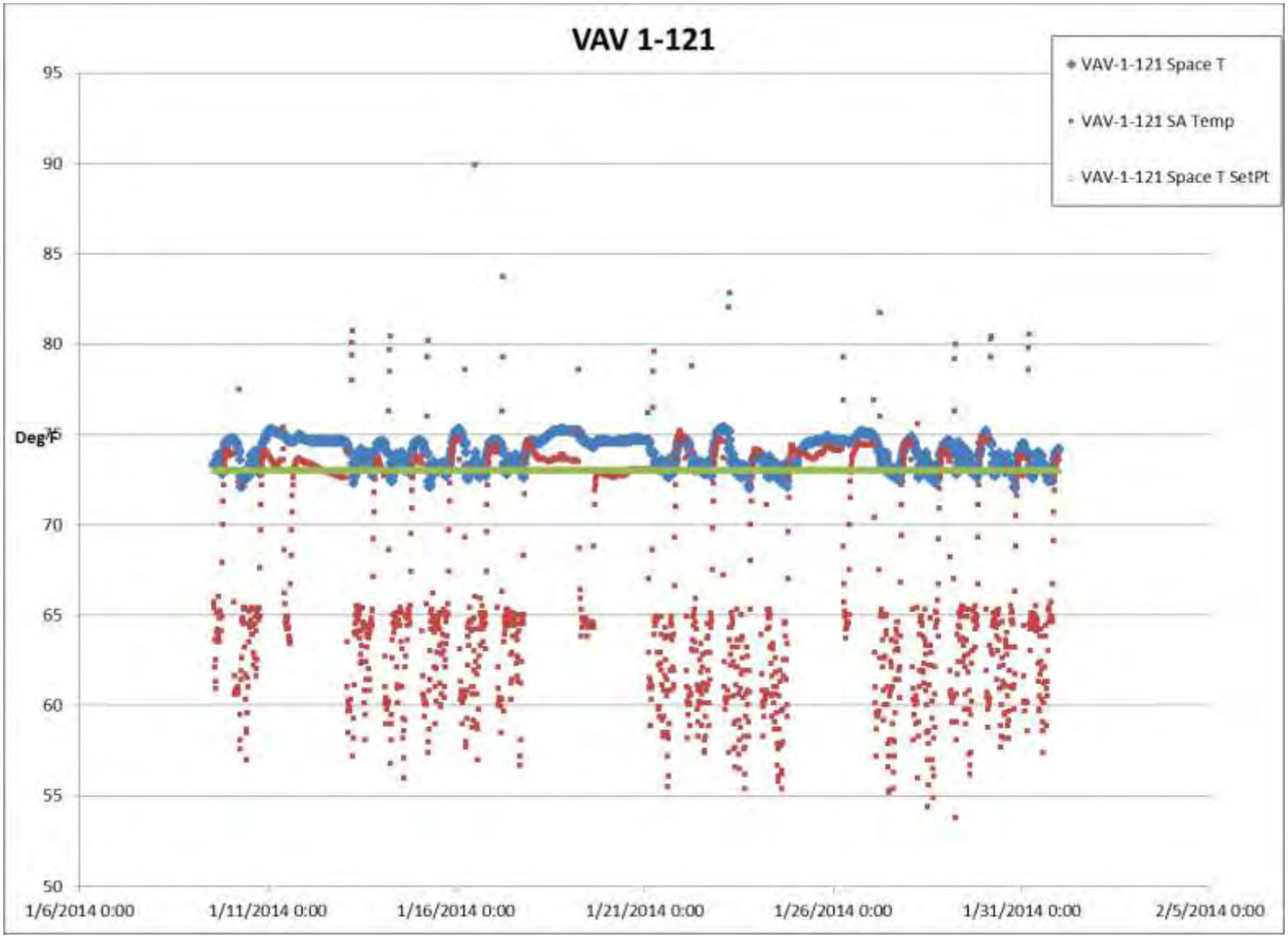

AHU-11
Heating Coil on Typical 2 Day Winter Period
Percent Valve Command
Deg F
Time
Heating Coil maintains minimum position, does not shut at night.
HC Vlv Cmd
Outside Air Temp
Supply Temp
12
10
8
6
4
2
0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
6/14/2013 12:00
6/15/2013 0:00
6/15/2013 12:00
6/16/2013 0:00
6/16/2013 12:00
6/17/2013 0:00
6/17/2013 12:00

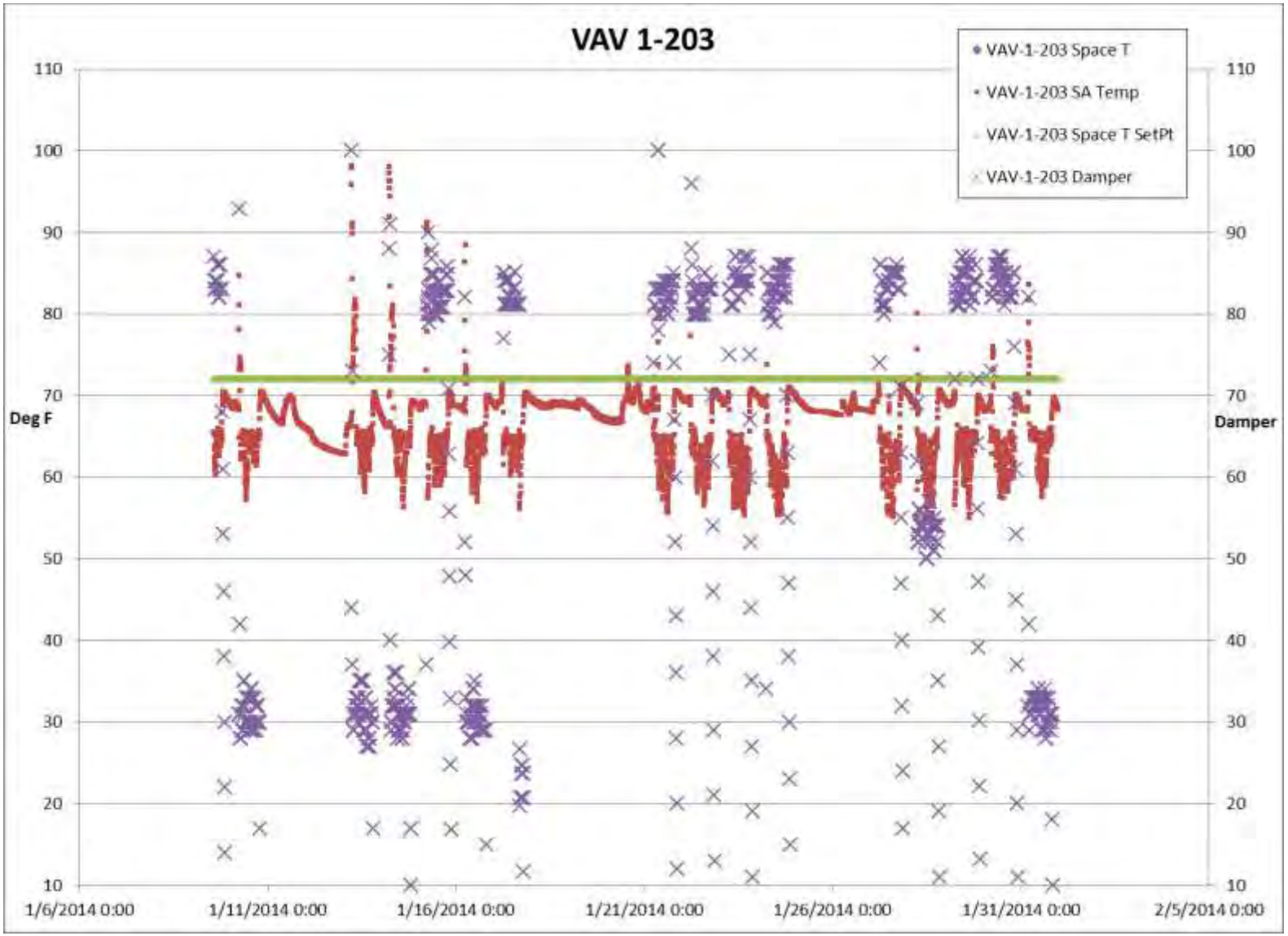
AHU 11 – Winter

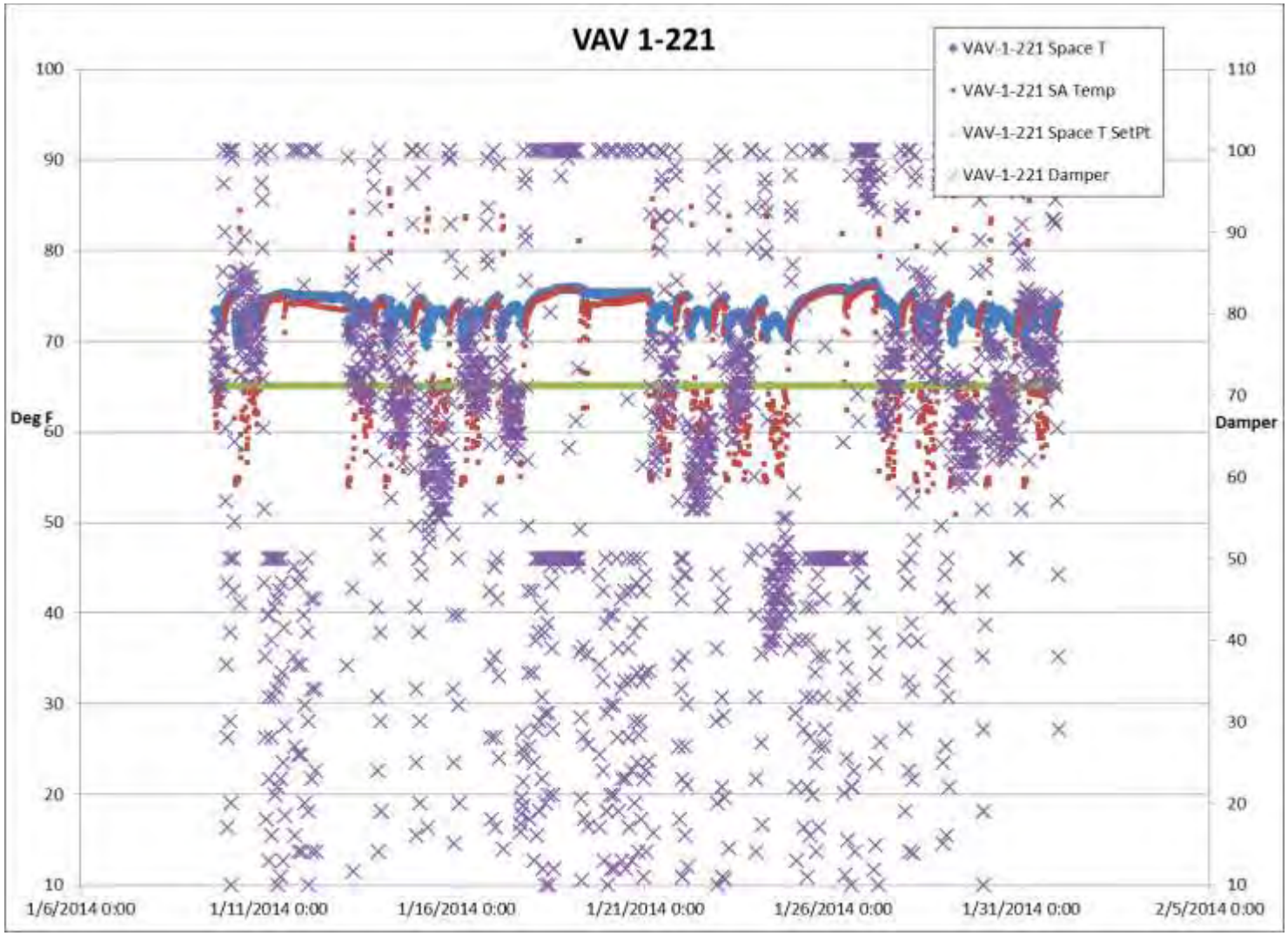


VAV Terminal Units




VAV 1-121
VAV-1-121 Space T
VAV-1-121 SA Temp
VAV-1-121 Space T SetPt
Deg F
95
90
85
80
75
70
65
60
55
50
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00


VAV 1-203
VAV-1-203 Space T
VAV-1-203 SA Temp
VAV-1-203 Space T SetPt
VAV-1-203 Damper
Deg F
Damper
110
100
90
80
70
60
50
40
30
20
10
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00


VAV 1-221
VAV-1-221 Space T
VAV-1-221 SA Temp
VAV-1-221 Space T SetPt
VAV-1-221 Damper
Deg F
Damper
100
90
80
70
60
50
40
30
20
10
110
100
90
80
70
60
50
40
30
20
10
1/6/2014 0:00
1/11/2014 0:00
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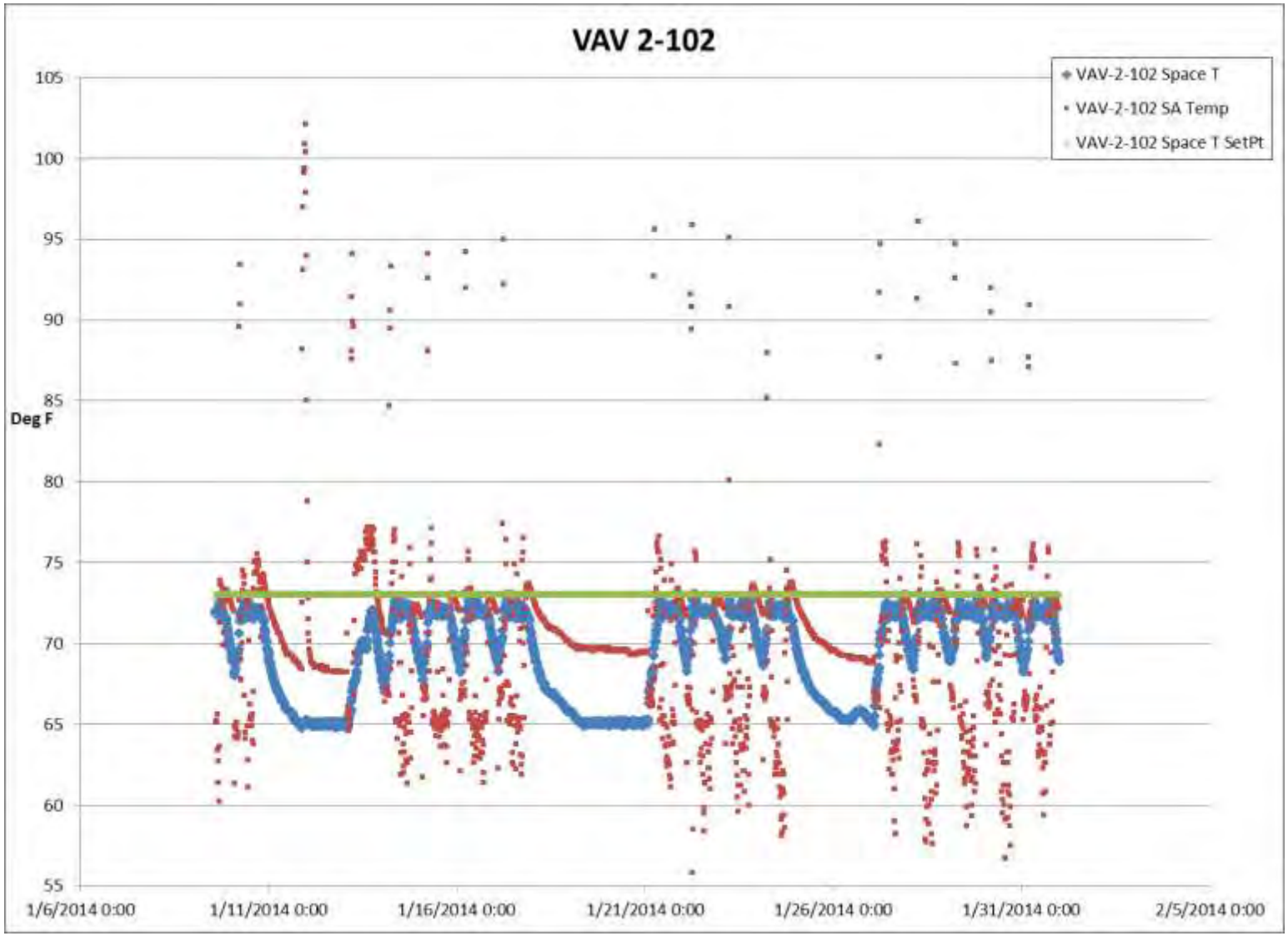
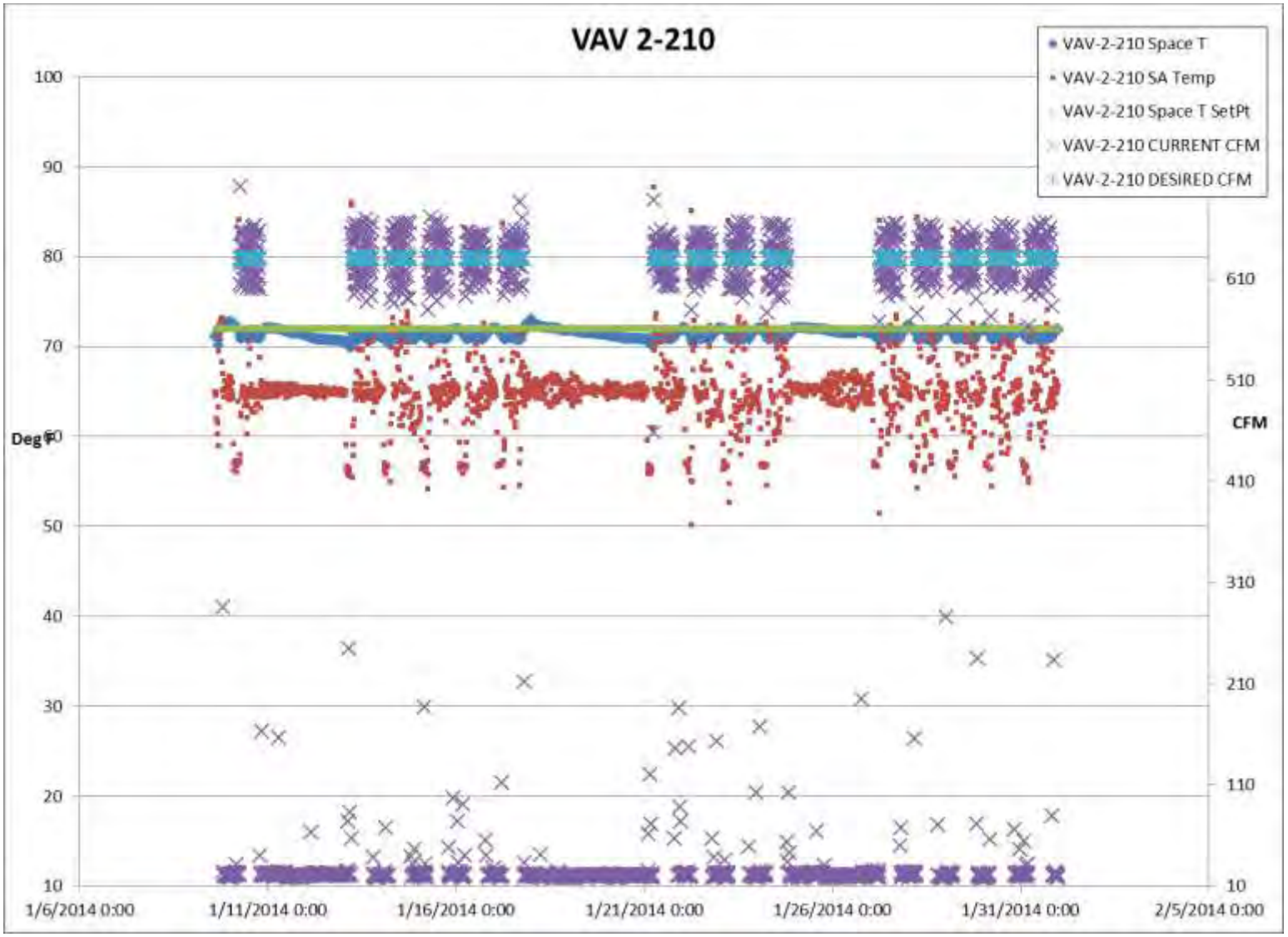

VAV 2-102
VAV-2-102 Space T
VAV-2-102 SA Temp
VAV-2-102 Space T SetPt
Deg F
105
100
95
90
85
80
75
70
65
60
55
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00


VAV 2-210
VAV-2-210 Space T
VAV-2-210 SA Temp
VAV-2-210 Space T SetPt
VAV-2-210 CURRENT CFM
VAV-2-210 DESIRED CFM
Deg F
CFM
100
90
80
70
60
50
40
30
20
10
610
510
410
310
210
110
10
1/6/2014 0:00
1/11/2014 0:00
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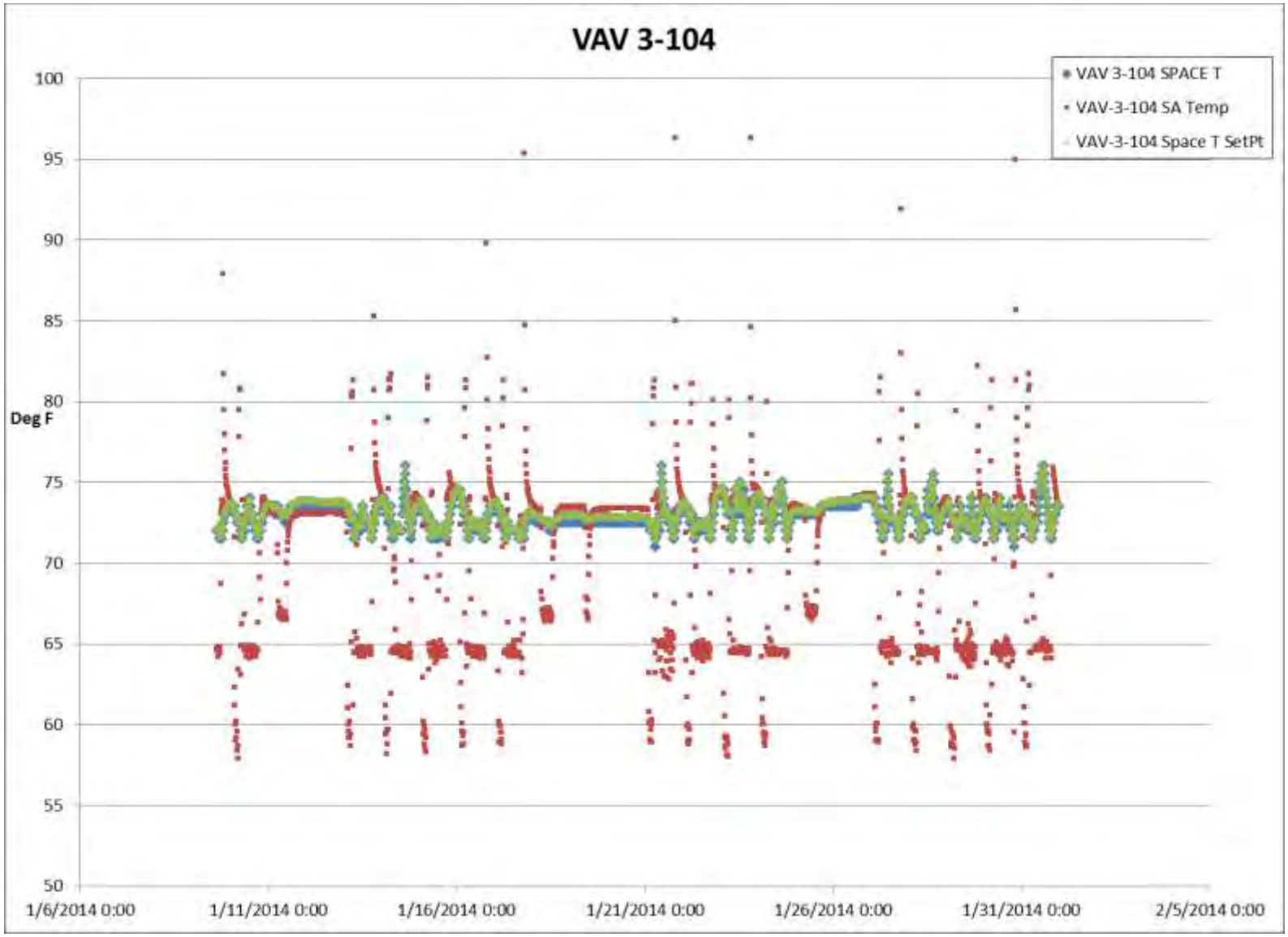
1/31/2014 0:00
2/5/2014 0:00


VAV 3-104
VAV 3-104 SPACE T
VAV-3-104 SA Temp
VAV-3-104 Space T SetPt
Deg F
100
95
90
85
80
75
70
65
60
55
50
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
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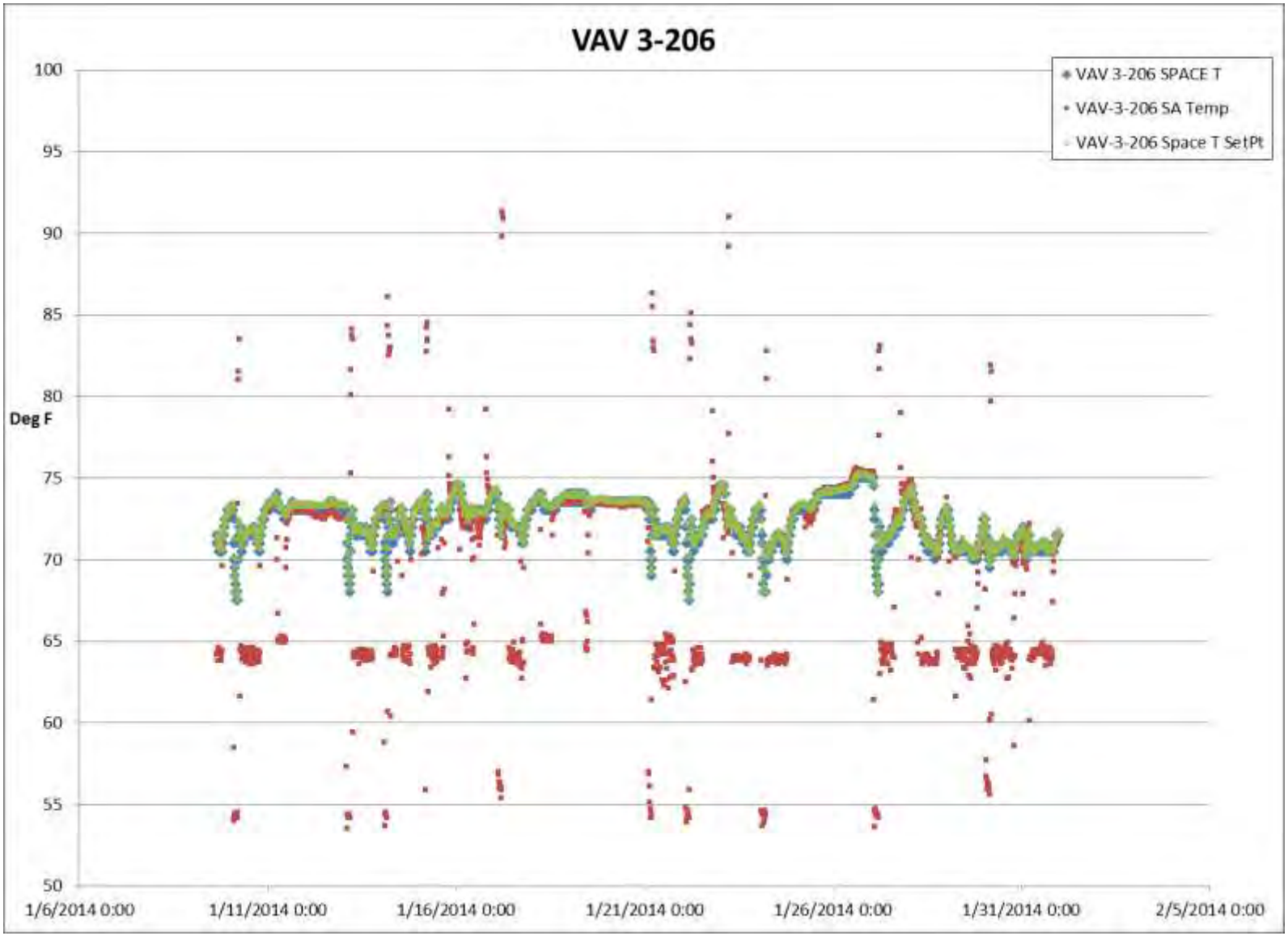
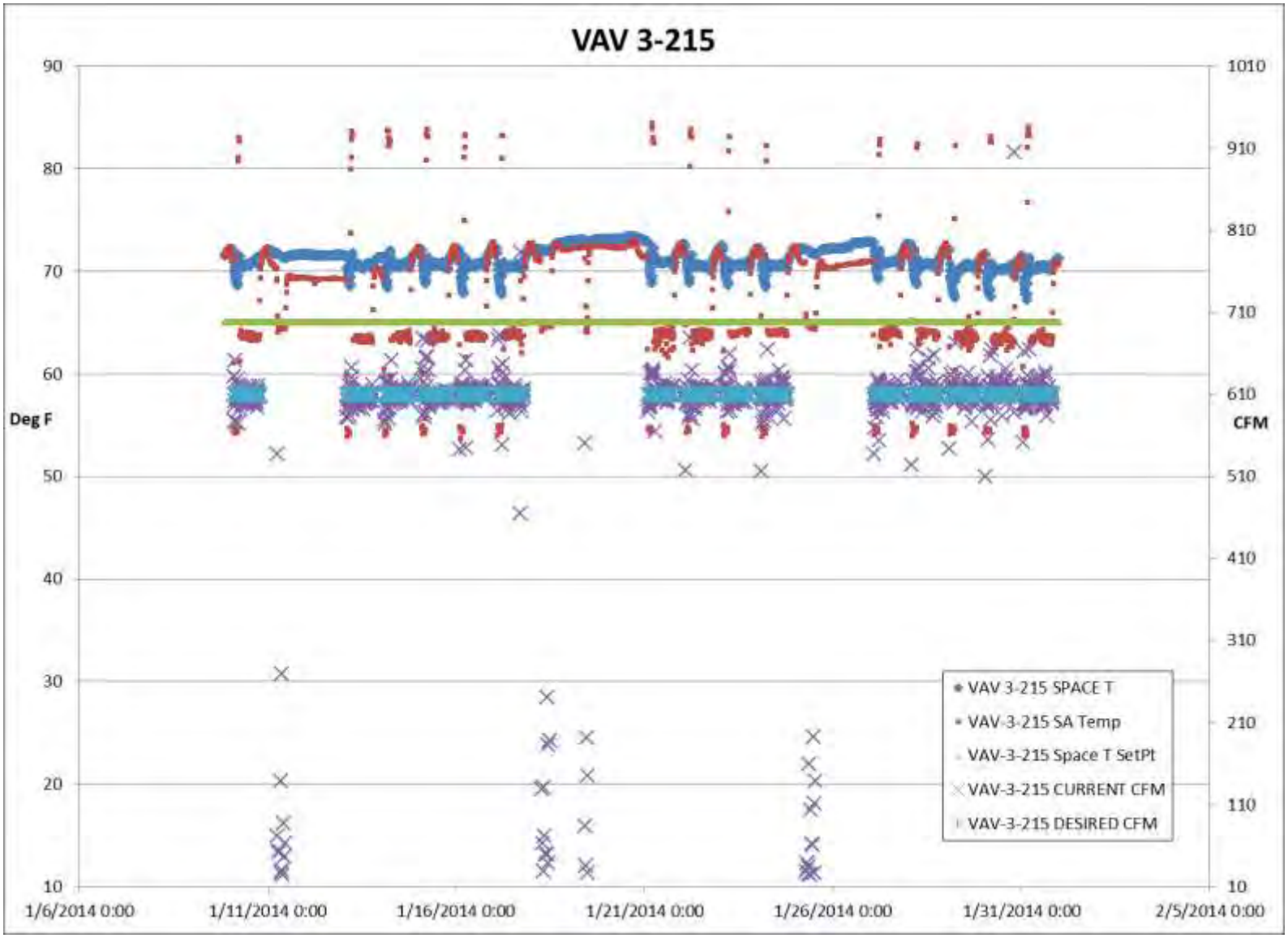
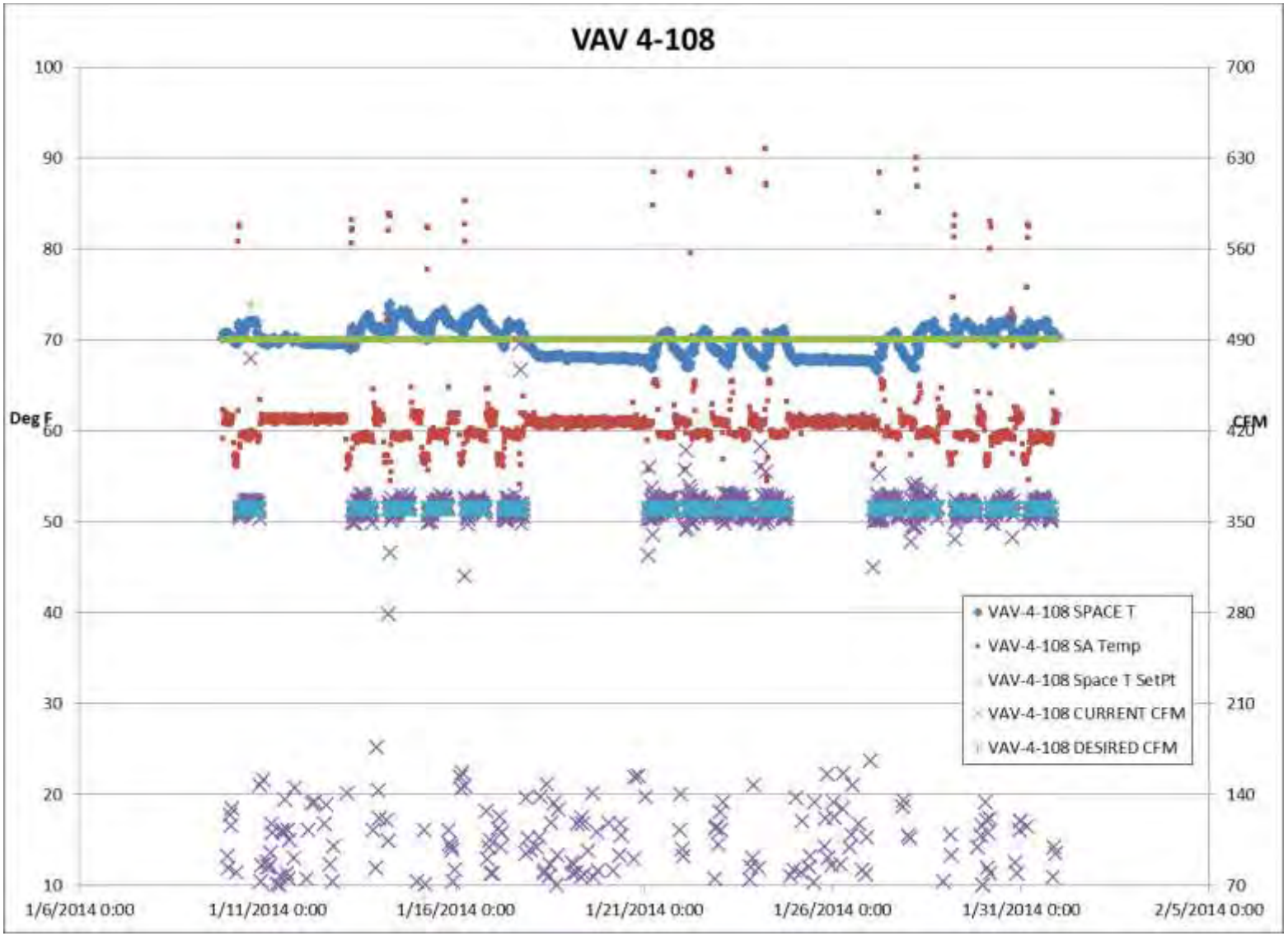
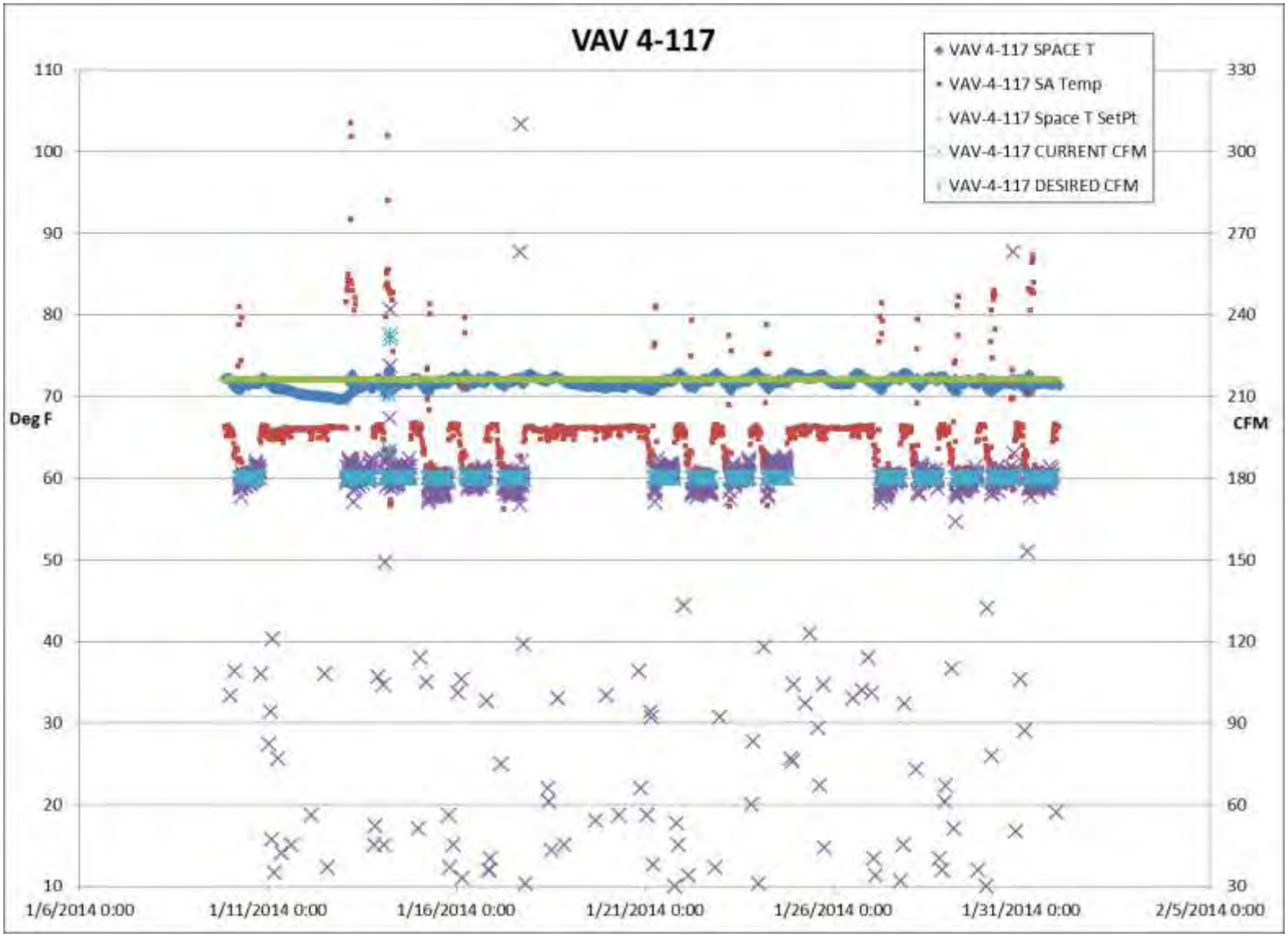
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00


VAV 3-206
VAV 3-206 SPACE T
VAV-3-206 SA Temp
VAV-3-206 Space T SetPt
Deg F
100
95
90
85
80
75
70
65
60
55
50
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00


VAV 3-215
Deg F
CFM
90
80
70
60
50
40
30
20
10
1010
910
810
710
610
510
410
310
210
110
10
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
VAV 3-215 SPACE T
VAV-3-215 SA Temp
VAV-3-215 Space T SetPt
VAV-3-215 CURRENT CFM
VAV-3-215 DESIRED CFM


VAV 4-108
Deg F
CFM
100
90
80
70
60
50
40
30
20
10
700
630
560
490
420
350
280
210
140
70
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
VAV-4-108 SPACE T
VAV-4-108 SA Temp
VAV-4-108 Space T SetPt
VAV-4-108 CURRENT CFM
VAV-4-108 DESIRED CFM

VAV 4-109
Deg F
CFM
100
90
80
70
60
50
40
30
20
10
2510
2010
1510
1010
510
10
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
VAV-4-109 SPACE T
VAV-4-109 SA Temp
VAV-4-109 Space T SetPt
VAV-4-109 CURRENT CFM
VAV-4-109 DESIRED CFM


VAV 4-117
VAV 4-117 SPACE T
VAV-4-117 SA Temp
VAV-4-117 Space T SetPt
VAV-4-117 CURRENT CFM
VAV-4-117 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
330
300
270
240
210
180
150
120
90
60
30
1/6/2014 0:00
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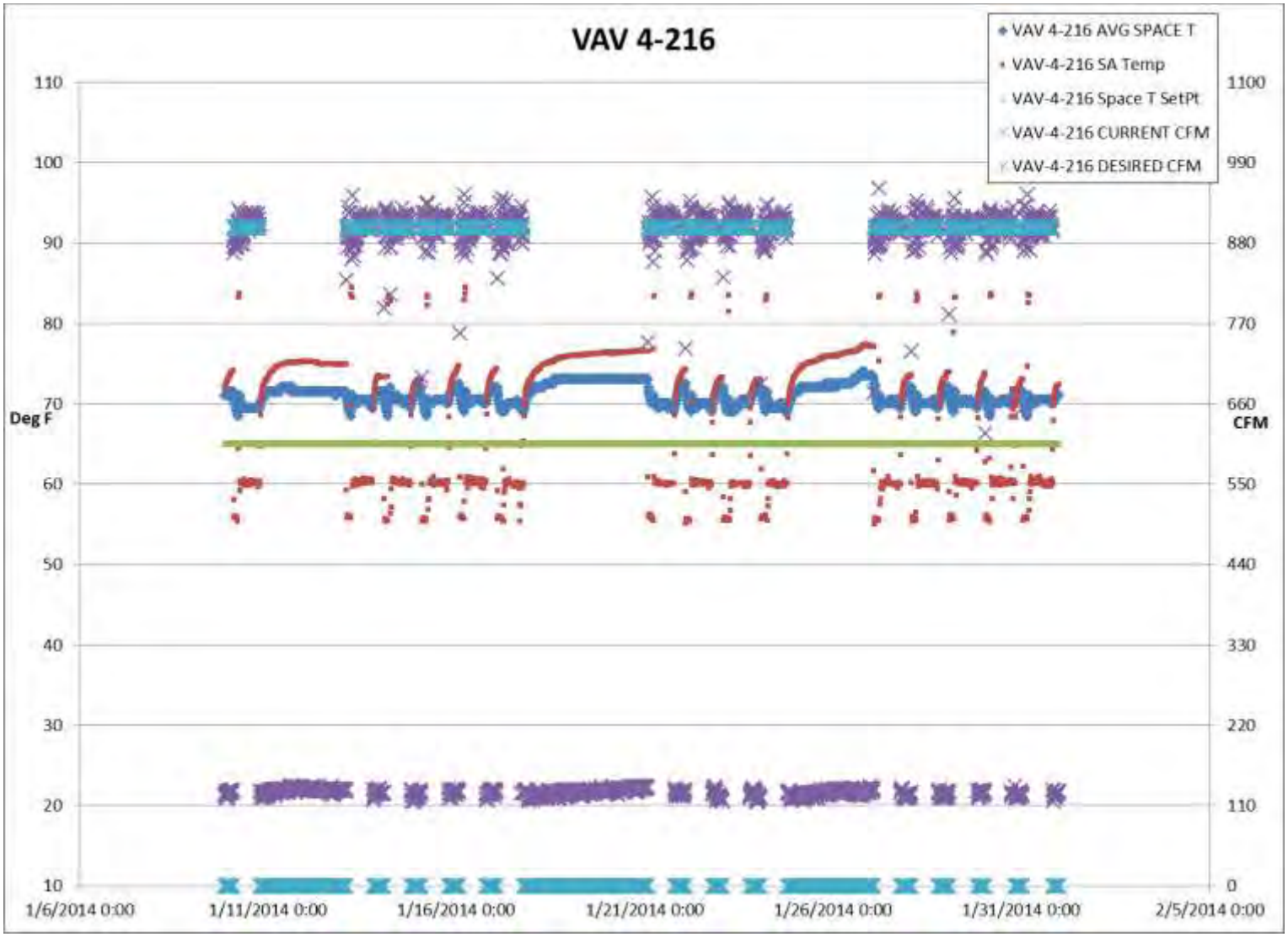
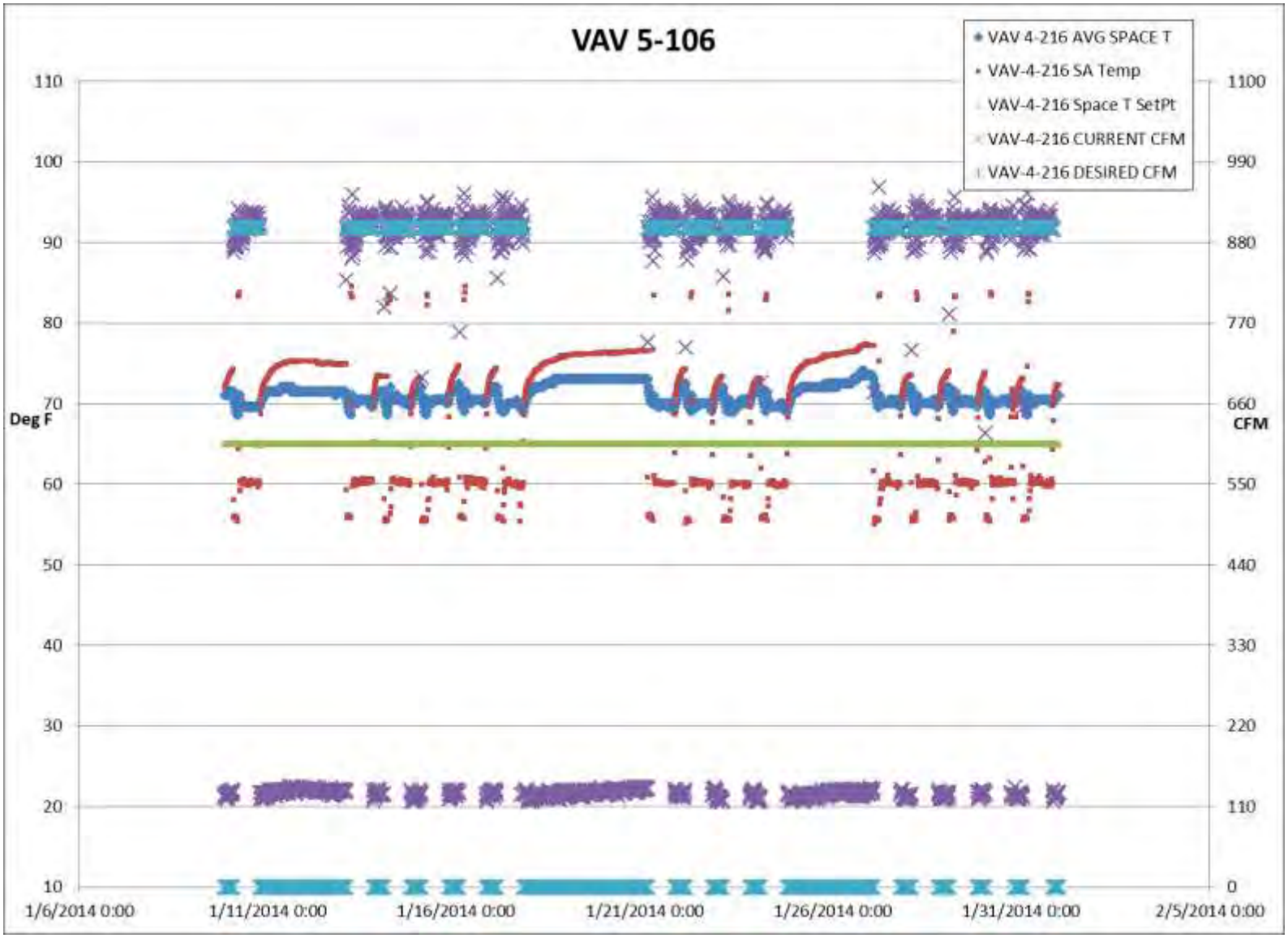
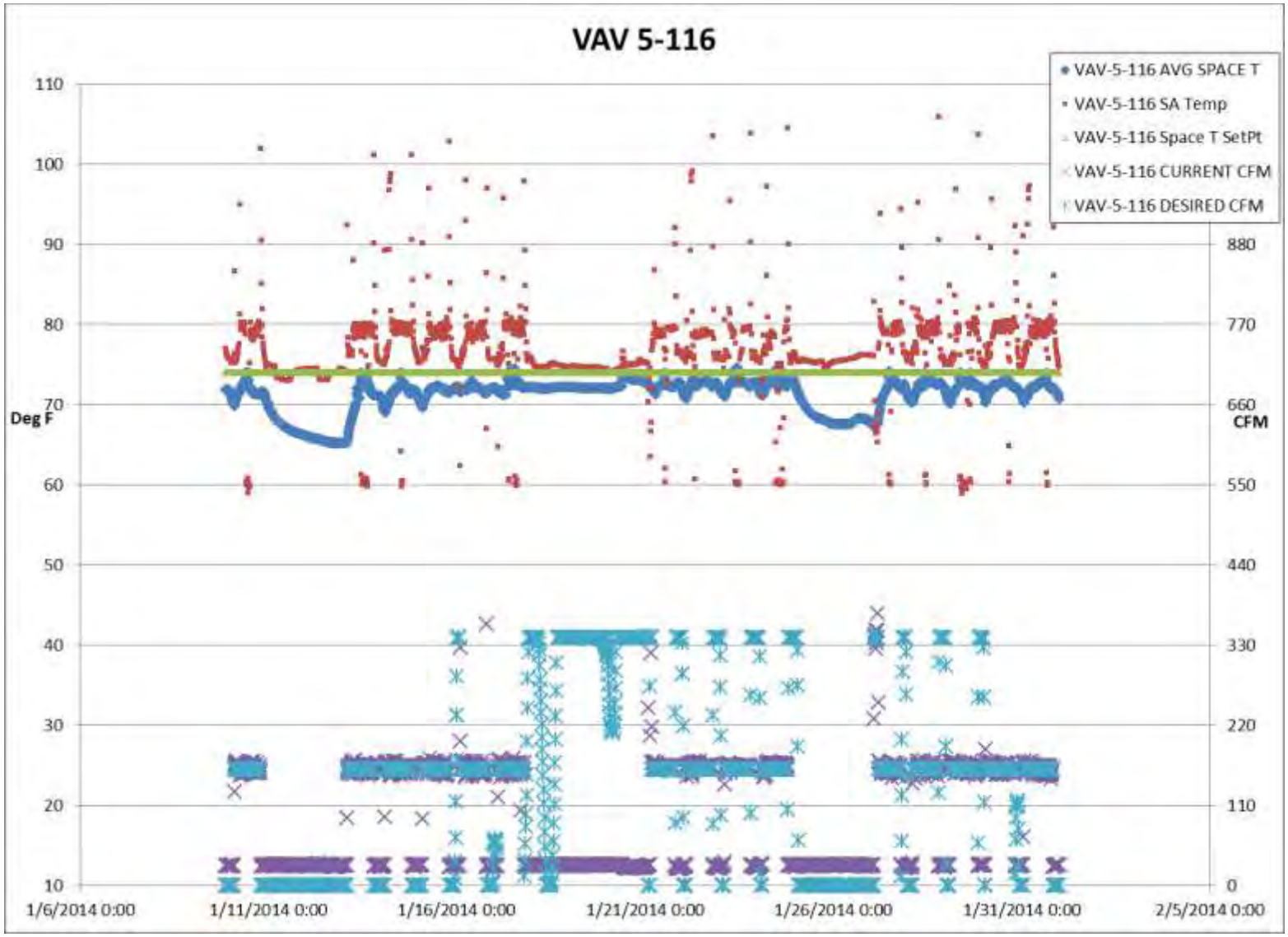
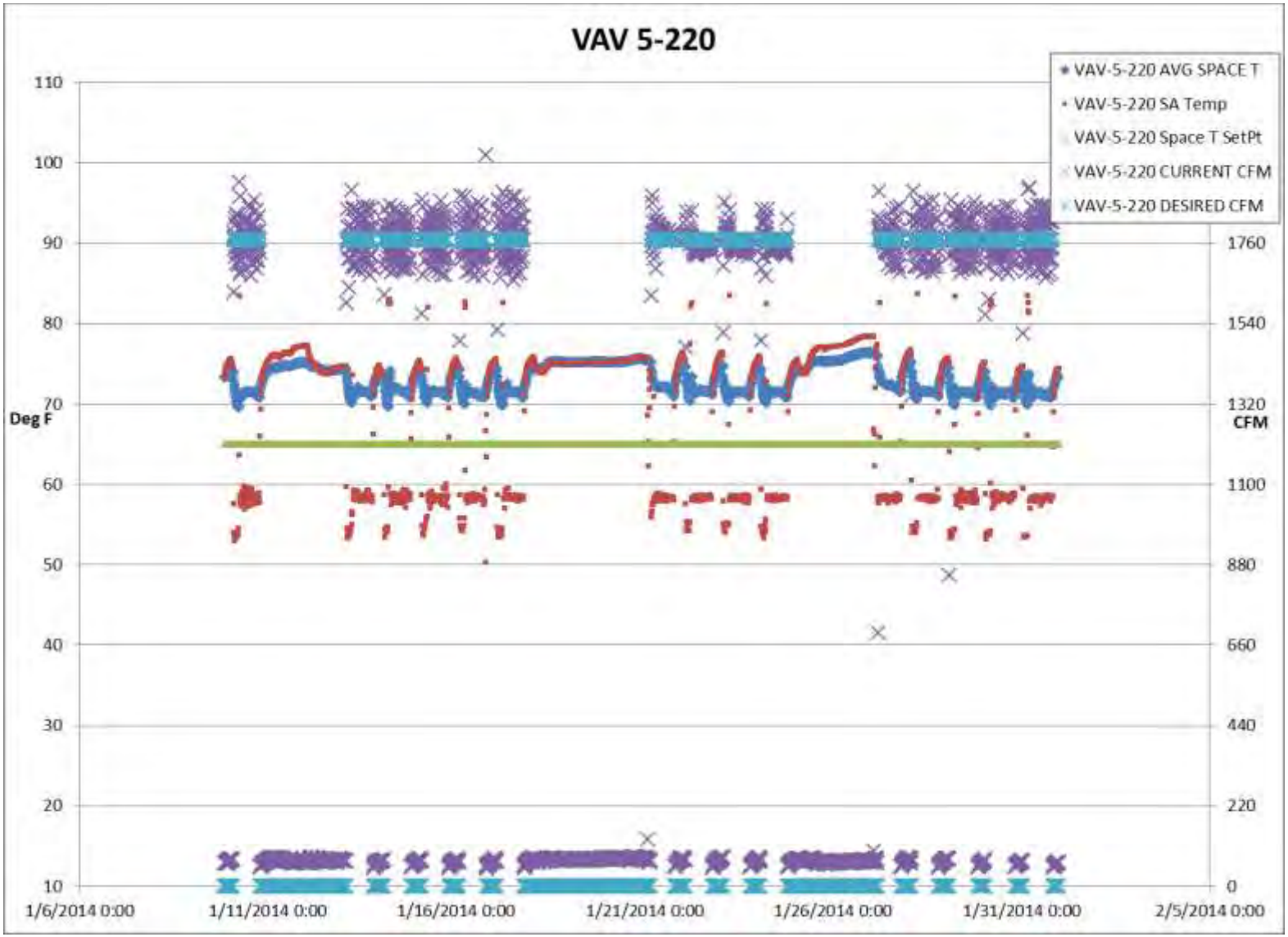
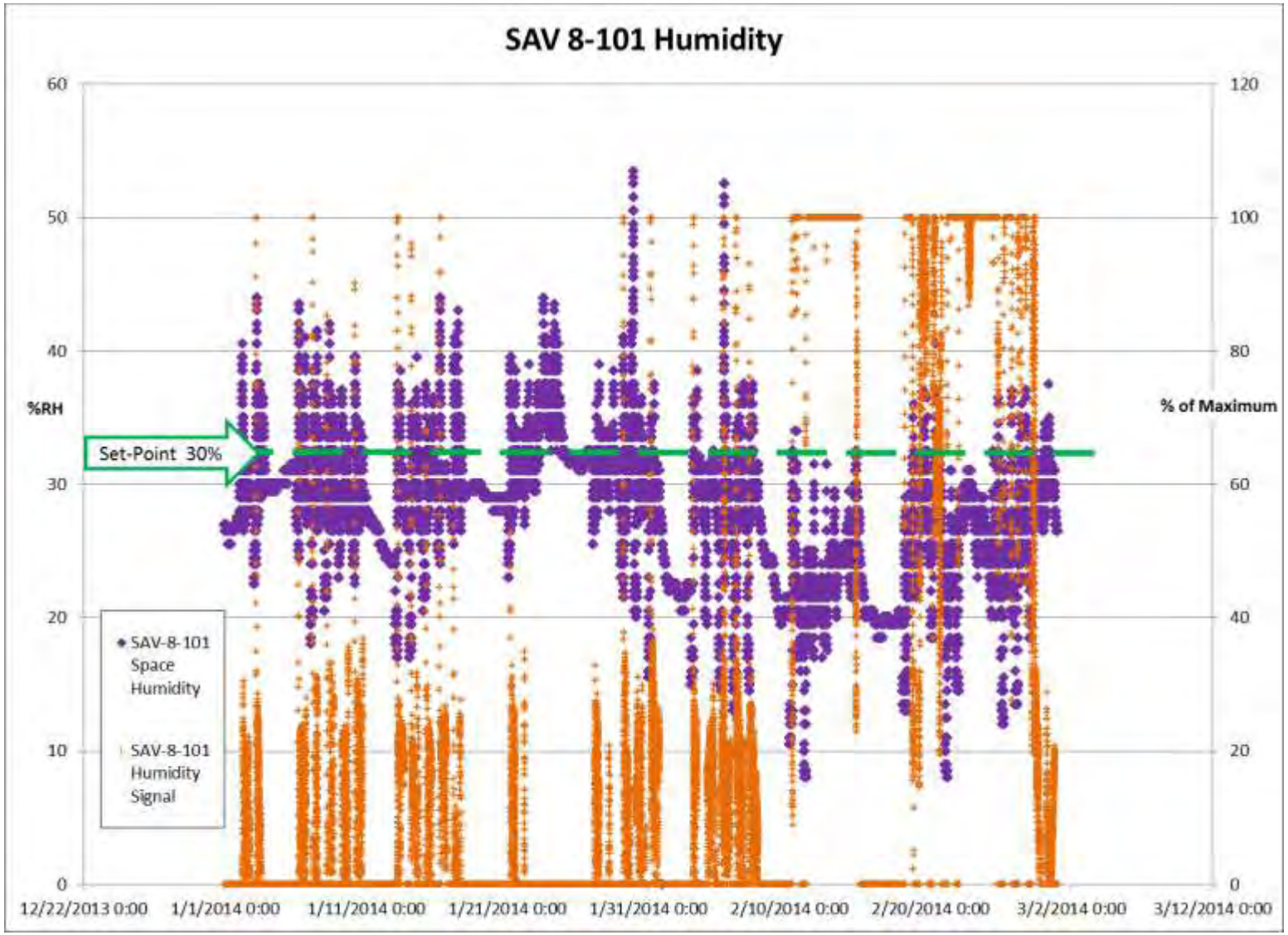
2/5/2014 0:00

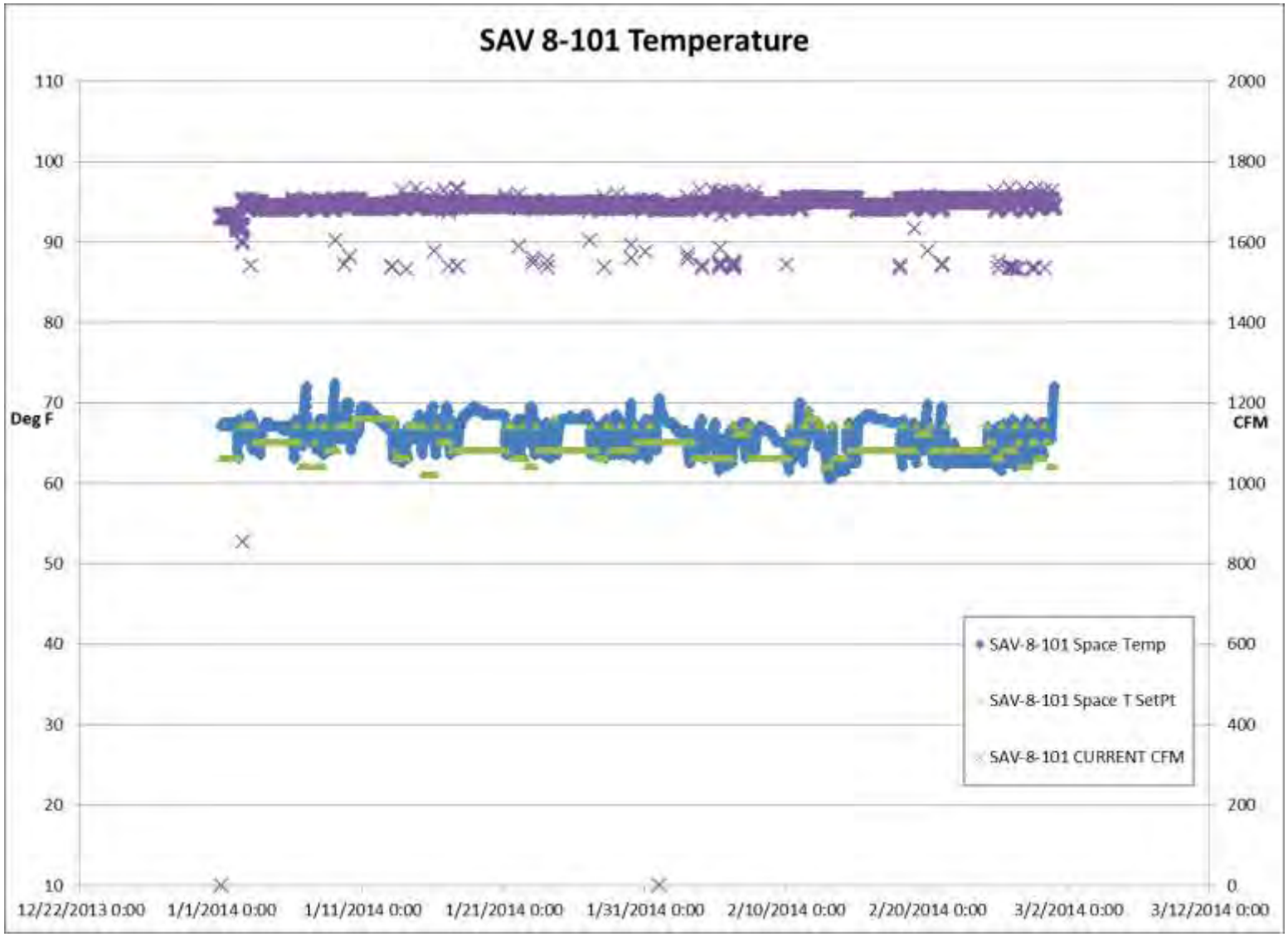

VAV 4-216
VAV 4-216 AVG SPACE T
VAV-4-216 SA Temp
VAV-4-216 Space T SetPt
VAV-4-216 CURRENT CFM
VAV-4-216 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
1100
990
880
770
660
550
440
330
220
110
0
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00

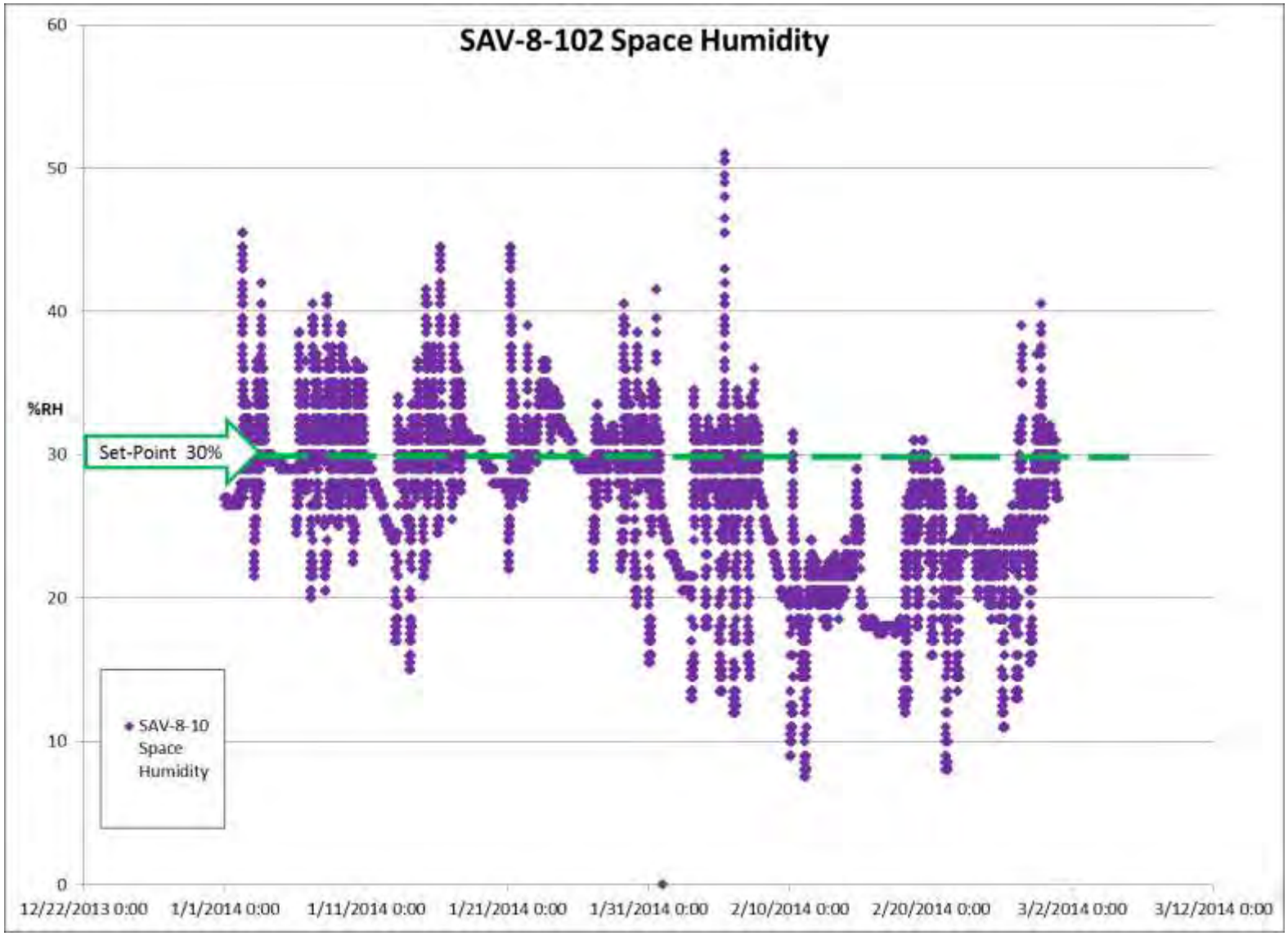

VAV 5-106
VAV 4-216 AVG SPACE T
VAV-4-216 SA Temp
VAV-4-216 Space T SetPt
VAV-4-216 CURRENT CFM
VAV-4-216 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
1100
990
880
770
660
550
440
330
220
110
0
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00

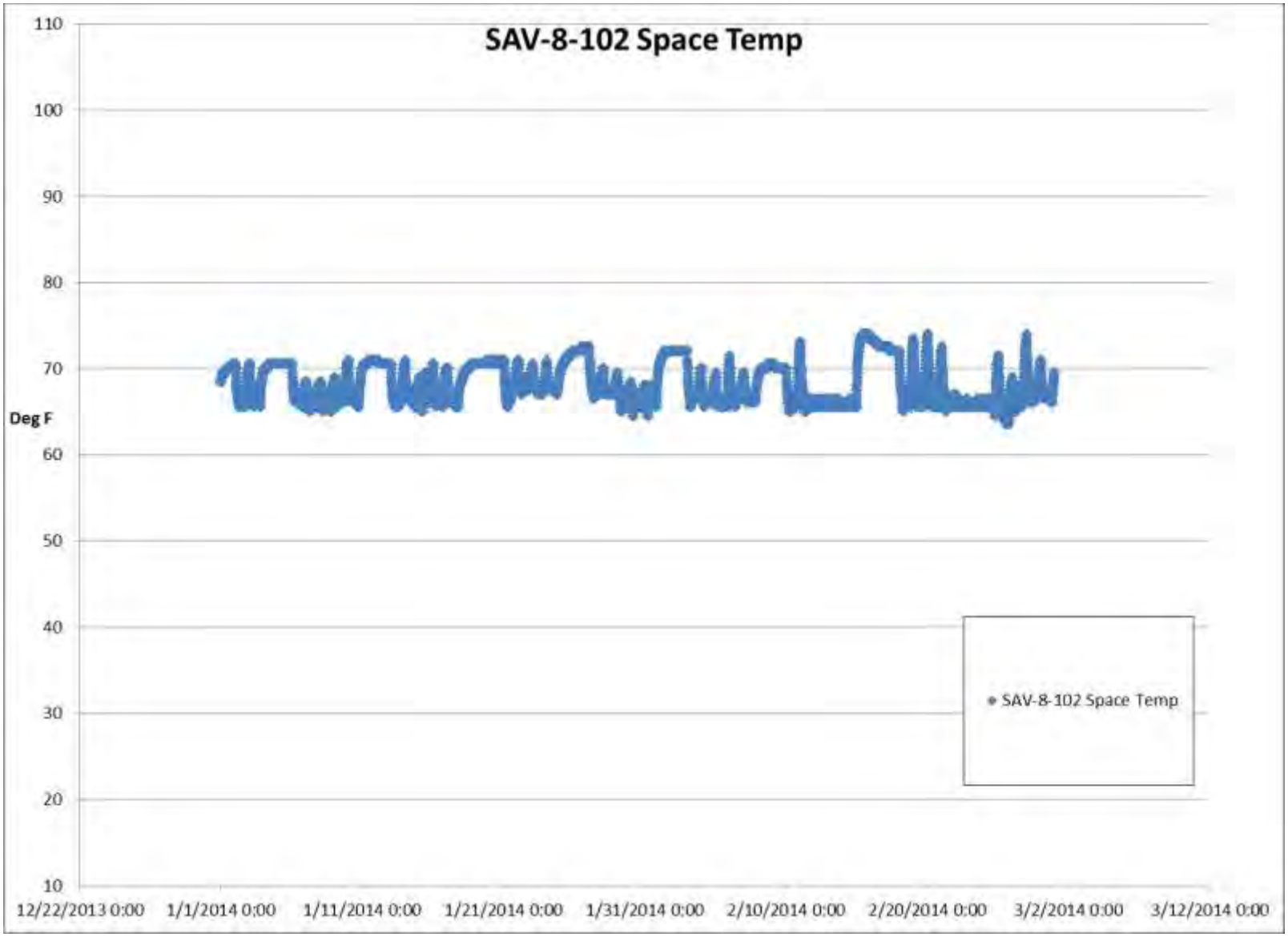

VAV 5-116
VAV-5-116 AVG SPACE T
VAV-5-116 SA Temp
VAV-5-116 Space T SetPt
VAV-5-116 CURRENT CFM
VAV-5-116 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
880
770
660
550
440
330
220
110
0
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00

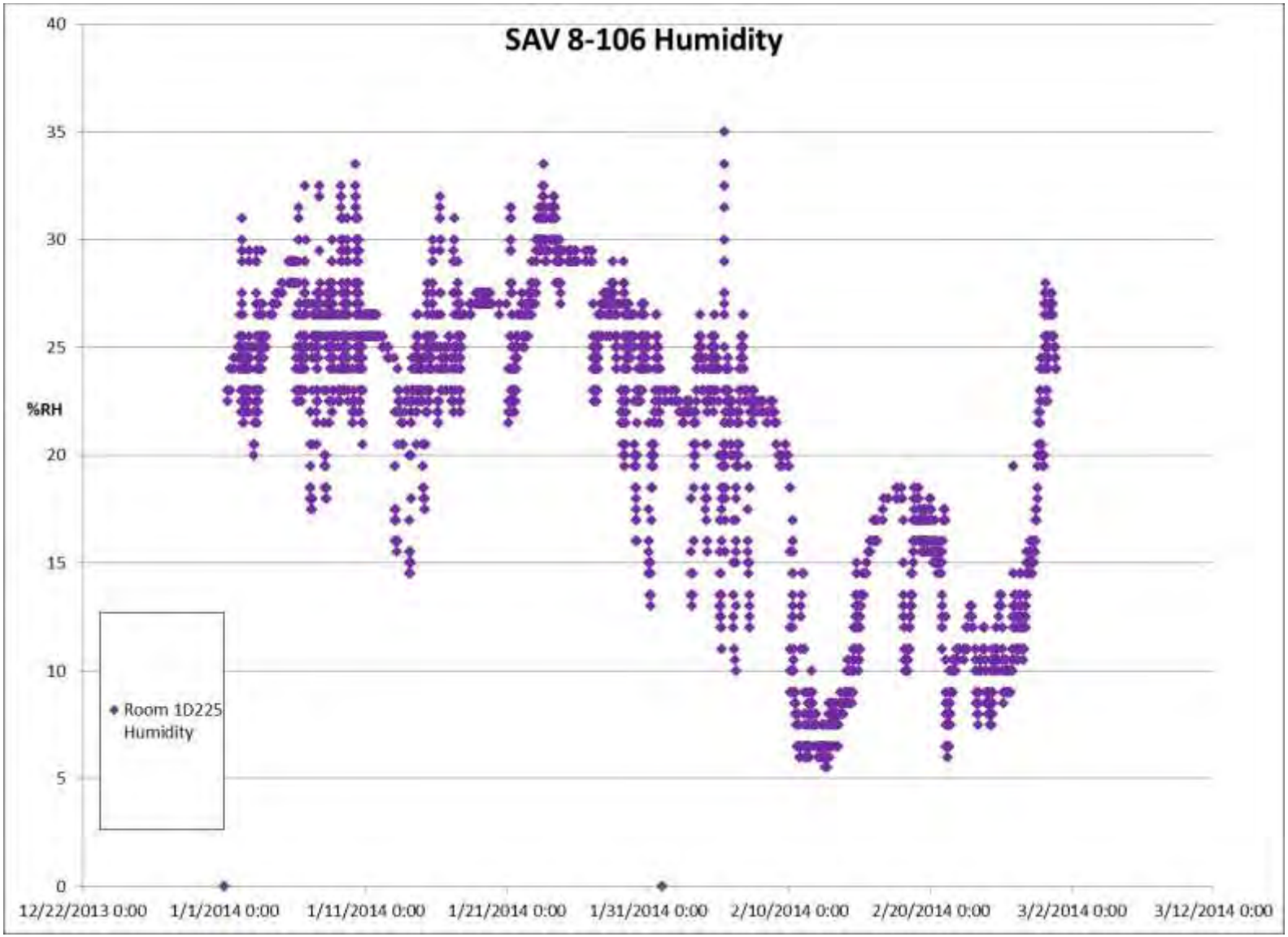

VAV 5-220
VAV-5-220 AVG SPACE T
VAV-5-220 SA Temp
VAV-5-220 Space T SetPt
VAV-5-220 CURRENT CFM
VAV-5-220 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
1760
1540
1320
1100
880
660
440
220
0
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00

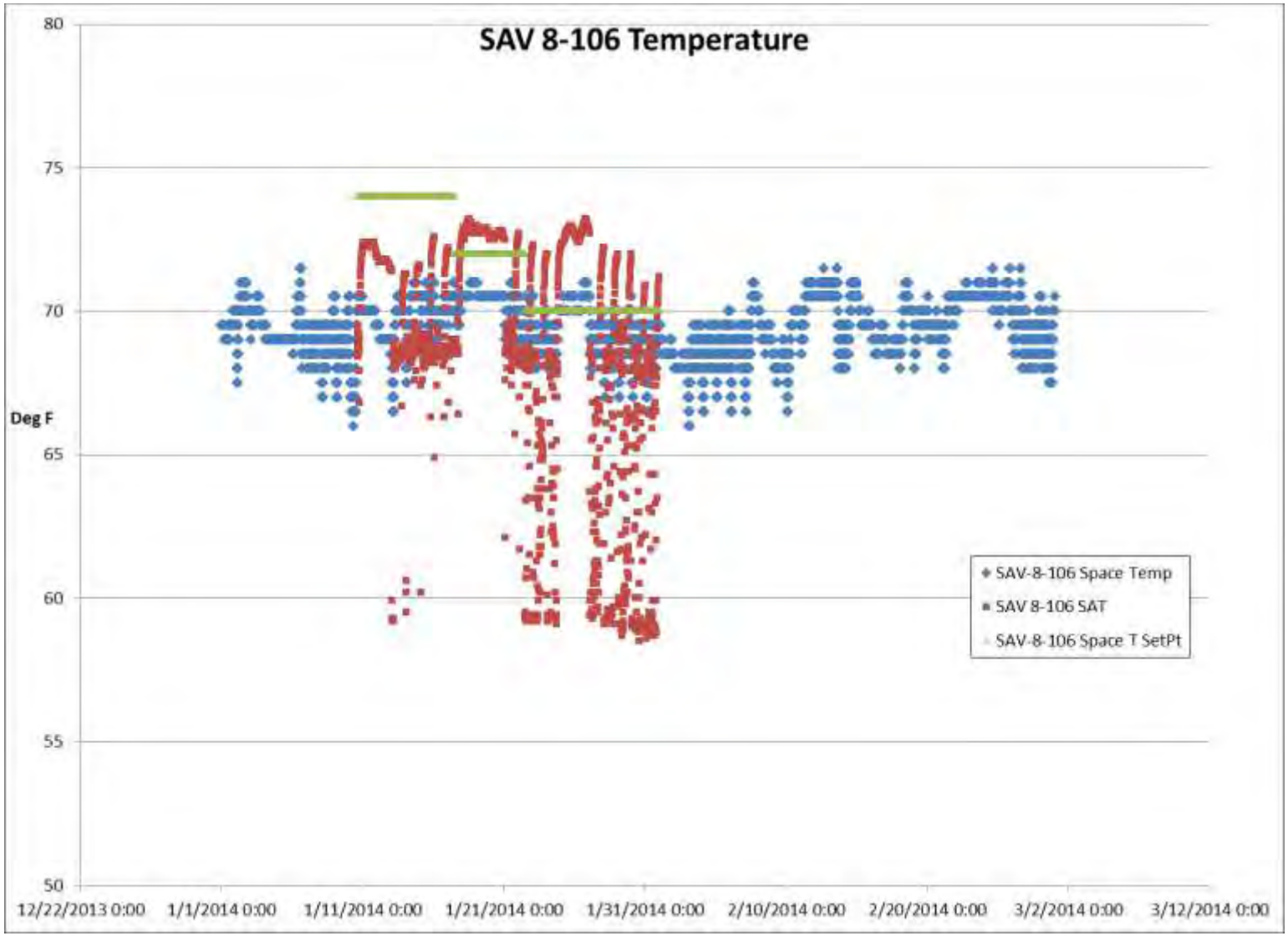

SAV 8-101 Humidity
%RH
% of Maximum
Set-Point 30%
SAV-8-101 Space Humidity
SAV-8-101 Humidity Signal
60
50
40
30
20
10
0
120
100
80
60
40
20
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00

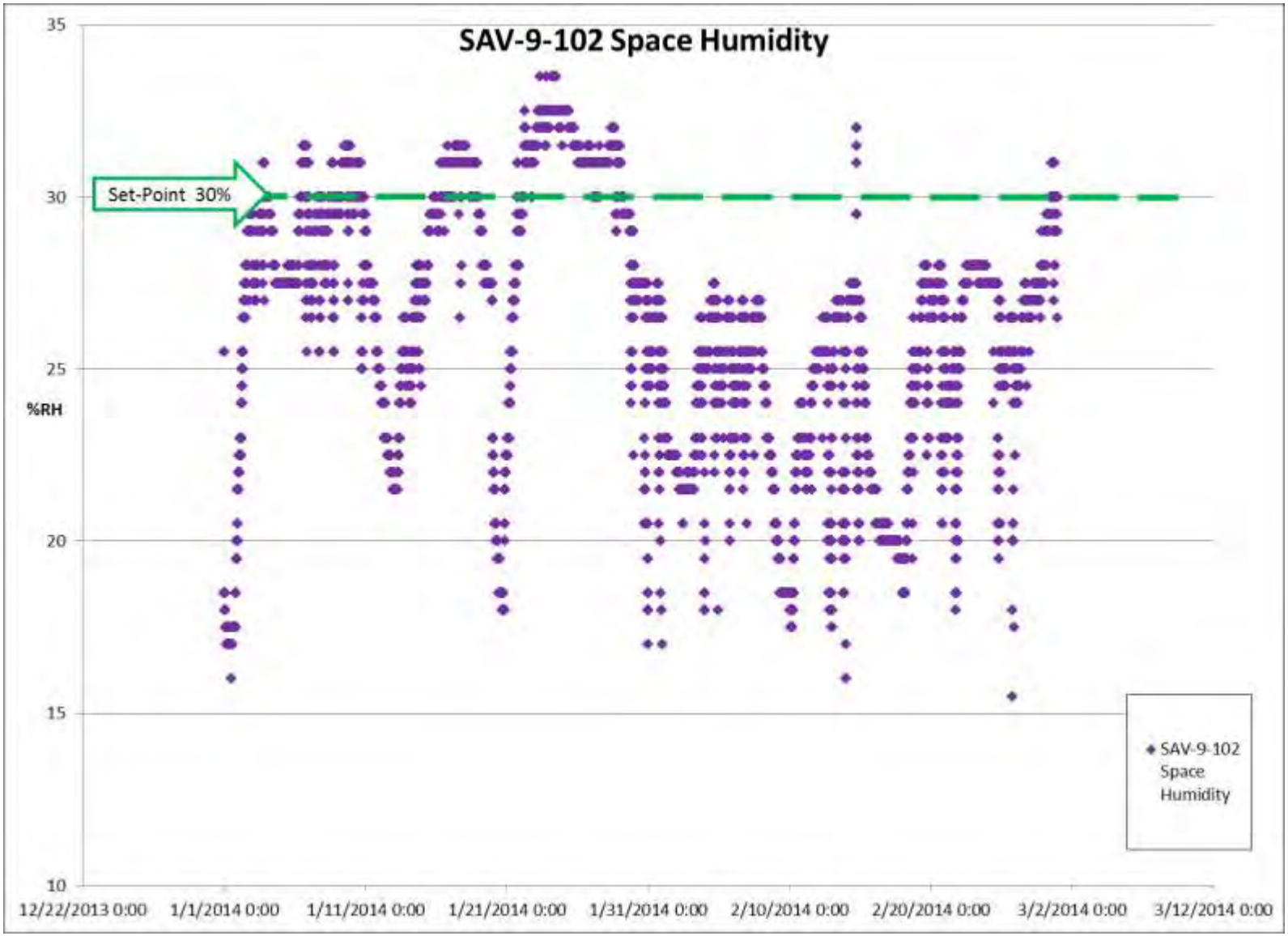

SAV 8-101 Temperature
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
2000
1800
1600
1400
1200
1000
800
600
400
200
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-8-101 Space Temp
SAV-8-101 Space T SetPt
SAV-8-101 CURRENT CFM

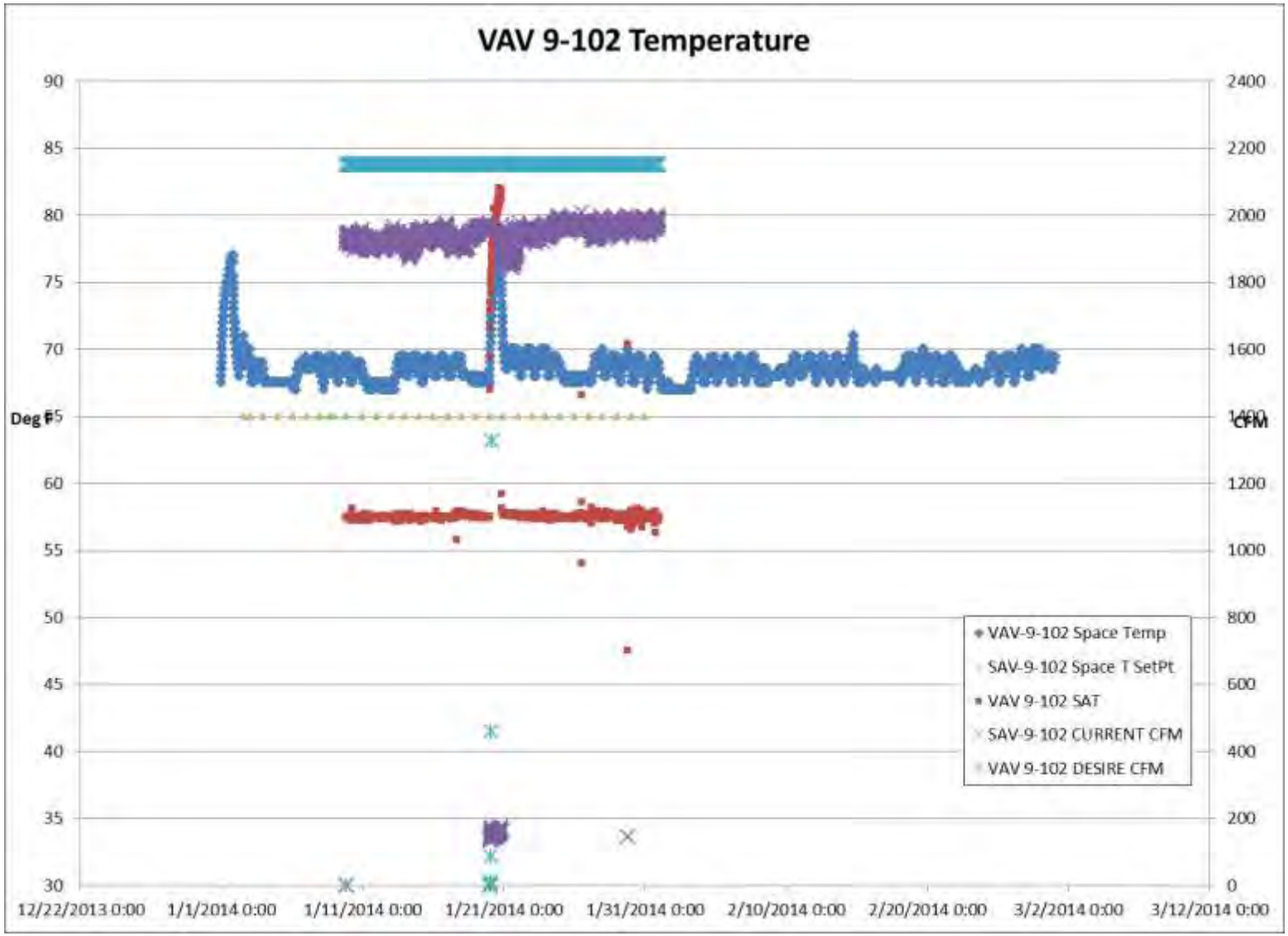

SAV-8-102 Space Humidity
%RH
60
50
40
30
20
10
0
Set-Point 30%
SAV-8-10 Space Humidity
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00

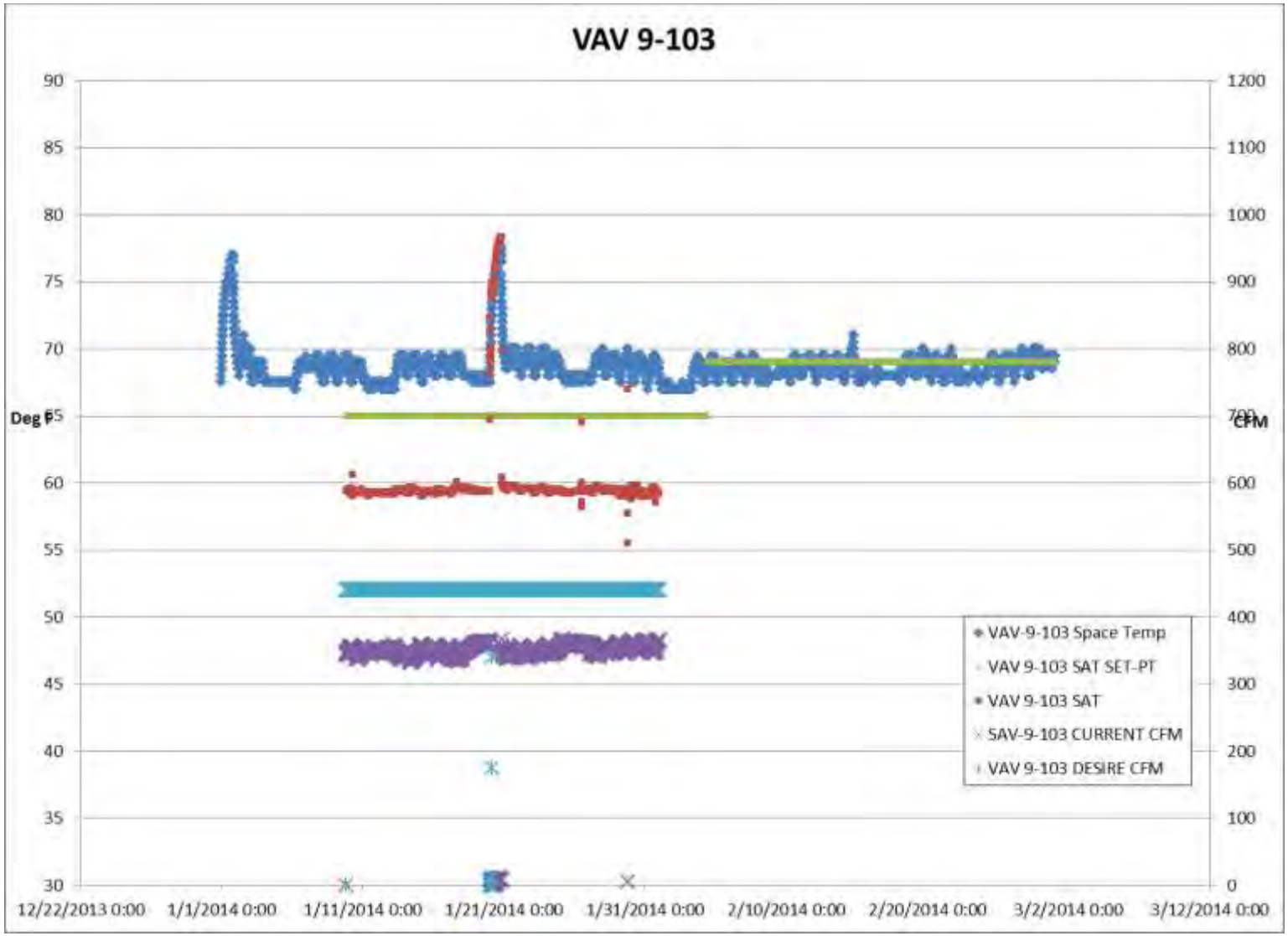

SAV-8-102 Space Temp
Deg F
110
100
90
80
70
60
50
40
30
20
10
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-8-102 Space Temp


SAV 8-106 Humidity
%RH
40
35
30
25
20
15
10
5
0
Room 1D225 Humidity
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00


SAV 8-106 Temperature
Deg F
80
75
70
65
60
55
50
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-8-106 Space Temp
SAV 8-106 SAT
SAV-8-106 Space T SetPt


SAV-9-102 Space Humidity
Set-Point 30%
%RH
35
30
25
20
15
10
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-9-102 Space Humidity


VAV 9-102 Temperature
Deg F
CFM
90
85
80
75
70
65
60
55
50
45
40
35
30
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
VAV-9-102 Space Temp
SAV-9-102 Space T SetPt
VAV 9-102 SAT
SAV-9-102 CURRENT CFM
VAV 9-102 DESIRE CFM


VAV 9-103
Deg F
CFM
90
85
80
75
70
65
60
55
50
45
40
35
30
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
VAV-9-103 Space Temp
VAV 9-103 SAT SET-PT
VAV 9-103 SAT
SAV-9-103 CURRENT CFM
VAV 9-103 DESIRE CFM

Appendix-G

For Final RCx Report

Systems Test Procedures and Testing Plan

&

Testing Results Report

VISN 20 Alaska VA Healthcare System

Systems Functional Testing Plan

JANUARY 28, 2013

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Functional Testing Plan

1.1 INTRODUCTION

As part of its RCx efforts at VISN 20, DAV Energy presents the following functional testing plan. DAV Energy plans to use this plan to perform functional testing activities. DAV Energy aims to identify issues, confirm compliance with the CFR, identify improvement opportunities and highlight problems that may require more rigorous and focused investigation. This is being completed under **Key Deliverable 8 Systems Functional Testing Plan**.

This report provides a summary of the HVAC systems and equipment to be tested. It includes functional test and point to point testing procedures, and planned TAB measurements.

The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	In Progress
4	Building Occupant Interviews & Goals	In Progress
5	Facility Performance Analysis & Performance Baseline	In Progress
6	Systems Diagnostic Monitoring Plan	In Progress
7	Systems Diagnostic Monitoring Report	3/26/2014
8	**Systems Test Procedures and Testing Plan**	In Progress
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Systems Testing Process

2.1 SYSTEMS TESTING OBJECTIVES

The objective of this Systems Test Procedures and Testing Plan is to organize the activities that will take place during the diagnostic testing portion of the RCx project. This includes the HVAC systems and equipment to be tested, the control points to be verified, sequences of operation to be confirmed and TAB measurements to be completed where applicable.

System testing includes point to point and functional testing. The point to point testing is used to verify that what is displayed on the operator control workstation is what is actually happening in the field. These points include air and water temperatures, valve operation, motor start/stop, and motor status. In addition, the calibration of sensors will be verified. The functional sequence testing is used to operate the equipment through its programmed sequence of control and verify equipment operation.

The objectives of the system testing include the following:

- Identify sensors whose values do not correspond to measured conditions, indicating a need for calibration or replacement.
- Assess equipment condition to identify deferred maintenance issues.
- Verify the current operating conditions and the operating sequence of control to assess system performance.
- Identify system components that do not respond to commands and are in need of repair or replacement.
- Identify systems that do not respond to control set-points or cannot maintain set-points.
- Confirm operating issues from field observations.
- Identify operating set-points for temperatures, pressures, humidity, speeds, and flow rates where available.
- Identify issues which could have potential energy savings such as incidents of simultaneous heating and cooling, inadequate or faulty economizer operation, excessive variable frequency drive (VFD) speeds, and other incidents of non-optimal operation.

2.2 SCHEDULE

This section sets forth the intended detailed schedule of diagnostic testing tasks to be carried out at the Anchorage VA Medical Center.

Table 2-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 through 1/10/2014 March 2014	Yes	Functional Testing was Completed in January of 2014 with potential wrap up testing in March to investigate items found during trend analysis
Onsite TAB Measurements	March 2014	Yes	Anticipate bringing in TAB contractor in March of 2014 to take selected measurements.
Prepare Deficiencies Log	1/6/2014 through 4/9/2014	Partial	Ongoing during functional testing and completed in the office after testing is finished.
Prepare Systems Testing Report and Deliver to VA for approval	4/9/2014	No	This report will summarize findings from the testing.

2.3 APPROACHES, LIMITATIONS, & PRIORITIES

This section describes the available approaches to testing, limitations that may apply, and criteria considered in establishing priorities.

Where there are large quantities of equipment controlled by the BAS or local controls, sample sizes can be guided by industry standards such as "M&V Guidelines: Measurement and Verification for Federal Energy Projects, Version 3.0" Appendix A Sampling Guidelines. The sample size will vary based on the total population of systems or components being evaluated. Smaller populations will require a larger test sample.

System testing will include the following:

- Major equipment on the BAS or with local control will be tested with a sampling rate of 100%. Major equipment includes dedicated chilled water systems, building central chilled water plant equipment, and building central heating water plant equipment. It also includes fans, pumps, and air handling units with motors 5HP or greater. It does not include the central campus chilled water plant or steam plant located at Elmendorf AFB.

- A sample of small Equipment and Terminal units with BAS or local control will be tested Small equipment includes pumps and exhaust fans. Terminal units include VAV boxes, CV boxes, reheat coils, steam radiators, unit heaters, fan coil units, dual duct mixing boxes and cabinet unit heaters.

3.0 System Testing Plan

This section describes the testing procedures planned for major equipment types. System test procedures were developed based on documented and ideal sequences of operation, manufacturer data and O&M instructions, and established testing procedures from the commissioning industry. Point to point and system testing forms can be found in **Appendix A**.

3.1 OVERVIEW OF POINT TO POINT TESTING

Calibration of DDC sensors will be verified and damper linkages and control valves will be inspected and operated through their full range to verify smooth operation. Analog and digital inputs and outputs are all included. Point to point checklists will catalog the control points on the DDC system, as well as other devices.

Temperatures will be measured as close to the sensor as possible. If temperature sensor wells are not available near the chilled water/hot water temperature sensors, temperatures will be taken using contact probes.

Damper and valve positions will be stroked through their full ranges (open to closed) by overriding control points.

3.1.1 Cooling System

Sensors and components included in the point to point testing will vary for each chilled water plant and can be found in the testing plan in **Appendix A**. The following control points are typically included in the point to point testing:

- Chilled Water Supply Temperature
- Chilled Water Return Temperature
- Pump Start/Stop & VFD speed Command
- Pump Status
- Chilled Water Valves

3.1.2 Heating System

Sensors and components included in the point to point testing will vary for each heating plant and can be found in the testing plan in **Appendix A**. The following control points are typically included in the point to point testing:

- Heating Supply Glycol Temperatures
- Heating Glycol Return Temperatures
- Pump Start/Stop & VFD speed Command
- Converter Hot Water Valves
- Heating Valve Command Response

3.1.3 Air Handling Units

Sensors and components included in the point to point testing will vary per air handling unit and can be found in the testing plan in **Appendix A**. The following control points are typically included in the point to point testing:

- Supply Air Temperature
- Return Air Temperature
- Mixed Air Temperature
- Outside Air Temperature
- Zone Temperature (where applicable as a controlling point for AHU)
- Fan Status
- Fan Start/Stop
- Outside/Return/Exhaust Air Dampers
- Chilled Water Valve
- Hot Water Valve
- Fan Speed

3.1.4 Terminal Units

Sensors and components included in the point to point testing can be found in the testing plan in **Appendix A**. The following sensor points are typically included in the point to point testing:

- Space Temperature
- Discharge Air Temperature
- Heating Valve response
- Primary Air Damper (verified full range of motion using airflow)

3.2 OVERVIEW OF FUNCTIONAL TESTING

The following equipment at the Anchorage VA Medical Center will be tested:

- All Air Handler Units with the exception or AHU-10 which is used only when the generator operates.
- A sampling of VAV boxes and their respective spaces.
- Snowmelt Systems
- Heating/Chilled Water Components (pumps, valve, heat exchangers, controls)

3.3 OVERVIEW OF SYSTEM CONDITION ASSESMENT

A condition assessment of the HVAC systems will be performed during the diagnostic testing. Observations documenting issues affecting HVAC system

operation will be compiled in the Issues Log and included in the System Testing Report. This section summarizes the inspections to be performed.

- Airside Equipment Inspection, to assess whether:
    - Outside and return air damper linkages are connected and functioning properly.
    - Control valve actuators are functioning properly.
    - Control sensors locations are appropriate.
    - Control sensors are calibrated.
    - Belts are in good working condition.
    - Coils and filters are clean and free of debris.
    - Routine preventative maintenance has been performed.
- Chilled / Hot Water System Inspection, to assess whether:
    - Control valve actuators are functioning properly.
    - Control sensors are calibrated.
    - Control sensor locations are appropriate.
    - Routine preventative maintenance has been performed.
- Terminal Unit Inspection, to assess whether:
    - Routine preventative maintenance has been performed.
    - Control sensors are calibrated.
    - Control sensor locations are appropriate.
    - Control valve and damper actuators are functioning properly (if installed).
- BAS Inspection to:
    - Analyze BAS capabilities and available control points.
    - Evaluate equipment control through the BAS.
    - Determine if BAS includes required control points for additional energy conservation opportunities.
    - Determine if the existing BAS provides significant capability for ensuring sustainability of energy savings.

3.4 OVERVIEW OF TAB MEASUREMENTS

Air and water flow measurements will be performed on select mechanical equipment. These measurements will be used to evaluate operational issues and identify system issues. The following systems are planned to have TAB measurements taken.

- AHU-08
    - Cooling CHG Coil Flow Measurement
    - Pre-Heat Coil HGS Flow Measurement
    - Heating Coil HGS Flow Measurement
    - Air-Flow Measurement

- AHU-09
    - Cooling CHG Coil Flow Measurement
    - Pre-Heat Coil HGS Flow Measurement
    - Heating Coil HGS Flow Measurement
    - Air-Flow Measurement

VISN 20 Alaska VA Healthcare System

Systems Testing Report

JANUARY 28, 2013

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Executive Summary

1.1 INTRODUCTION

This testing report prepared by DAV Energy Solutions Inc for the VISN 20 Alaska Health care Systems provides a summary of the systems that were tested during the point to point and functional testing process, a summary of findings and the issues identified. Deviations between the Testing Plan as it was originally outlined and the actual execution of the equipment testing process are also addressed. Completed testing forms, issues log, and supporting documents are presented in the appendices. This is being completed under **Key Deliverable 9 Testing Report**.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs,
4. Identify energy or capital improvement projects for implementation in the future.

The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	**CURRENT**
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Systems Testing Process

2.1 SYSTEMS TESTING OBJECTIVES

The objective of this Systems Test Procedures and Testing Plan is to organize the activities that will take place during the diagnostic testing portion of the RCx project. This includes the HVAC systems and equipment to be tested, the control points to be verified, sequences of operation to be confirmed and TAB measurements to be completed where applicable.

System testing includes point to point and functional testing. The point to point testing is used to verify that what is displayed on the operator control workstation is what is actually happening in the field. These points include air and water temperatures, valve operation, motor start/stop, and motor status. In addition, the calibration of sensors will be verified. The functional sequence testing is used to operate the equipment through its programmed sequence of control and verify equipment operation.

The objectives of the system testing include the following:

- Identify sensors whose values do not correspond to measured conditions, indicating a need for calibration or replacement.
- Assess equipment condition to identify deferred maintenance issues.
- Verify the current operating conditions and the operating sequence of control to assess system performance.
- Identify system components that do not respond to commands and are in need of repair or replacement.
- Identify systems that do not respond to control set-points or cannot maintain set-points.
- Confirm operating issues from field observations.
- Identify operating set-points for temperatures, pressures, humidity, speeds, and flow rates where available.
- Identify issues which could have potential energy savings such as incidents of simultaneous heating and cooling, inadequate or faulty economizer operation, excessive variable frequency drive (VFD) speeds, and other incidents of non-optimal operation.

2.2 SCHEDULE

This section sets forth the intended detailed schedule of diagnostic testing tasks to be carried out at the Anchorage, Alaska VA Outpatient Clinic.

Table 2-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 through 1/10/2014 March 2014	Yes	Functional Testing was Completed in January of 2014 with potential wrap up testing in March to investigate items found during trend analysis
Onsite TAB Measurements	April 2014	Yes	Anticipate bringing in TAB contractor in April of 2014 to take selected measurements.
Prepare Deficiencies Log	1/6/2014 through 4/9/2014	Partial	Ongoing during functional testing and completed in the office after testing is finished.
Prepare Systems Testing Report and Deliver to VA for approval	4/9/2014	No	This report will summarize findings from the testing.

2.3 SYSTEM TESTING EXECUTION

Field testing was performed on a large portion of the equipment in the buildings. This included 100% of the major equipment such as chillers, boilers, fans, pumps and air handling units and a sample of smaller terminal equipment. The main findings discovered during testing are summarized in the following Results Section.

The field testing included the following tasks:

- Controls point-to-point testing. The point to point testing included verification of inputs and outputs on the DDC system such as air and water temperatures, valve operation, motor start/stop, and motor status. When the actual operation or feedback from a sensor, control valve, or damper varied from the indication in the controls system, the variance was noted. Appendix A contains the detailed point to point test results including all recorded spot measurements.
- Sensor calibration checks. As part of point to point testing, sensor calibration checks were performed according to the System Test Procedures and Testing Plan. Appendix A contains all recorded spot measurements.
- Controls functional testing. The functional performance testing was used to determine how the equipment is currently operating. These tests evaluated the control of the major airside equipment and assessed the central plant equipment operation. It also included testing of a sample of the small packaged equipment

and terminal units to evaluate proper operation. Appendix A contains the detailed functional performance test results.

- System condition assessment. A condition assessment of the HVAC systems was performed during the diagnostic testing. Observations documenting issues affecting HVAC system operation were compiled in the Issues Log presented in Appendix B. Observations were not documented for systems where operation was acceptable based on the provided sequences of operation and system operation data gathered from site surveys and facility personnel interviews.

An issues log can be found in Appendix B. It identifies the items that did not pass the point-to-point, sensor calibration checks, functional testing, system condition assessment or other measurements. The detailed testing approach and a summary of equipment included in the testing were provided in the System Test Procedures and Testing Plan.

3.0 System Testing Results

The following section presents issues found during the point to point testing, functional testing, and equipment condition assessment. All issues, including the locations and equipment affected, are summarized in the Issues Log in **Appendix B**.

3.1 IDENTIFIED ISSUES SUMMARY

Overall there were very few issues to be notes throughout the building. After a thorough investigation the systems were found to be in excellent condition which is unusual in RCx studies. One issue was identified through testing. The following list summarizes the identified issue, including the locations and equipment affected, are also summarized in the Issues Log found in Appendix B.

- During testing is was discovered that the PHC control valve on AHU #8 may not be able to fully close.
    - Sensors Passed point to point testing within one degree.
    - Additional investigation by a TAB specialist is warranted, therefore we have brought in a subcontractor to make the investigation by measurement of the delta pressure across the PHC with the valve commanded closed.
    - A likely cause of this issue is deposits inside the Griswold valve cartridge preventing it from fully seating in the closed position. The corrective action for this likely cause is replacement of the Griswold valve cartridge.
    - This issue effects AHU #8 only.

3.2 COOLING SYSTEM / CHILLED WATER PLANT

Cooling Plant equipment condition and operation was assessed using observations, point to point testing and functional testing. Testing activities indicated that the programmed chilled water supply temperature set points and cooling system lockouts were being observed for the majority of the systems. In some instances, there are opportunities to further automate system control and improve the energy efficiency of the building operation. The most frequent issues identified through the testing process are presented in the following sections.

Point to point testing was used to check the calibration of DDC sensors, valves, VFDs, set-points, etc. associated with chilled water plant control. The following list summarizes the testing results. A detailed list of each point checked and the test associated in **Appendix A**. A list of the findings and proposed resolution is available in the Issues Log in **Appendix B**. There were no failures or issues discovered in this system.

Per VA request the pumps could be point-to-point tested, but not functionally tested since changing the fluid delta pressure would set off alarms at the Elmendorf side of the system. Point to Point testing procedure used on CHGP-13 is as follows:

- Pump 13A was commanded to 60%
  - **Drive display indicated 62% which is within acceptable limits**
- Pump 13A was commanded to 80%
  - **Drive display indicated 82% which is within acceptable limits**
- Pump 13B was commanded to 60%
  - **Drive display indicated 60%**
- The CHG bypass valve was commanded to close
  - **The valve was visually observed to fully close within 5 minutes**

3.3 SNOWMELT SYSTEM

The following parameters were tested for the snowmelt system:

- Point to Point Testing:
  - East Slab surface Temp
    - **Pass: within +/- 3 degrees using handheld IR thermometer**
  - East Slab Moisture Detection
    - **Pass: visual observation by pouring water on sensor**
  - West Slab Surface Temp
    - **Pass: within +/- 3 degrees using handheld IR thermometer**
  - West Slab Moisture Detection
    - **Pass: visual observation by pouring water on sensor**
  - Snowmelt HX Valve Closes Fully
    - **Pass: visual observation**

- Functional Testing:
  - Snowmelt HX Loop Idle temperature
    - **Pass: Measurement within +/-3 degrees using handheld IR thermometer**
  - Adjust the HGS set-point Up
    - **Bypass valve visually observed - Modulates to maintain set-point**
  - Adjust the HGS set-point Down
    - **Bypass valve visually observed - Modulates to maintain set-point**
  - Override the slab temp below set-point
    - **As slab temp rises, HGS valve observed to adjust to maintain slab rate of temperature increase below 0.2Deg F per minute**

3.4 RE-CIRCULATING AHU TESTING PROCEDURES & RESULTS

The following procedure was performed where applicable to functionally test the Air Handling Units.

- **Simulate a Call for heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Return Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Visually check that the OA & RA Dampers are set for minimum OSA
    - **In all cases this was found to be true**
  - Visually observe the heating coil valve modulates to maintain SAT
    - **In all cases the heating valve was found to be functioning normally**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for no heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Return Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Visually check that the OA & RA Dampers are set for minimum OSA
    - **In all cases this was found to be true**
  - Visually check that the heating coil valve is fully closed within 5 minutes
    - **In all cases the heating valve was found to be functioning normally and able to fully close**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when both the Airside Economizer and Mechanical Cooling are enabled**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Return Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**

- Visually observe that the OA & RA & EA Dampers are set to maintain the SAT set-point
    - **In all cases the dampers were visually observed to modulate fully and correctly**
- Once the OA & RA & EA dampers are 100% open, mechanical cooling should modulate to maintain the SAT set-point.
    - **Due to winter conditions the unit's freeze alarm would be triggered and the SAT would be far too low for occupied conditions long before the OA damper is fully opened.**
- Visually observe the heating coil valve is fully closed
    - **In all cases the heating valve was found to be able to fully close**
- Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when the Airside Economizer is disabled and Mechanical Cooling is enabled**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to the minimum airflow position
        - **In all cases the dampers were visually observed to operate correctly**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the Cooling Coil valve modulates to maintain SAT set-point
        - **In all cases the cooling valve was found to be operating normally**

- **Simulate conditions when there is no call for cooling**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to the minimum airflow position
        - **In all cases the dampers were visually observed to operate correctly**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the cooling coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Test Supply Fan Functionality**
  - Override the duct static pressure set-point to 1.2” W.C.
    - **In all cases the fan was found to be able to maintain 1.2” W.C**
  - Override the duct static pressure set-point to 1.9” W.C.
    - **In all cases EXCEPT AHU #6 Supply Fan, the fan was able to maintain this pressure.**
    - **AHU #6 Supply Fan only able to maintain a maximum of 1.3” W.C.**
  - Override the duct static pressure set-point to 1.5” W.C.
    - **In all cases EXCEPT AHU #6 Supply Fan, the fan was able to maintain this pressure.**
    - **AHU #6 Supply Fan only able to maintain a maximum of 1.3” W.C.**

- **Test Humidification System Functionality**
  - Simulate a call for humidity by overriding the set-point
    - **In all cases the humidification system was visually observed to start and modulate normally to maintain the set-point**
  - Simulate the conditions when there is no call for humidity
    - **In all cases the humidification system was visually observed to stop completely**

- **Test SAT Reset Functionality**
  - Override the number of zones requesting DAT decrease
    - **In all cases the SAT was observed to decrease to the minimum set-point**
  - Override the number of zones requesting DAT increase
    - **In all cases the SAT was observed to increase to the maximum set-point**
  - Override the number of zones requesting DAT decrease to 6 and the number of zones requesting DAT increase to 6
    - **In all cases the SAT was observed to increase to the maximum set-point**

- **Test Duct SP Reset Functionality**
  - Override the number of zones requesting duct static pressure decrease
    - **In all cases the DSP was observed to decrease to the minimum set-point**
  - Override the number of zones requesting duct static pressure increase
    - **In all cases the DSP was observed to increase to the maximum set-point**

3.5 SINGLE-PASS AHU TESTING PROCEDURES & RESULTS

The following procedure was testing was performed where applicable to functionally test the Air Handling Units.

- **Simulate a Call for heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Check that the Humidity Valve is running in Auto
    - **In all cases this was found to be true**
  - Visually check that the PHC valve modulates to maintain SAT
    - **In all cases this was found to be true**
  - Visually observe the heating coil valve modulates to maintain SAT once the PHC valve is 100% open
    - **In all cases the heating valve was found to be functioning normally**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for no heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Check that the Humidity Valve is running in Auto
    - **In all cases this was found to be true**
  - Visually check that the PHC valve closes fully
    - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**
    - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when both the Airside Economizer and Mechanical Cooling are enabled**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Visually check that the PHC valve closes fully
    - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**

        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually observe the Cooling Coil valve is modulate to maintain SAT set-point
        - **In all cases the cooling valve was observed to modulate normally**

- **Simulate conditions when there is no call for cooling**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running
        - **In all cases this was found to be true**
    - Visually check that the PHC valve closes fully
        - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**
        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the cooling coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Test Supply Fan Functionality**
    - Override the duct static pressure set-point to 1.2” W.C.
        - **In all cases the fan was found to be able to maintain 1.2” W.C**
    - Override the duct static pressure set-point to 1.9” W.C.
        - **In all cases the fan was found to be able to maintain 1.9” W.C**
    - Override the duct static pressure set-point to 1.5” W.C.
        - **In all cases the fan was found to be able to maintain 1.5” W.C**

- **Test Humidification System Functionality**
    - Simulate a call for humidity by overriding the set-point
        - **In all cases the humidification system was visually observed to start and modulate normally to maintain the set-point**
    - Simulate the conditions when there is no call for humidity
        - **In all cases the humidification system was visually observed to stop completely**

- **Test SAT Reset Functionality**
    - Override the number of zones requesting DAT decrease
        - **In all cases the SAT was observed to decrease to the minimum set-point**
    - Override the number of zones requesting DAT increase
        - **In all cases the SAT was observed to increase to the maximum set-point**

- Override the number of zones requesting DAT decrease to 6 and the number of zones requesting DAT increase to 6
    - **In all cases the SAT was observed to increase to the maximum set-point**

- **Test Duct SP Reset Functionality**
    - Override the number of zones requesting duct static pressure decrease
        - **In all cases the DSP was observed to decrease to the minimum set-point**
    - Override the number of zones requesting duct static pressure increase
        - **In all cases the DSP was observed to increase to the maximum set-point**

3.6 VAV TERMINAL BOX FUNCTIONAL TEST

The following procedure was used to functional test the VAV boxes:

- The space temp set-point is adjusted above the current space temp
    - zone is expected to go into heating mode to compensate.
        - **VAV box is visually observed to open HGS valve within 5 minutes.**
        - **VAV box is visually observed to modulate the air damper to the heating position (if not already in heat mode) within 5 minutes.**
        - **Discharge air temperature is measured with IR thermometer to increase by 2 degrees or more**.
- The space temp set-point is adjusted below the current space temp
    - zone is expected to go into cooling mode to compensate
        - **VAV box is visually observed to fully close HGS valve within 5 minutes.**
        - **VAV box is visually observed to modulate the air damper to the fully open position within 5 minutes.**
        - **Discharge air temperature is measured with IR thermometer to decrease by 2 degrees or more.**

All VAV boxes functionally tested were found to be within parameters, and responded normally to the tests which are designed to test both the control routine and the physical equipment functionality. No Issues discovered in the VAV boxed through functional testing.

4.0 Appendix A: Functional Testing Results

4.1 AIR HANDLING UNIT FUNCTIONAL TEST RESULTS

4.1.1 AHU #1 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #1. The Tables below present the test procedure and the results of the testing procedure for AHU #1.

Table 4-1: AHU 1 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-1 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	5800 CFM	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-2: AHU 1 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-1 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	5800 CFM	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-3: AHU 1 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-4: AHU 1 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	N/A	N/A	
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-5: AHU 1 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Re-Enabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-6: AHU 1 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-7: AHU 1 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-8: AHU 1 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-9: AHU 1 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

Notes for AHU #1:

1. When cooling mode is released and the sequence then calls for heat, the heating valve opens while the airside economizer is still open

4.1.2 AHU #2 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #2. The Tables below present the test procedure and the results of the testing procedure for AHU #2.

Table 4-10: AHU 2 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-2 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-11: AHU 2 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-2 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-12: AHU 2 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-13: AHU 2 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-14: AHU 2 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Re-Enabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-15: AHU 2 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-16: AHU 2 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-17: AHU 2 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-18: AHU 2 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-19: AHU 2 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.3 AHU #3 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #3. The Tables below present the test procedure and the results of the testing procedure for AHU #3.

Table 4-20: AHU 3 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-3 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for	Yes	Pass	Functional Test was Completed 1/9/2014

Minimum OSA			
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-21: AHU 3 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-3 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-22: AHU 3 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-23: AHU 3 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-24: AHU 3 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-25: AHU 3 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-26: AHU 3 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-27: AHU 3 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-28: AHU 3 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The Duct SP Increases to the Maximum Set-Point

4.1.4 AHU #4 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #4. The Tables below present the test procedure and the results of the testing procedure for AHU #4.

Table 4-29: AHU 4 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-4 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-30: AHU 4 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-4 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-31: AHU 4 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-32: AHU 4 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-33: AHU 4 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-34: AHU 4 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there	Yes	Pass	Humidity Valve Closes

is No Call for Humidity			

Table 4-35: AHU 4 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-36: AHU 4 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.5 AHU #5 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #5. The Tables below present the test procedure and the results of the testing procedure for AHU #5.

Table 4-37: AHU 5 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-38: AHU 5 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-39: AHU 5 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-40: AHU 5 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	After 15 minutes of cooling valve fully open, economizer at 10%, the SAT reached 59F. Fan speed 93%. Delta T of coil is 7 Degrees. CGS Temp is 53F at the unit.

Table 4-41: AHU 5 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-42: AHU 5 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	1.3"W.C.	Fail	Can only maintain 1.3" W.C at 100% Fan Speed.
Override Duct SP Set-Point to 1.5" W.C.	1.3"W.C.	Fail	Can only maintain 1.3" W.C at 100% Fan Speed.

Table 4-43: AHU 5 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-44: AHU 5 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-45: AHU 5 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.6 AHU #6 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #6. The Tables below present the test procedure and the results of the testing procedure for AHU #6.

Table 4-46: AHU 6 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-47: AHU 6 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Return Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Humidifier to Auto	No		Not Simulated – Cannot complete due to available control in BAS
OA & RA Dampers set for Minimum OSA	No		Not Simulated – Cannot complete due to available control in BAS
Heating Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS
Cooling Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS

Table 4-48: AHU 6 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Return Fan On	No		Not Simulated – Cannot complete due to available control in BAS
OA & RA & EA Dampers set to Maintain the SAT Set-Point	No		Not Simulated – Cannot complete due to available control in BAS
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	No		Not Simulated – Cannot complete due to available control in BAS
Heating Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS
Cooling Coil Valve Modulates to	No		Not Simulated – Cannot complete due to available

Maintain SAT Set-Point			control in BAS

Table 4-49: AHU 6 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Return Fan On	No		Not Simulated – Cannot complete due to available control in BAS
OA & RA & EA Dampers set to the Minimum Airflow Position	No		Not Simulated – Cannot complete due to available control in BAS
Heating Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS
Cooling Coil Valve Modulates to Maintain SAT Set-Point	No		Not Simulated – Cannot complete due to available control in BAS

Table 4-50: AHU 6 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-51: AHU 6 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to .75" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 0.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-52: AHU 6 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-53: AHU 6 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

4.1.7 AHU #7 Functional Test Results

The following procedure was used to functional test the 100% OSA AHUs such as AHU #7. The Tables below present the test procedure and the results of the testing procedure for AHU #7.

Table 4-54: AHU 7 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-7 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidity Valve to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Once Pre-Heat Valve is 100% Open, then Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-55: AHU 7 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-7 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve is Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-56: AHU 7 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to	Yes	Pass	Functional Test was Completed 1/9/2014

Maintain SAT Set-Point			

Table 4-57: AHU 7 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-58: AHU 7 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-59: AHU 7 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-60: AHU 7 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-61: AHU 7 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones	Yes	Pass	The Duct SP Decreases to the Minimum

Requesting Duct SP Decrease			Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.8 AHU #8 Functional Test Results

The following procedure was used to functional test the 100% OSA AHUs such as AHU #8. The Tables below present the test procedure and the results of the testing procedure for AHU #8.

Table 4-62: AHU 8 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-9 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidity Valve to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Once Pre-Heat Valve is 100% Open, then Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-63: AHU 8 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-9 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve is Fully Closed	No	Fail	See Appendix A for notes
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-64: AHU 8 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	See Appendix A for notes

Table 4-65: AHU 8 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-66: AHU 8 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-67: AHU 8 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-68: AHU 8 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-69: AHU 8 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point

Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.9 AHU #9 Functional Test Results

The following procedure was used to functional test the 100% OSA AHUs such as AHU #9. The Tables below present the test procedure and the results of the testing procedure for AHU #9.

Table 4-70: AHU 9 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-11 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidity Valve to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Modulates to Maintain SAT	5800 CFM	Pass	Functional Test was Completed 1/9/2014
Once Pre-Heat Valve is 100% Open, then Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-71: AHU 9 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-11 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve is Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-72: AHU 9 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-73: AHU 9 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-74: AHU 9 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-75: AHU 9 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-76: AHU 9Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-77: AHU 9 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point

Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.10 AHU #11 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #11. The Tables below present the test procedure and the results of the testing procedure for AHU #11.

Table 4-78: AHU 11 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-79: AHU 11 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-80: AHU 11 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-81: AHU 11 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	OA & EA Dampers Fully Closed
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-82: AHU 11 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

4.2 PUMPING SYSTEM

Per VA request the pumps could be point-to-point tested, but not functionally tested since changing the fluid delta pressure would set off alarms at the Elmendorf side of the system. The Point to Point testing procedure used on pumps is as follows:

Table 4-83: Pump 1 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump 1A to 77.1%	80.7%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump 1B to 63.4%	65.0%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-84: Pump 2 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-85: Pump 3 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-86: Pump 4 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-87: Pump 5 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-88: Pump 6 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-89: Pump 7 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-90: Pump 8 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON		PASS	AK	1/8/2014	
Supply Fan S/S			ON		PASS	AK	1/8/2014	
EF-1 S/S			ON		PASS	AK	1/8/2014	

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON		PASS	AK	1/8/2014	
Supply Fan Status			ON		PASS	AK	1/8/2014	
EF-1 Status			ON		PASS	AK	1/8/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed		0	N/A	50	100	PASS	AK	1/8/2014	
RF VFD Speed			30-30	50	100	PASS	AK	1/8/2014	1
Economizer		0	0	50	100	PASS	AK	1/8/2014	
Humidity		0	50	50	100	PASS	AK	1/8/2014	
Heating Vavle		100	0	50	100	PASS	AK	1/8/2014	
Cooling Valve		0	0	50	100	PASS	AK	1/8/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72	73.7	°F	2	-1.7		PASS	AK	1/8/2014	
Mixed Air Temperature		57.7	53.9	°F	5	3.8		PASS	AK	1/8/2014	
Supply Air Temperature		59.7	59	°F	2	0.7		PASS	AK	1/8/2014	
Outside Air Temperature		10	11.4	°F	2	-1.4		PASS	AK	1/8/2014	
GHS Temp		190	190	°F	2	0		PASS	AK	1/8/2014	
GHR		181	180	°F	2	1		PASS	AK	1/8/2014	
EF-1 Duct Static Pressure											
Supply Air Humidity											

NOTES
1. Due to building operations, the fan was tested at min 30% Speed.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt	55			
	Min SAT Set-Pt (and corresponding VAV requests)	55			
	Max SAT Set-Pt (and corresponding VAV requests)	60			
	Supply DSP Set-Pt	1.3			
	Min DSP Set-Pt (and corresponding VAV requests)				
	Max DSP Set-Pt (and corresponding VAV requests)				
	EF-1 Duct Static Pressure				
	Space Humidity Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	RF VFD Speed				
	EF-1 Fan Speed				
	Economizer				
	EA Damper				
	Humidity				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On	YES	PASS	AK	1/9/2014	
	Return Fan On	YES	PASS	AK	1/9/2014	
	EF-1 On	YES	PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA	5800 CFM	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On	YES	PASS	AK	1/9/2014	
	Return Fan On	YES	PASS	AK	1/9/2014	
	EF-1 On	YES	PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Heat Valve Closed	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
Release Override Commands						
	All Overrides are Released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			2
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			2
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					3
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		N/A			
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint	YES	PASS	AK	1/9/2014	
Simulate a call for cooling where the economizer is re-enabled and mechanical cooling is enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			2
Simulate the conditions where there is no call for cooling					1
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve is closed	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

NOTES
1. SEE SCREEN SHOT. WHEN COOLING MODE IS RELEASED AND THE SEQUENCE STARTS CALLING FOR HEAT, THE HEATING VALVE OPENS WHILE THE ECONOMIZER IS STILL OPEN.
2. Not tested, OA temperature is below freezing and freeze stat alarm temperature and building is occupied.
3. Since OA temp is below freezing, this was tested by locking out economizer.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

OCCUPIED HUMMIDITY CONTROL		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for hummidity					
	Hummidity Valve modulates to maintain hummidity Set-Pt	YES	PASS	AK	1/9/2014	
	Simulate the conditions where there is no call for hummidity					
	Hummidity Valve Closes	YES	PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released	YES				

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON		PASS	AK	1/8/2014	
Supply Fan S/S			ON		PASS	AK	1/8/2014	
EF-2 S/S			ON		PASS	AK	1/8/2014	

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON		PASS	AK	1/8/2014	
Supply Fan Status			ON		PASS	AK	1/8/2014	
EF-2 Status			ON		PASS	AK	1/8/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/31	52	100	PASS	AK	1/8/2014	1
RF VFD Speed			38/38	52	100	PASS	AK	1/8/2014	1
Economizer			0	50	100	PASS	AK	1/8/2014	
EA Damper			0	50	100	PASS	AK	1/8/2014	
Humidity			0	50	100	PASS	AK	1/8/2014	
Heating Vavle			0	50	100	PASS	AK	1/8/2014	
Cooling Valve			0	45	100	PASS	AK	1/8/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72.2	72.3	°F	1	-0.1		PASS	AK	1/8/2014	
Mixed Air Temperature				°F				PASS	AK	1/8/2014	
Supply Air Temperature		62.9	64.3	°F	1	-1.4				1/8/2014	
Supply Air Temperature		65.6	68	°F	1	-2.4				11/22/2014	
Supply Air Humidity											

NOTES
1. Due to building operations, the fan was tested at min 30% Speed.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
AHU Control Set-Points					
	Supply Air Temperature Set-Pt	65	JTWB	1/9/2014	
	Min SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
	Max SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
	Supply DSP Set-Pt	1.2	JTWB	1/9/2014	
	Min DSP Set-Pt (and corresponding VAV requests)	1	JTWB	1/9/2014	
	Max DSP Set-Pt (and corresponding VAV requests)	1.4	JTWB	1/9/2014	
	EF-2 Duct Static Pressure	0.483	JTWB	1/9/2014	
	Space Humidity Set-Pt	30%	JTWB	1/9/2014	
	Filter Dirty Set-Pt	1.25	JTWB	1/9/2014	
	Low Temperature Set-Pt.				can not find
	High Duct Static Pressure Set-Pt				can not find
As-Found Conditions					
	SF VFD Speed	64.40%	JTWB	1/9/2014	
	RF VFD Speed	30%	JTWB	1/9/2014	
	EF-14 Fan Speed	82.40%	JTWB	1/9/2014	
	Economizer	59.70%	JTWB	1/9/2014	
	EA Damper	same as above	JTWB	1/9/2014	same as above?
	Humidity	36.80%	JTWB	1/9/2014	
	Heating Vavle	54%	JTWB	1/9/2014	
	Cooling Valve	0%	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On	YES	PASS	JTWB	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-2 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On	YES	PASS	JTWB	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-2 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heat Valve Closed	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released	YES	PASS	JTWB	1/9/2014	
	Supply Fan, EF-2 & Return Fan to Auto	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Heat Valve Set to Auto	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
	Humidification Set to Auto	YES	PASS	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			1
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					3
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint	YES	PASS	AK	1/9/2014	
Simulate a call for cooling where the economizer is re-enabled and mechanical cooling is enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			
Simulate the conditions where there is no call for cooling					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve is closed		N/A			
Release all system overrides					
All overrides are released		YES			

NOTES
1. Not tested, OA temperature is below freezing and freeze stat alarm temperature and building is occupied.
3. Since OA temp is below freezing, this was tested by locking out economizer.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	YES	PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	YES	PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt	YES	PASS	AK	1/9/2014	1
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

NOTES
1 HUMIDIFIER VERY SLOW TO RESPOND

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES	PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON		PASS	AK	1/9/2014	
Supply Fan S/S			ON		PASS	AK	1/9/2014	
EF-3 S/S			ON		PASS	AK	1/9/2014	

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON		PASS	AK	1/9/2014	
Supply Fan Status			ON		PASS	AK	1/9/2014	
EF-3 Status			ON		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/31	52	100	PASS	AK	1/9/2014	
RF VFD Speed			30/31	52	100	PASS	AK	1/9/2014	
Economizer			0	30	100	PASS	AK	1/9/2014	1
EA Damper			0	50	100	PASS	AK	1/9/2014	
Humidity			0	50	100	PASS	AK	1/9/2014	
Heating Vavle			0	50	100	PASS	AK	1/9/2014	
Cooling Valve			0	45	100	PASS	AK	1/9/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72.5	74.6	°F		-2.1		PASS	AK	1/9/2014	
Mixed Air Temperature		49.4	56	°F		-6.6		PASS	AK	1/9/2014	2
Supply Air Temperature		64.7	64	°F		0.7		PASS	AK	1/9/2014	
Return Duct Static Pressure											
Supply Duct Static Pressure											
EF-3 Duct Static Pressure											
Supply Air Humidity											

NOTES
1 RA DAMPER AT 50, OA DAMPER AT 30
2. Bad stratification MA box

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt	65	JTWB	1/9/2014	
		Min SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
		Max SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
		Supply DSP Set-Pt	1	JTWB	1/9/2014	
		Min DSP Set-Pt (and corresponding VAV requests)				
		Max DSP Set-Pt (and corresponding VAV requests)				
		EF-3 Duct Static Pressure				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
	As-Found Conditions					
		SF VFD Speed				
		RF VFD Speed				
		EF-3 Fan Speed				
		Economizer				
		EA Damper				
		Humidity				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On	YES	PASS	AK	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-3 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On	YES	PASS	JTWB	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-3 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heat Valve Closed	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			1
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		N/A			2
	Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	JTWB	1/9/2014	
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on	YES	PASS	AK	1/9/2014	
	Return fan is on	YES	PASS	AK	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
	Hot water valve is closed	YES	PASS	AK	1/9/2014	
	Chilled water valve is closed	YES	PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released	YES				

NOTES
1. OAT below freezing, I closed the economizer manually, then cooling valve opened & modulates
2. OAT below freezing, economizer never at 100%

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		PASS	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					
EF-4 S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON					
Supply Fan Status			ON					
EF-4 Status			ON					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/32	52	100	P			
RF VFD Speed			30/31	52	100	P			
Economizer			0	50	100	P			
EA Damper			0	50	100	P			
Humidity			0	50	100	P			
Heating Vavle			0	50	100	P			
Cooling Valve			0	45	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		71.2	73.7			-2.5					
Mixed Air Temperature		40.3	36.6			3.7					
Supply Air Temperature		62.1	62.5			-0.4					
Outside Air Temperature											
Return Duct Static Pressure											
Supply Duct Static Pressure											
EF-4 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt				
	Min SAT Set-Pt (and corresponding VAV requests)				
	Max SAT Set-Pt (and corresponding VAV requests)				
	Supply DSP Set-Pt				
	Min DSP Set-Pt (and corresponding VAV requests)				
	Max DSP Set-Pt (and corresponding VAV requests)				
	EF-4 Duct Static Pressure				
	Space Humidity Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	RF VFD Speed				
	EF-4 Fan Speed				
	Economizer				
	EA Damper				
	Humidity				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	AK	1/9/2014	
	Return Fan On		PASS	AK	1/9/2014	
	EF-4 On		PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On		PASS	AK	1/9/2014	
	Return Fan On		PASS	AK	1/9/2014	
	EF-4 On		PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Heat Valve Closed		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
Release Override Commands						
	All Overrides are Released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			1
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		N/A			1
	Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					4
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	JTWB	1/9/2014	
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	JTWB	1/9/2014	
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve is closed	YES	PASS	JTWB	1/9/2014	
	Release all system overrides					
	All overrides are released		YES			

NOTES
1. Not tested, OA temperature is below freezing and freeze stat alarm temperature and building is occupied.
4. Since OA temp is below freezing, this was tested by locking out economizer.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt					
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes					
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint					
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint					
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					
EF-5 S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON					
Supply Fan Status			ON					
EF-5 Status			ON					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/31	50	100	P	AK	1/8/2014	
RF VFD Speed			30/31	50	100	P	AK	1/8/2014	
Economizer			0	50	100	P	AK	1/8/2014	
EA Damper			0	50	100	P	AK	1/8/2014	
Humidity			0	50	100	P	AK	1/8/2014	
Heating Vavle			0	55	100	P	AK	1/8/2014	
Cooling Valve			0	50	100	P	AK	1/8/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72.3	71.2			1.1				11/22/2013	
Mixed Air Temperature		47	56.5			-9.5				11/22/2013	
Supply Air Temperature		59.7	59			0.7				11/22/2013	
Outside Air Temperature											
Return Duct Static Pressure											
Supply Duct Static Pressure											
EF-5 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt	60			
		Min SAT Set-Pt (and corresponding VAV requests)	60 (5)			
		Max SAT Set-Pt (and corresponding VAV requests)	60 (5)			
		Supply DSP Set-Pt	0.7			
		Min DSP Set-Pt (and corresponding VAV requests)	1.1 (2)			
		Max DSP Set-Pt (and corresponding VAV requests)	.7 (7)			
		EF-5 Duct Static Pressure				
		Space Humidity Set-Pt	30			
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
	As-Found Conditions					
		SF VFD Speed	76			
		RF VFD Speed	74			
		EF-5 Fan Speed				
		Economizer	13			
		Humidity	32			
		Heating Vavle	0			
		Cooling Valve	0			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

OCCUPIED HEATING			VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating						
		Supply Fan On		P			
		Return Fan On		P			
		OA & RA Dampers set for Min OSA		P			
		Humidifier Valve Auto		P			
		Heating Valve Modulates to Maintain Supply Air Temp		P			
		Cooling Valve is Closed		P			
	Simulate NO Call for Heating						
		Supply Fan On		P			
		Return Fan On		P			
		OA & RA Dampers set for Min OSA		P			
		Humidifier Valve Auto		P			
		Heat Valve Closed		P			
		Cooling Valve is Closed		P			
	Release Override Commands						
		All Overrides are Released		P			
		Supply Fan, EF-5 & Return Fan to Auto		P			
		OA & RA Dampers set for Min OSA		P			
		Heat Valve Set to Auto		P			
		Cooling Valve is Closed		P			
		Humidification Set to Auto		P			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on		PASS	AK	1/9/2014	
Return fan is on		PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint		PASS	AK	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		n/a			
Hot water valve is closed		PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		n/a			
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
Supply fan is on		PASS	AK	1/9/2014	
Return fan is on		PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	AK	1/9/2014	
Hot water valve is closed		PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint					1
Simulate the conditions where there is no call for cooling					
Supply fan is on		PASS	AK	1/9/2014	
Return fan is on		PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	AK	1/9/2014	
Hot water valve is closed		PASS	AK	1/9/2014	
Chilled water valve is closed		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

NOTES
1. AFTER 15 MIN OF COOLING VALVE FULLY OPEN, ECONOMIZER AT 10%, MAT AT 67, THE SAT IS 59 AND THE SETPOINT IS 55, FAN SPEED 93%. ONLY 7 DEGREES OF COOLING ON THE COIL. COOLING SUPPLY TEMP IS 53 AT UNI

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		FAIL	JTWB	1/9/2014	can only maintain 1.
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		FAIL	JTWB	1/9/2014	can only maintain 1.
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	AK	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON					
Supply Fan Status			ON					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/32	50	100	PASS			
RF VFD Speed			30/32	50	100	PASS			
Economizer			NOTE 1	50	100	PASS			1
Humidity			0	50	100	PASS			
Heating Vavle			0	50	100	PASS			
Cooling Valve			0	50	100	PASS			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		67.2	70.7			-3.5				11/22/2013	
Mixed Air Temperature		58.4	50			8.4				11/22/2013	
Supply Air Temperature		64.2	64.9			-0.7				11/22/2013	
Outside Air Temperature											

NOTES
1. 1/4" GAP ON RIGHT SIDE OF OA DAMPER WHEN COMMANDED CLOSED.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt				
		Min SAT Set-Pt (and corresponding space temp deviation)				
		Max SAT Set-Pt (and corresponding space temp deviation)				
		Supply DSP Set-Pt				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
		Return Duct Hugh CO2 Set-Pt				
	As-Found Conditions					
		SF VFD Speed				
		RF VFD Speed				
		Economizer				
		Humidity				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	Return Fan On		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Humidifier Valve Auto		PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On					1
	Return Fan On					1
	OA & RA Dampers set for Min OSA					1
	Humidifier Valve Auto					1
	Heat Valve Closed					1
	Cooling Valve is Closed					1
Release all system overrides						
	All overrides are released		PASS	JTWB	1/9/2014	

NOTES
1 NOT SIMULATED - cannot simulate due to avaiable controls in BAS

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on					1, 2
Return fan is on					1, 2
OA/RA/EA dampers modulate to maintain the SAT setpoint					1, 2
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled					1, 2
Hot water valve is closed					1, 2
Chilled water valve modulates to maintain SAT setpoint					1, 2
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
Supply fan is on					1, 2
Return fan is on					1, 2
OA/RA/EA dampers are at the minimum outside airflow position					1, 2
Hot water valve is closed					1, 2
Chilled water valve modulates to maintain SAT setpoint					1, 2
Simulate the conditions where there is no call for cooling					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	JTWB	1/9/2014	
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve is closed		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		yes			

NOTES	
1 NOT SIMULATED - cannot simulate due to avaiable controls in BAS	(this unit's controls are different than the other units)
2 Manual setpoint of 55F commanded to observe unit in cooling mode (both with and without economizer)	Heating valve closes, economizer opens.
	If economizer is locked shut then cooling valve will open

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 0.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 0.75 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released					

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON SPACE TEMPEARTURE DEVIATION	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override space temperature above setpoint with 1 deg					1
The SAT setpoint decreases to the minimum SAT setpoint					
Override space temperature below setpoint with 1 deg					1
The SAT setpoint increases to the maximum SAT setpoint					
Override space temperature below setpoint with 2 deg					1
The SAT setpoint increases to the maximum SAT setpoint					
Release all system overrides					
All overrides are released		yes			

NOTES
1 Not possible, no space temperature feedback to override

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan S/S								
EF-7 S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan Status								
EF-7 Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			35/36.3	75/77.5	100/100	PASS	AK	1/9/2014	
EF-7 Fan Speed			35/36.5	75/78	100/100	PASS	AK	1/9/2014	
Humidity			0	50	100	PASS	AK	1/9/2014	
Pre-Heat Vavle			0	45	100	PASS	AK	1/9/2014	
Heating Vavle			0	50	100	PASS	AK	1/9/2014	
Cooling Valve			0	50	100	PASS	AK	1/9/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Pre Heat Air Temperature		62.6	63.6	°F		-1		PASS	JTWB	11/22/2013	
Supply Air Temperature		60.7	59	°F		1.7		PASS	JTWB	1/9/2014	
Outside Air Temperature		10	11.4	°F		-1.4		PASS	JTWB	11/22/2013	
Supply Duct Static Pressure											
EF-7 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt				
		Min SAT Set-Pt (and corresponding zone requests)				
		Max SAT Set-Pt (and corresponding zone requests)				
		Supply DSP Set-Pt				
		Min DSP Set-Pt (and corresponding zone requests)				
		Max DSP Set-Pt (and corresponding zone requests)				
		EF-7 Duct Static Pressure				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
	As-Found Conditions					
		SF VFD Speed				
		EF-7 Fan Speed				
		OA Damper				
		EA Damper				
		Humidity				
		Pre-Heat Valve				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating					
	Supply Fan On		PASS	AK	1/9/2014	
	EF-7 On		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Pre-Heat Valve Modulates to Maintain Supply Air Temp		PASS	AK	1/9/2014	
	Once Pre-Heat is 100% Open, Heating Valve Modulates to Maintain Supply Air Temp		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
	Simulate NO Call for Heating					
	Supply Fan On		PASS	AK	1/9/2014	
	EF-7 On		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Pre-Heat Valve is Closed		PASS	AK	1/9/2014	
	Heating Valve is Closed		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
	Release Override Commands					
	All Overrides are Released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 &EF-7

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on		PASS	AK	1/9/2014	
	EF-7 is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		PASS	AK	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on		PASS	AK	1/9/2014	
	EF-7 is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve is closed		PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 &EF-7

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	AK	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 &EF-7

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON ZONE HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		pass	JTWB	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES	JTWB	1/9/2014	

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON ZONE REQUESTS	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		pass	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan S/S								
EF-9 S/S								
DX Stage #1 S/S								
DX Stage #2 S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan Status								
EF-9 Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/32	50	100	P			
Humidity			0	50	100	P			
Pre-Heat Vavle			0	50	100	P			
Heating Vavle			0	50	100	P			
Cooling Valve			0	50	100	P			
EF-9 VFD SPEED			30/32	50	100	P			

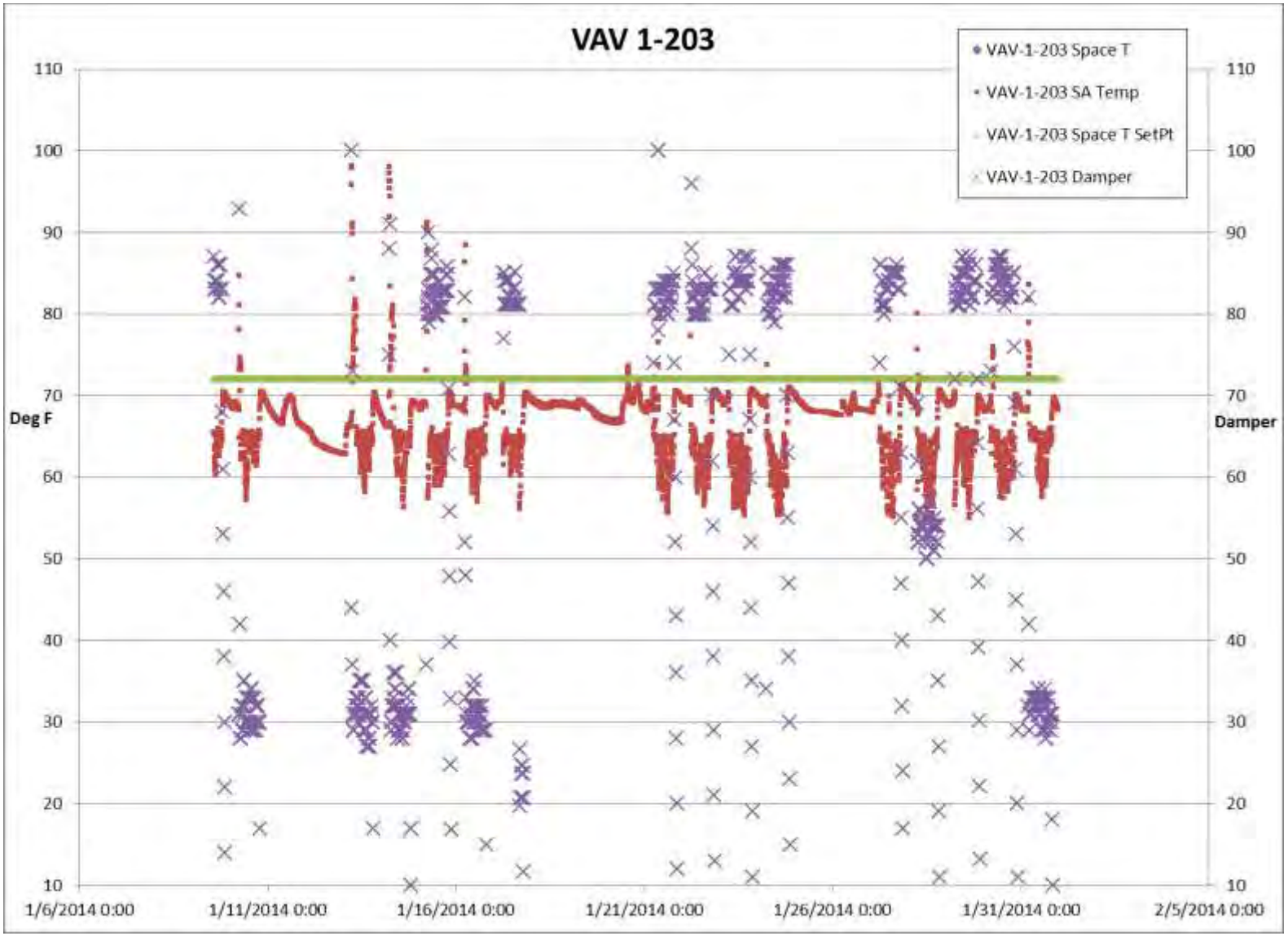
ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Pre Heat Air Temperature		52.5	55			-2.5					
Supply Air Temperature		55.2	59.7			-4.5					
Outside Air Temperature		10	11			-1					
After DX Temperature		48.8	48.5			0.3					*Potential CHW C

NOTES
HOBO OA, PREHEAT, AFTER DX

Appendix-A

For Final RCx Report

Retro-Commissioning Plan


VAV 1-203
VAV-1-203 Space T
VAV-1-203 SA Temp
VAV-1-203 Space T SetPt
VAV-1-203 Damper
Deg F
Damper
110
100
90
80
70
60
50
40
30
20
10
1/6/2014 0:00
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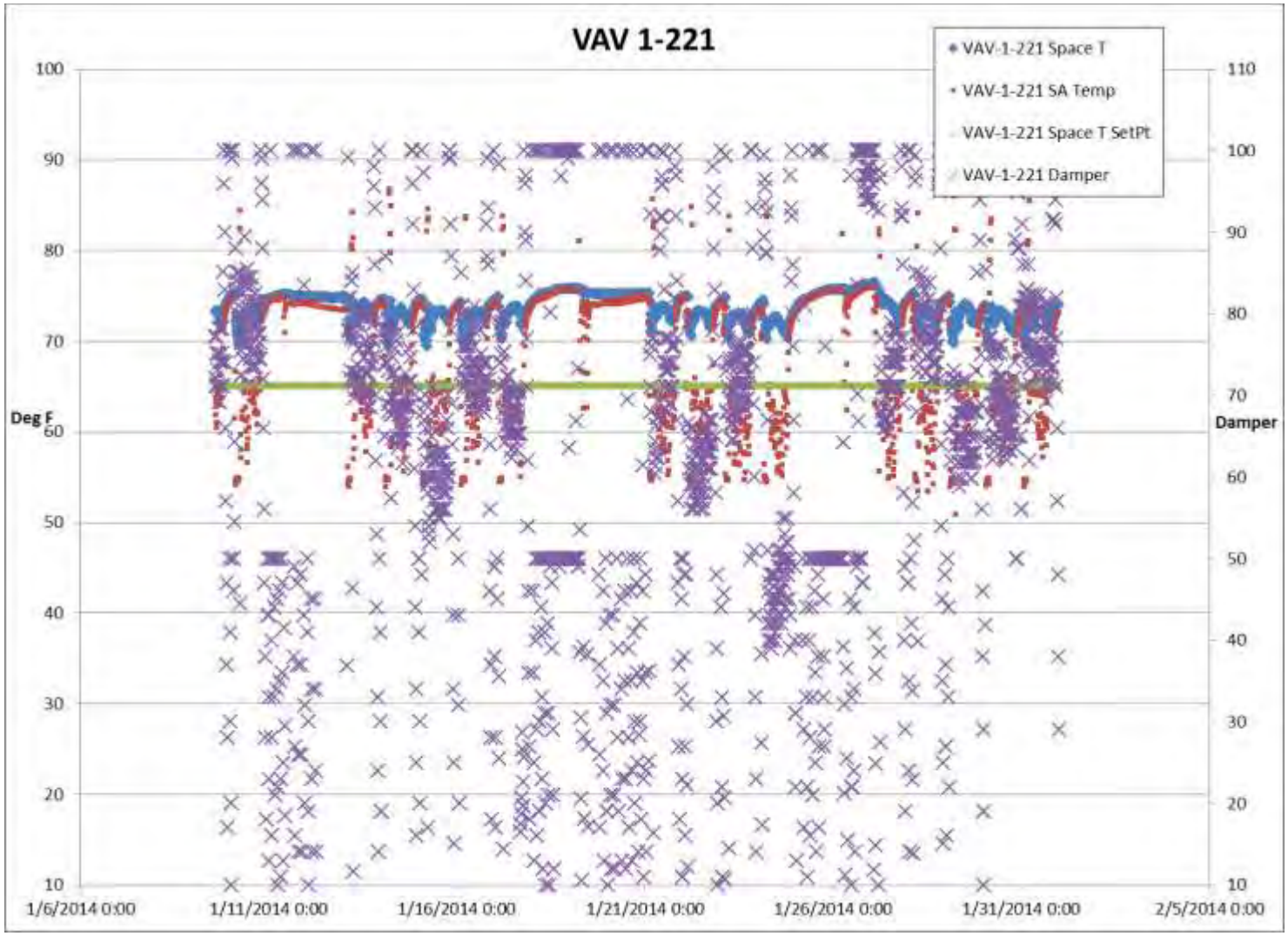
2/5/2014 0:00


VAV 1-221
VAV-1-221 Space T
VAV-1-221 SA Temp
VAV-1-221 Space T SetPt
VAV-1-221 Damper
Deg F
Damper
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90
80
70
60
50
40
30
20
10
110
100
90
80
70
60
50
40
30
20
10
1/6/2014 0:00
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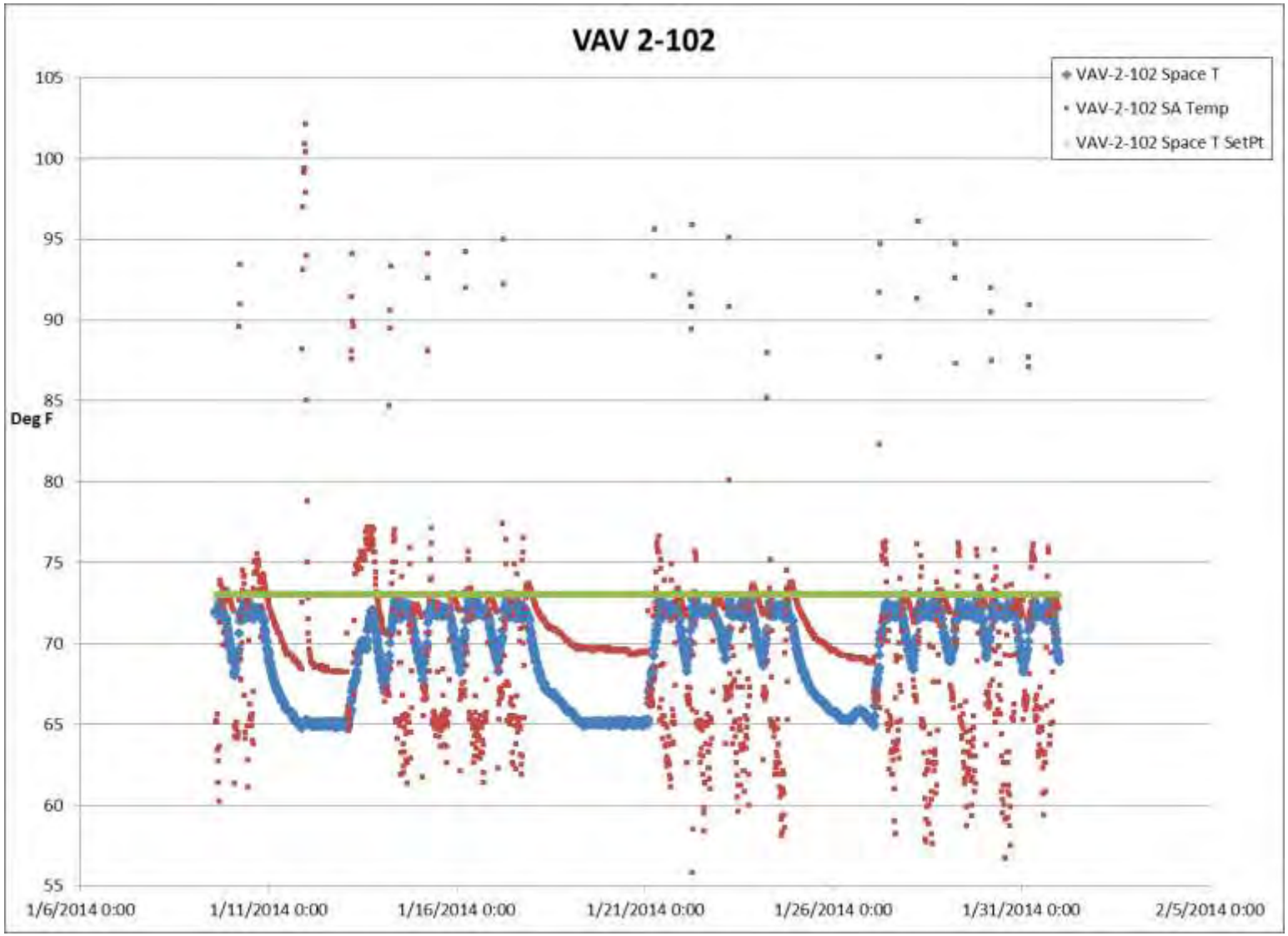
2/5/2014 0:00


VAV 2-102
VAV-2-102 Space T
VAV-2-102 SA Temp
VAV-2-102 Space T SetPt
Deg F
105
100
95
90
85
80
75
70
65
60
55
1/6/2014 0:00
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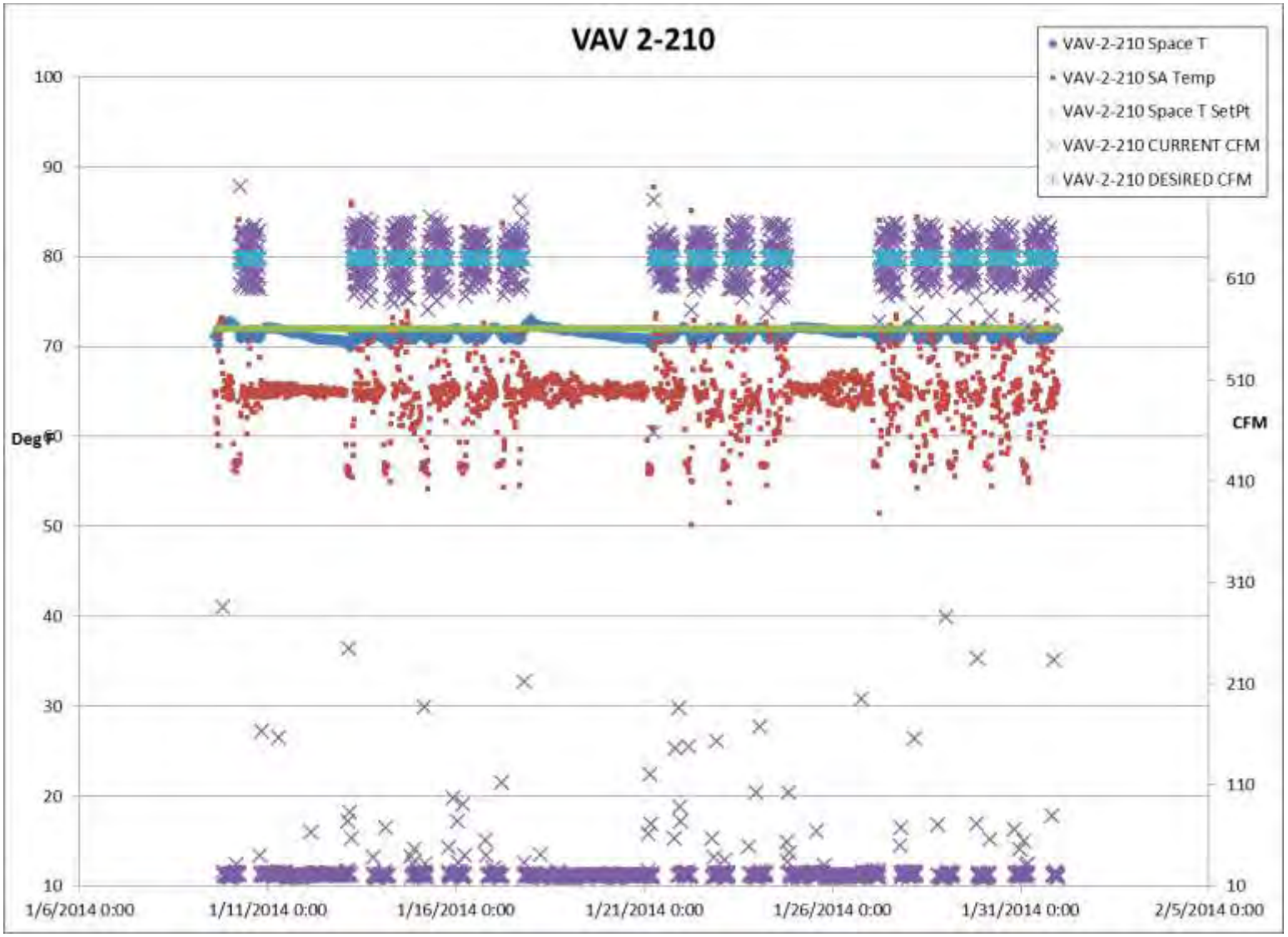
2/5/2014 0:00


VAV 2-210
VAV-2-210 Space T
VAV-2-210 SA Temp
VAV-2-210 Space T SetPt
VAV-2-210 CURRENT CFM
VAV-2-210 DESIRED CFM
Deg F
CFM
100
90
80
70
60
50
40
30
20
10
610
510
410
310
210
110
10
1/6/2014 0:00
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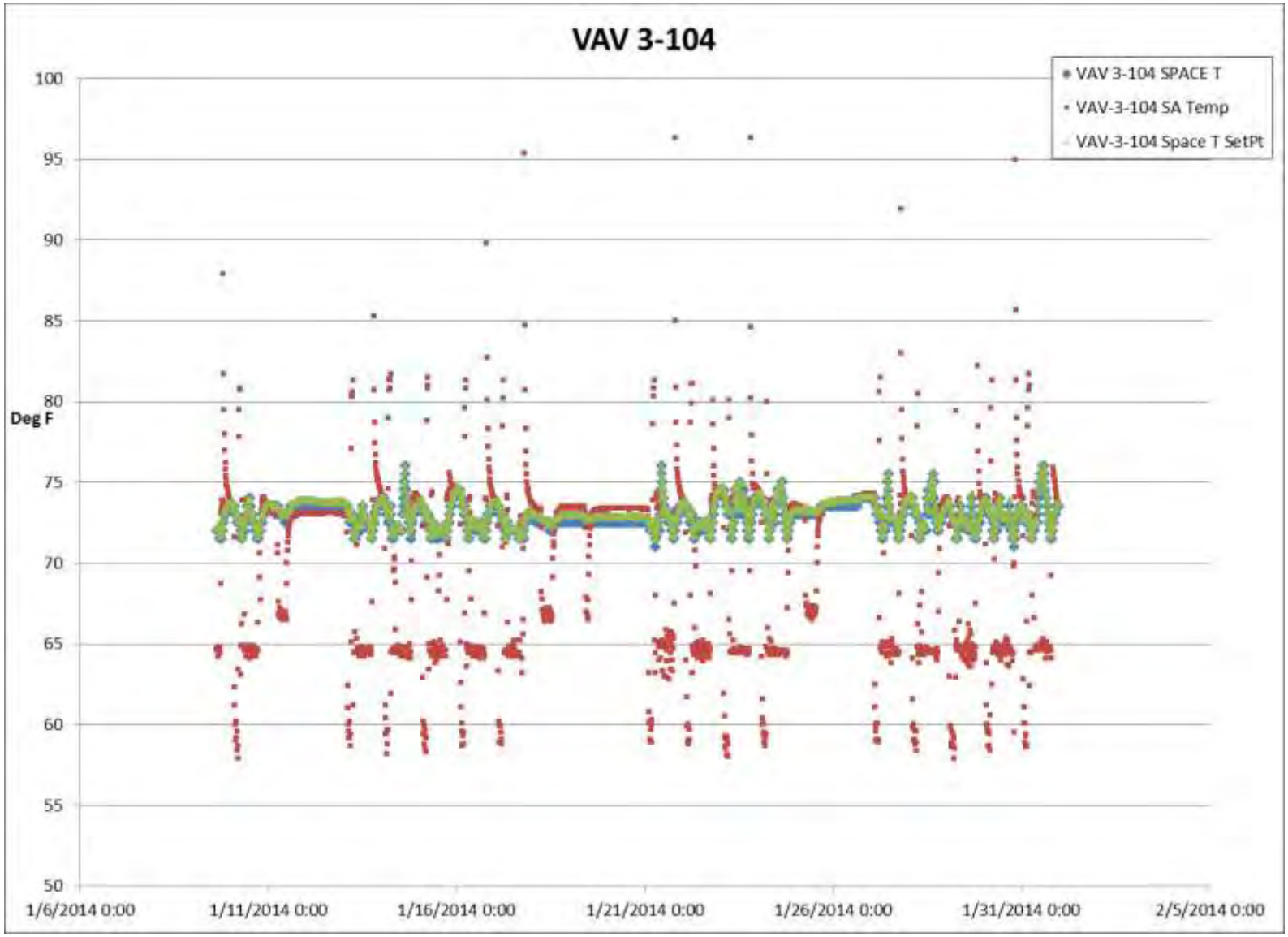
2/5/2014 0:00


VAV 3-104
VAV 3-104 SPACE T
VAV-3-104 SA Temp
VAV-3-104 Space T SetPt
Deg F
100
95
90
85
80
75
70
65
60
55
50
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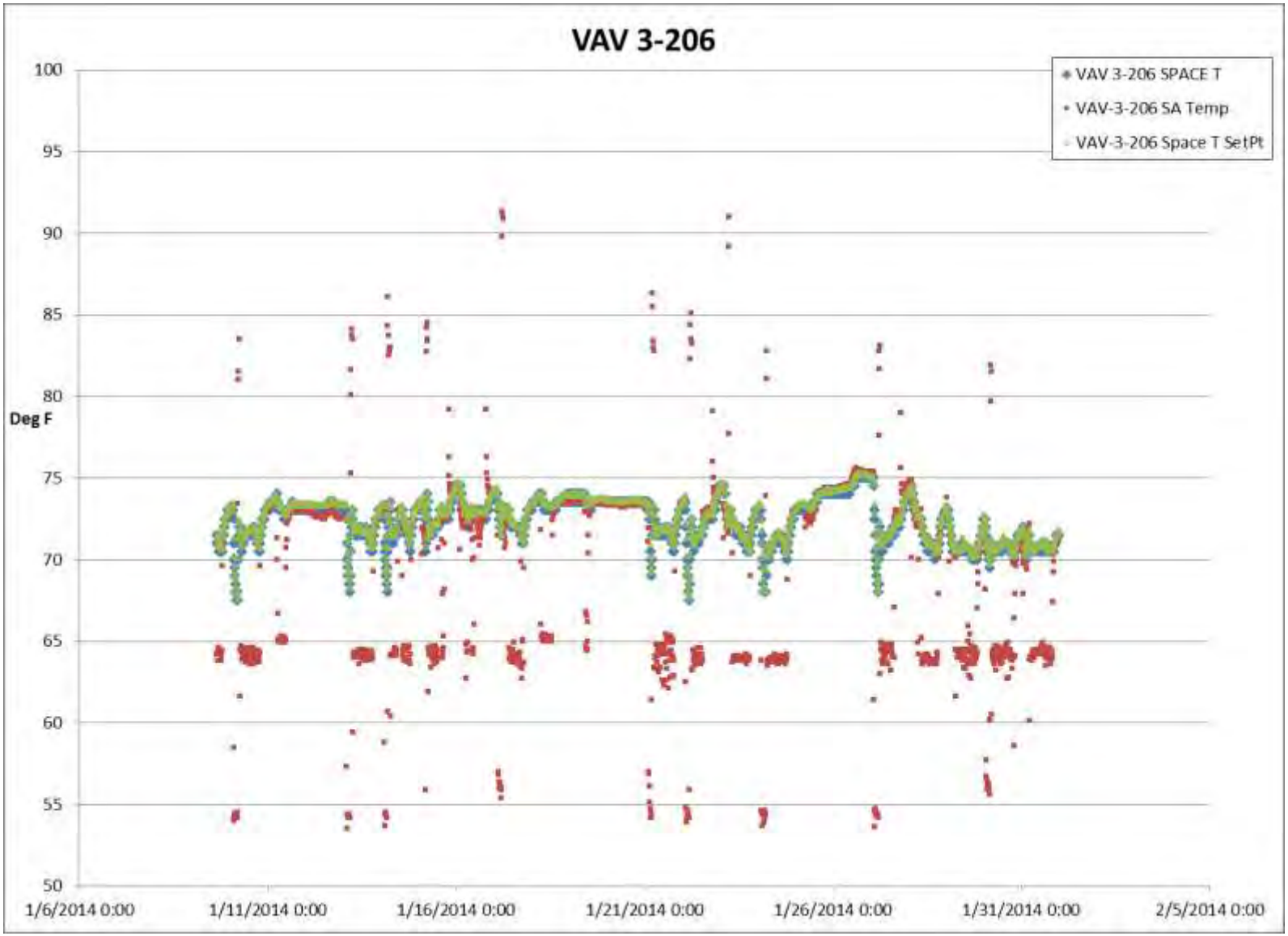
2/5/2014 0:00


VAV 3-206
VAV 3-206 SPACE T
VAV-3-206 SA Temp
VAV-3-206 Space T SetPt
Deg F
100
95
90
85
80
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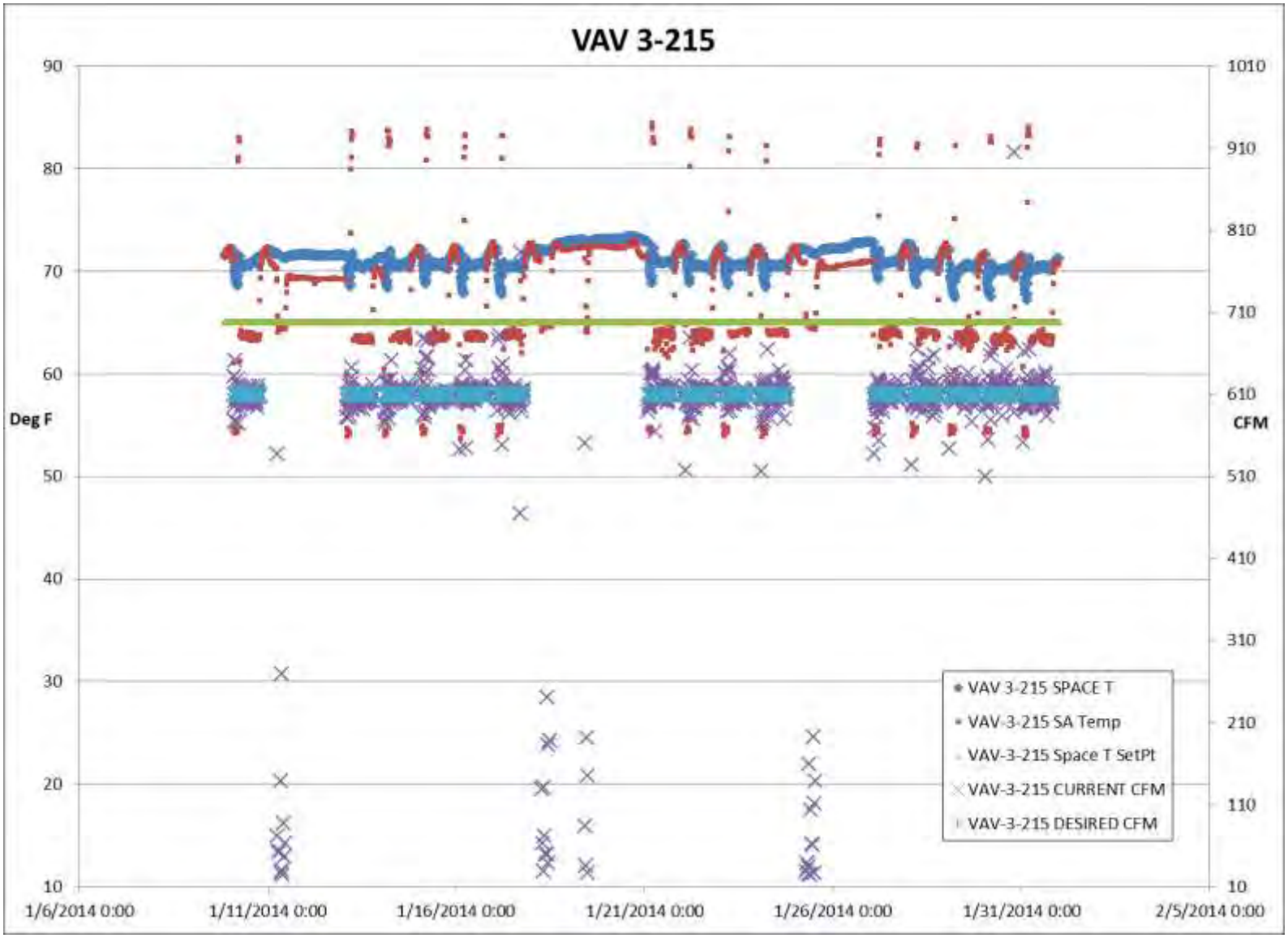
70
65
60
55
50
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00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Deg F
CFM
90
80
70
60
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40
30
20
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1010
910
810
710
610
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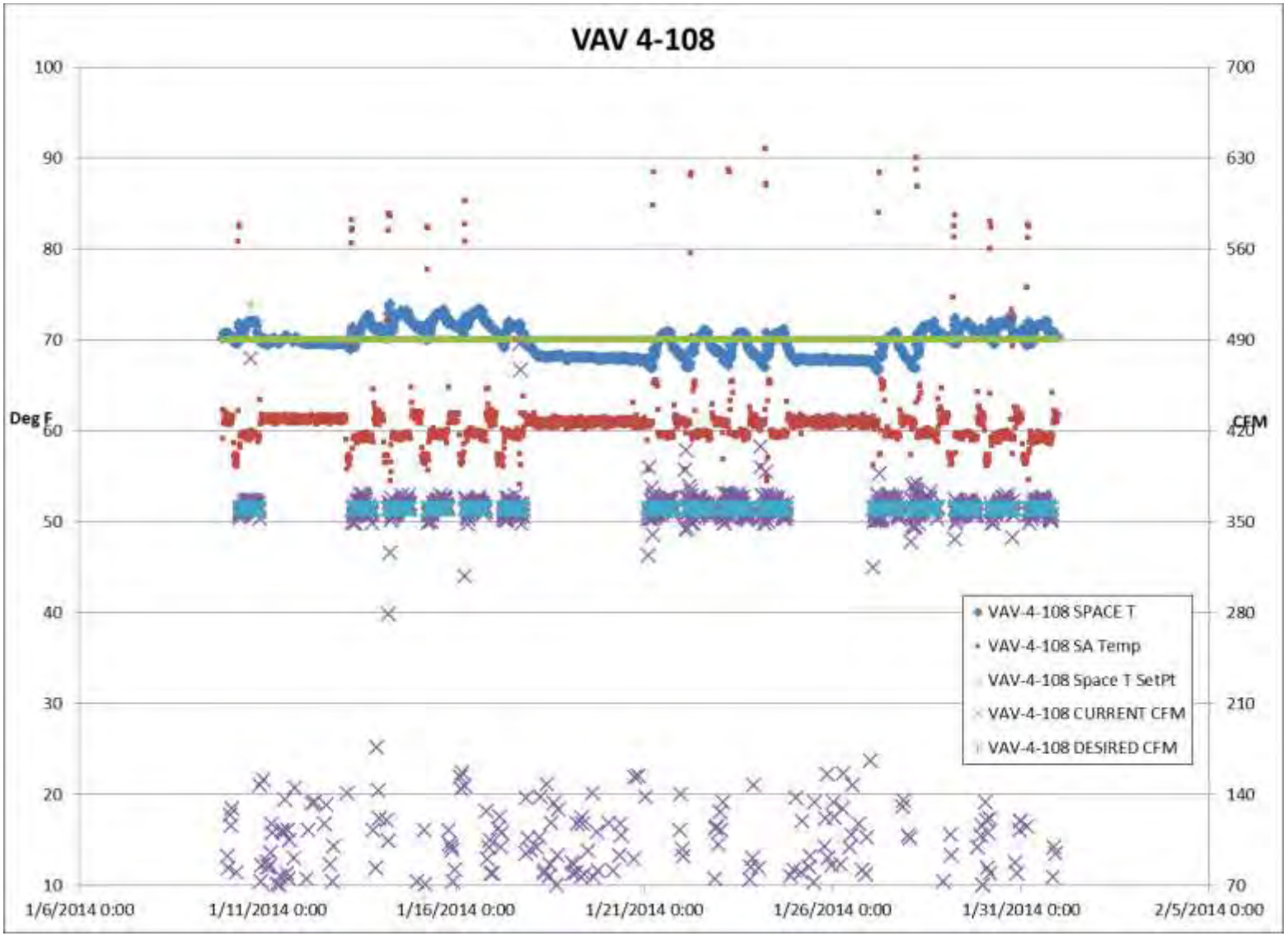
310
210
110
10
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
VAV 3-215 SPACE T
VAV-3-215 SA Temp
VAV-3-215 Space T SetPt
VAV-3-215 CURRENT CFM
VAV-3-215 DESIRED CFM


VAV 4-108
Deg F
CFM
100
90
80
70
60
50
40
30
20
10
700
630
560
490
420
350
280
210
140
70
1/6/2014 0:00
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1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
VAV-4-108 SPACE T
VAV-4-108 SA Temp
VAV-4-108 Space T SetPt
VAV-4-108 CURRENT CFM
VAV-4-108 DESIRED CFM

VAV 4-109
Deg F
CFM
100
90
80
70
60
50
40
30
20
10
2510
2010
1510
1010
510
10
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00
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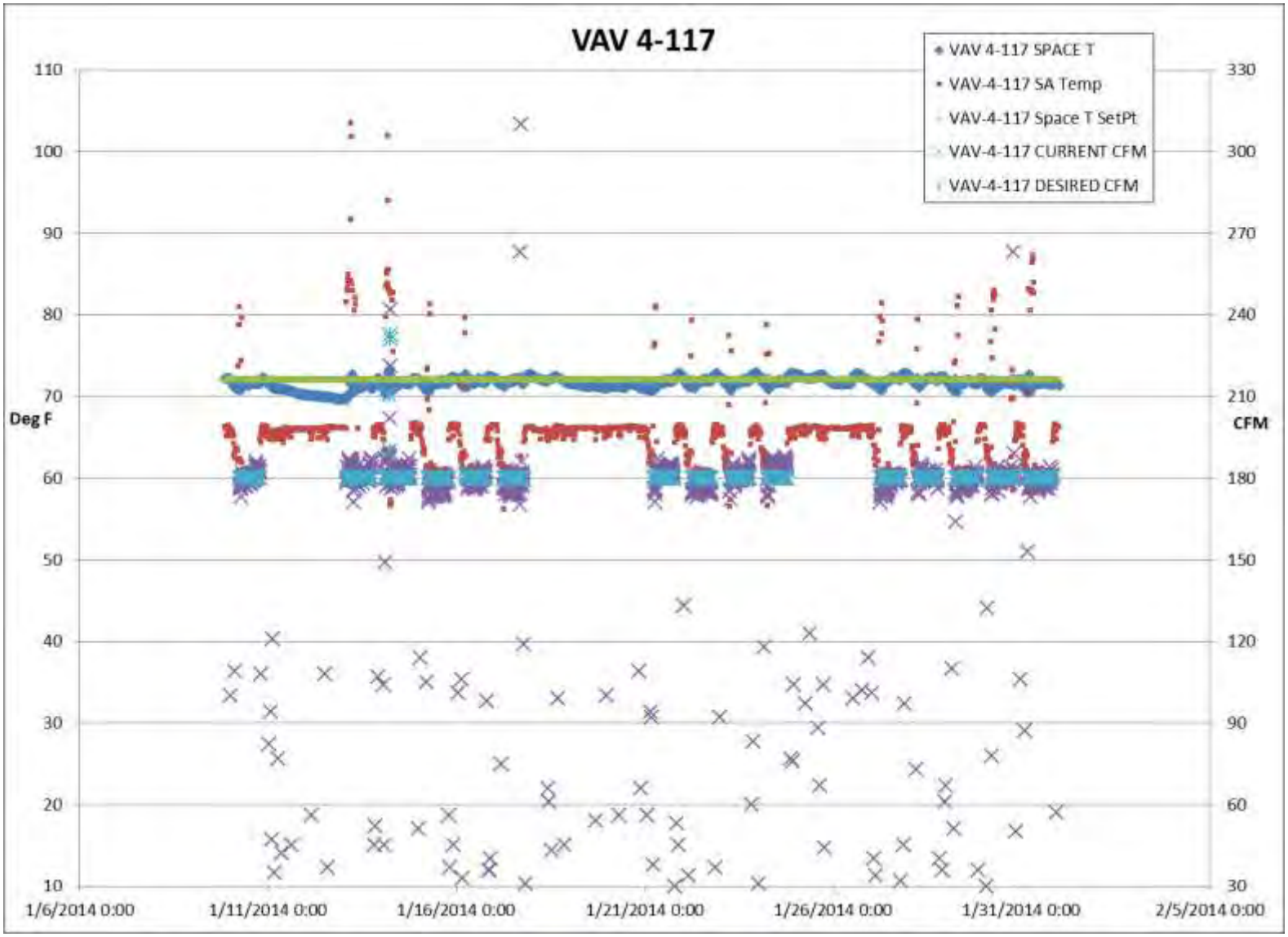
VAV-4-109 SA Temp
VAV-4-109 Space T SetPt
VAV-4-109 CURRENT CFM
VAV-4-109 DESIRED CFM


VAV 4-117
VAV 4-117 SPACE T
VAV-4-117 SA Temp
VAV-4-117 Space T SetPt
VAV-4-117 CURRENT CFM
VAV-4-117 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
330
300
270
240
210
180
150
120
90
60
30
1/6/2014 0:00
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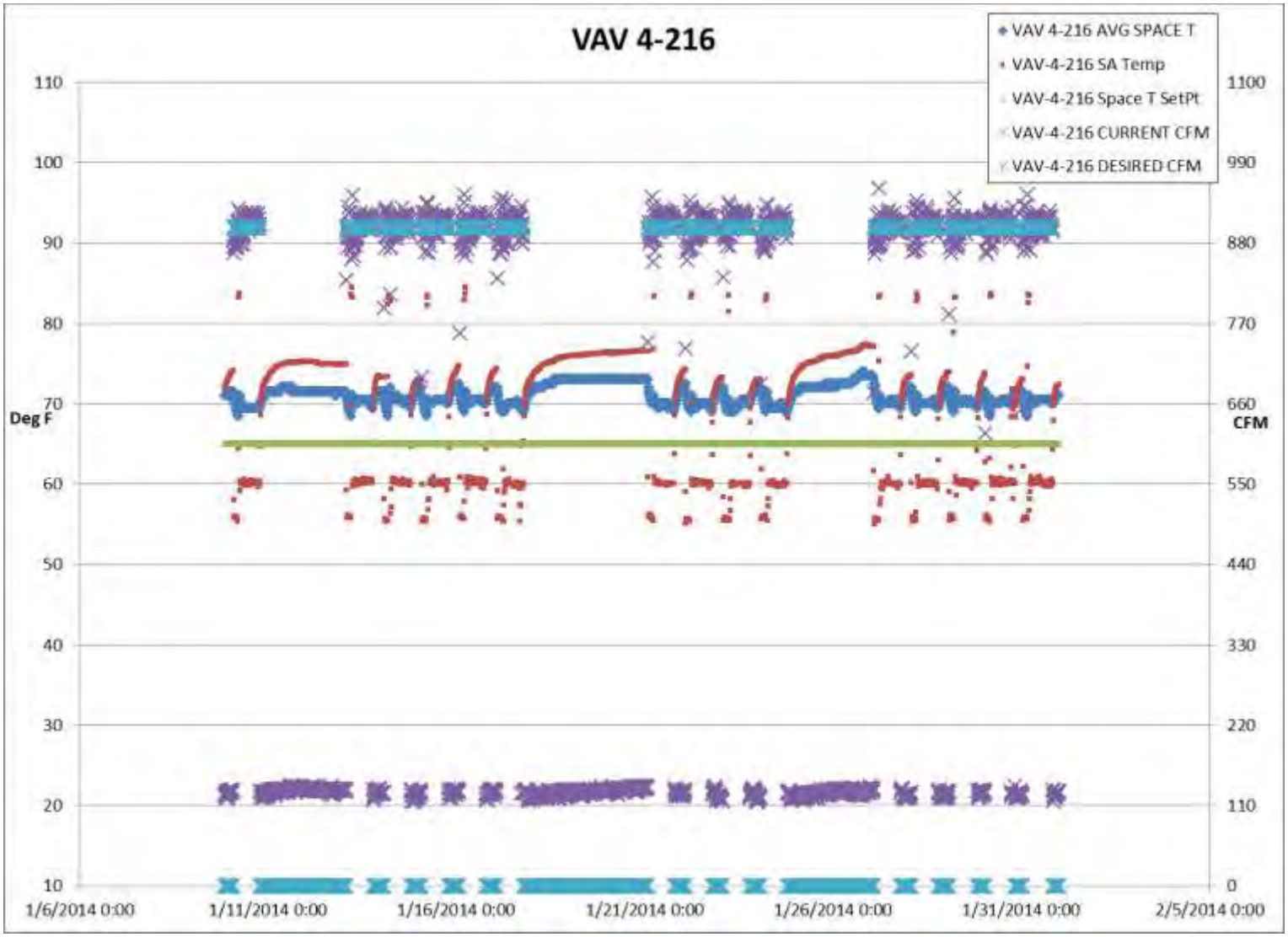
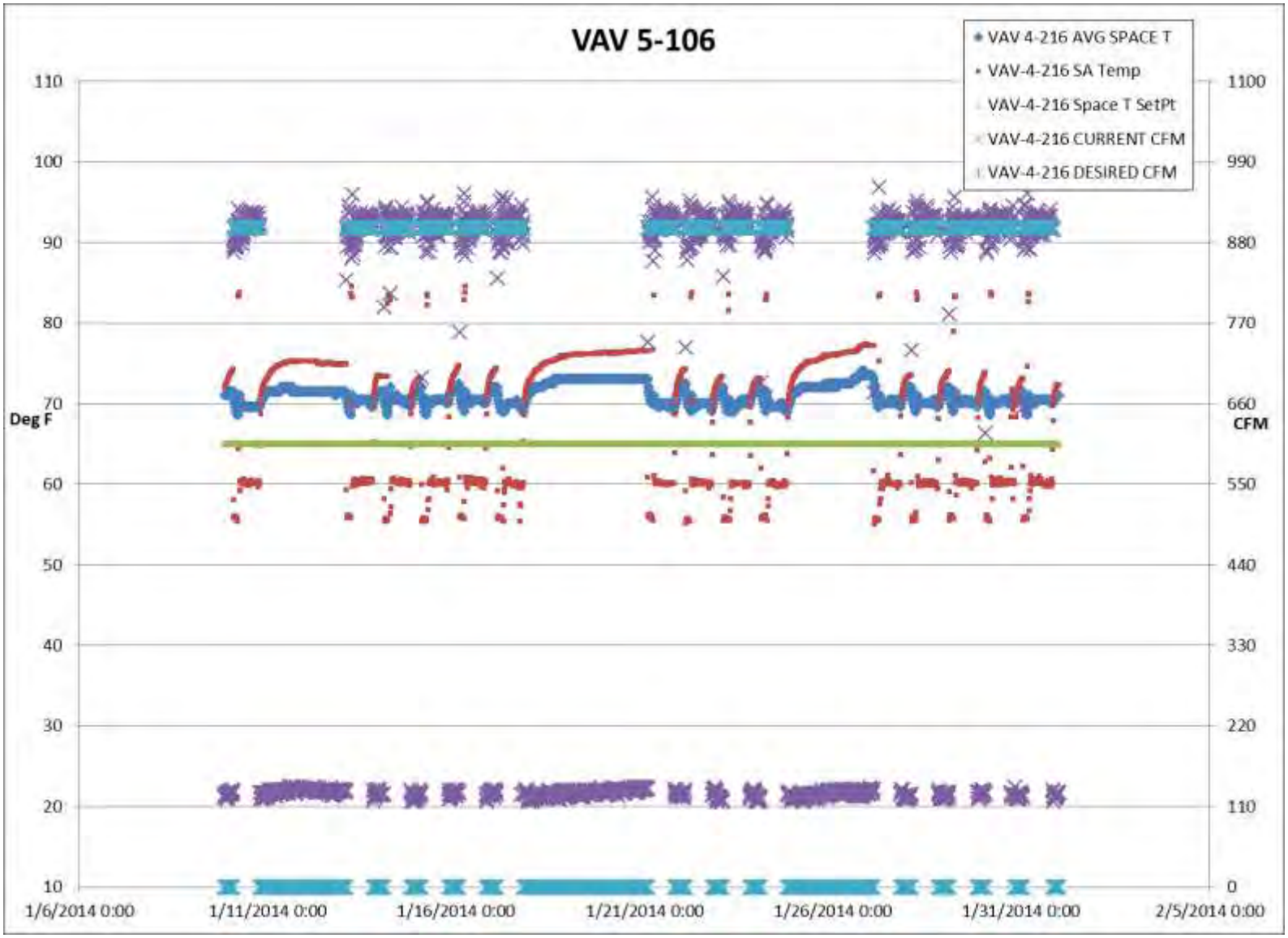

VAV 4-216
VAV 4-216 AVG SPACE T
VAV-4-216 SA Temp
VAV-4-216 Space T SetPt
VAV-4-216 CURRENT CFM
VAV-4-216 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
1100
990
880
770
660
550
440
330
220
110
0
1/6/2014 0:00
1/11/2014 0:00
1/16/2014 0:00
1/21/2014 0:00
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00


VAV 5-106
VAV 4-216 AVG SPACE T
VAV-4-216 SA Temp
VAV-4-216 Space T SetPt
VAV-4-216 CURRENT CFM
VAV-4-216 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
1100
990
880
770
660
550
440
330
220
110
0
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1/26/2014 0:00
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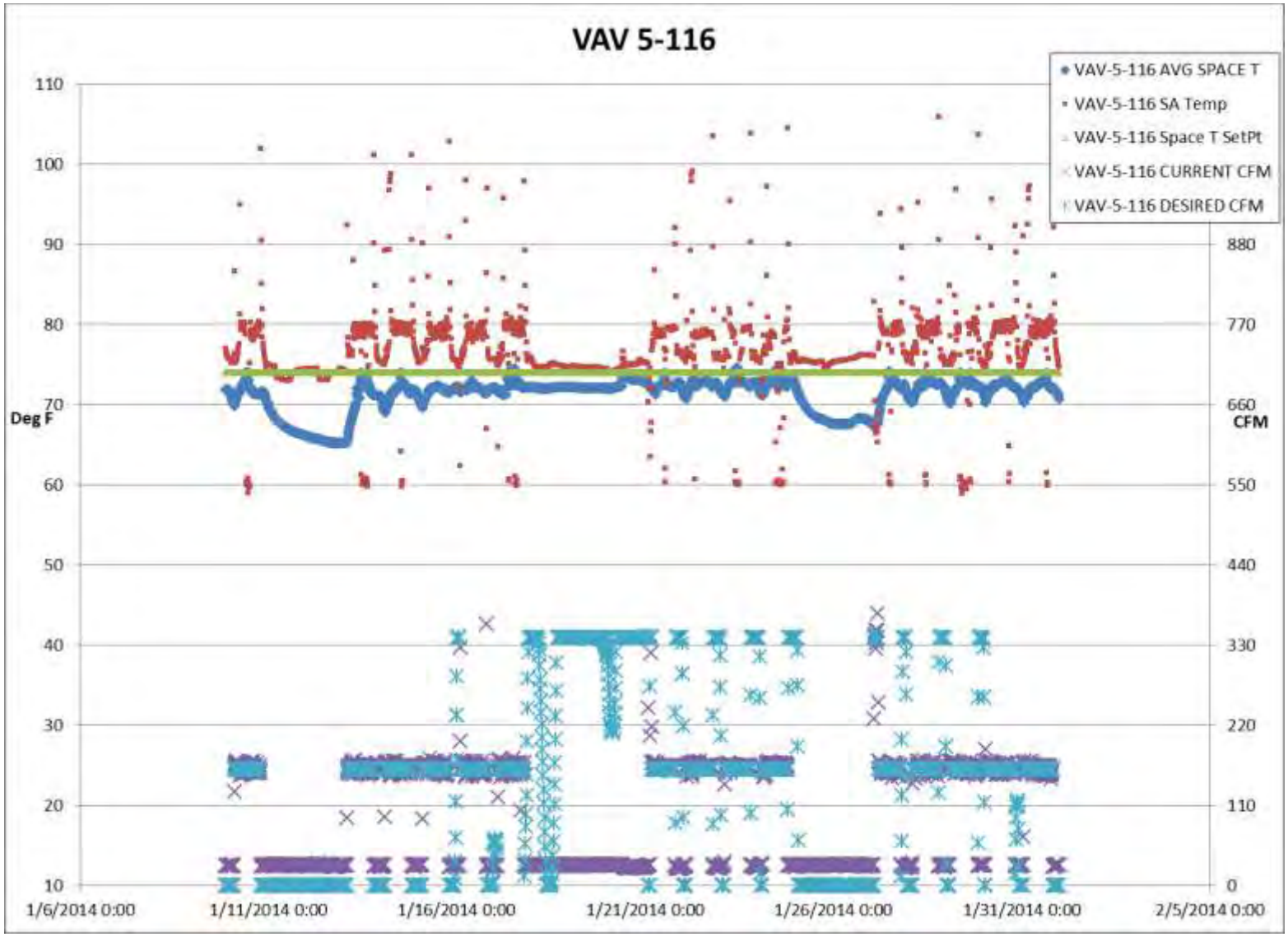
2/5/2014 0:00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VAV-5-116 AVG SPACE T
VAV-5-116 SA Temp
VAV-5-116 Space T SetPt
VAV-5-116 CURRENT CFM
VAV-5-116 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
880
770
660
550
440
330
220
110
0
1/6/2014 0:00
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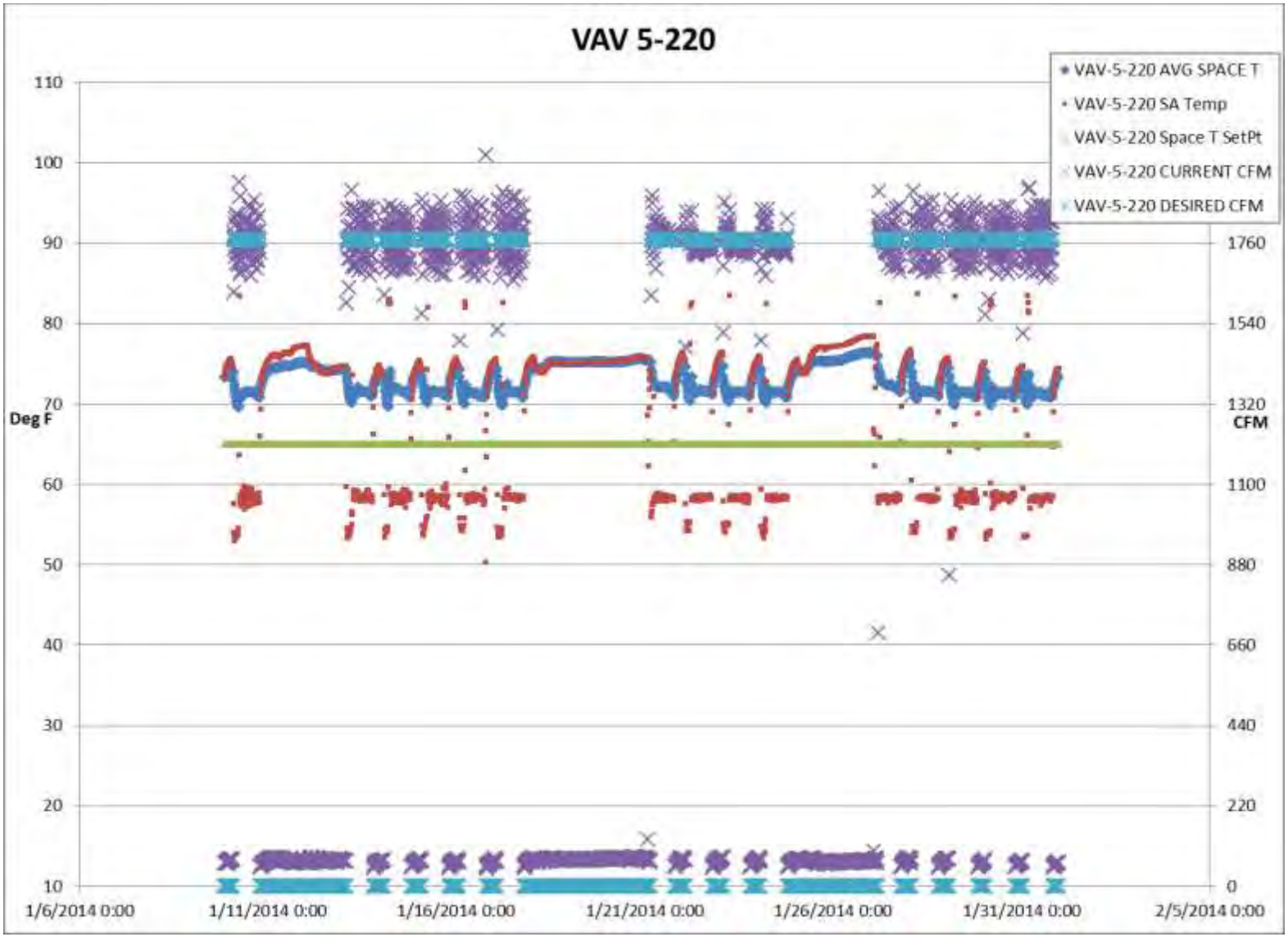
1/26/2014 0:00
1/31/2014 0:00
2/5/2014 0:00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VAV-5-220 AVG SPACE T
VAV-5-220 SA Temp
VAV-5-220 Space T SetPt
VAV-5-220 CURRENT CFM
VAV-5-220 DESIRED CFM
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
1760
1540
1320
1100
880
660
440
220
0
1/6/2014 0:00
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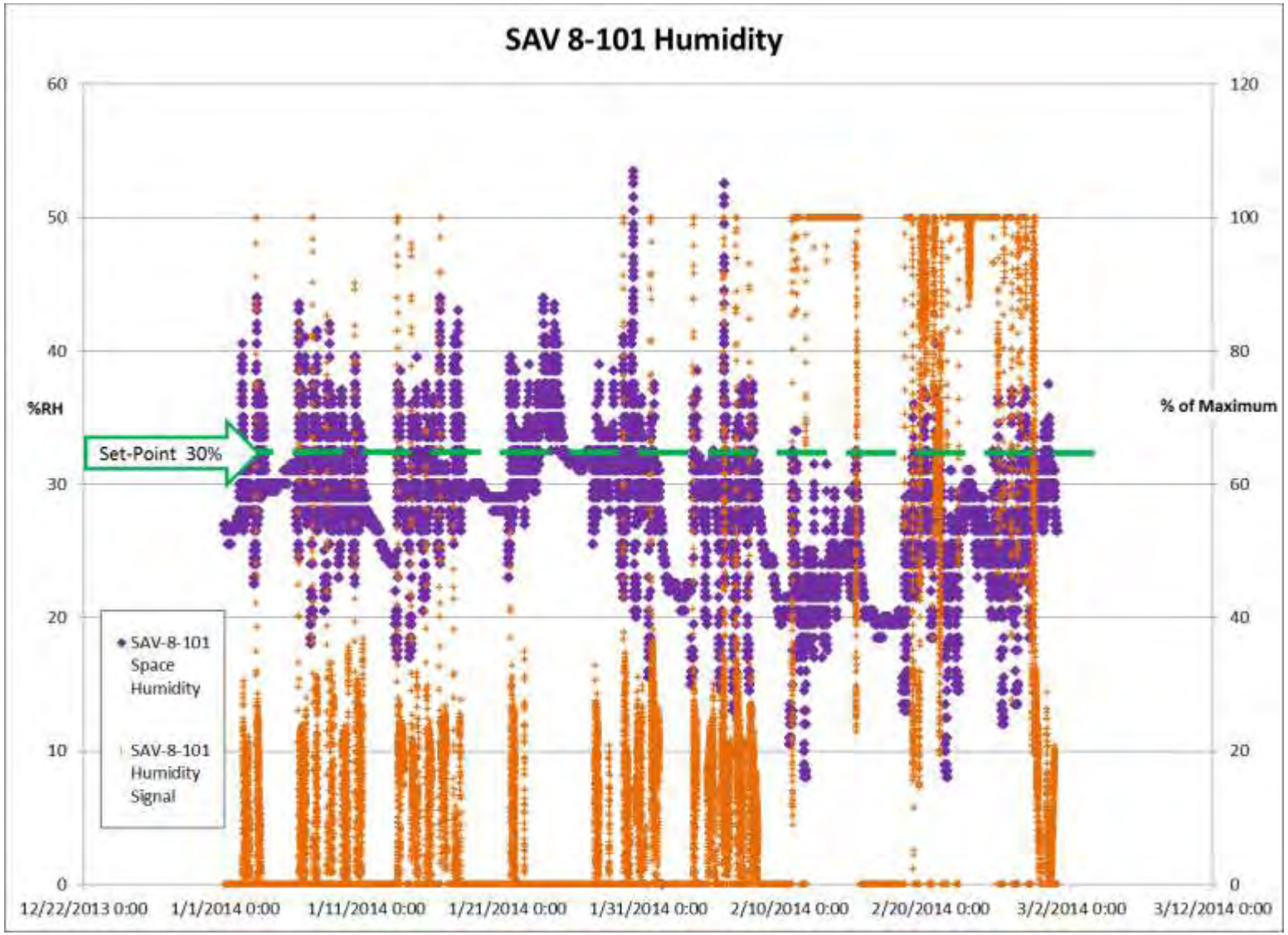
1/31/2014 0:00
2/5/2014 0:00


SAV 8-101 Humidity
%RH
% of Maximum
Set-Point 30%
SAV-8-101 Space Humidity
SAV-8-101 Humidity Signal
60
50
40
30
20
10
0
120
100
80
60
40
20
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
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2/10/2014 0:00
2/20/2014 0:00
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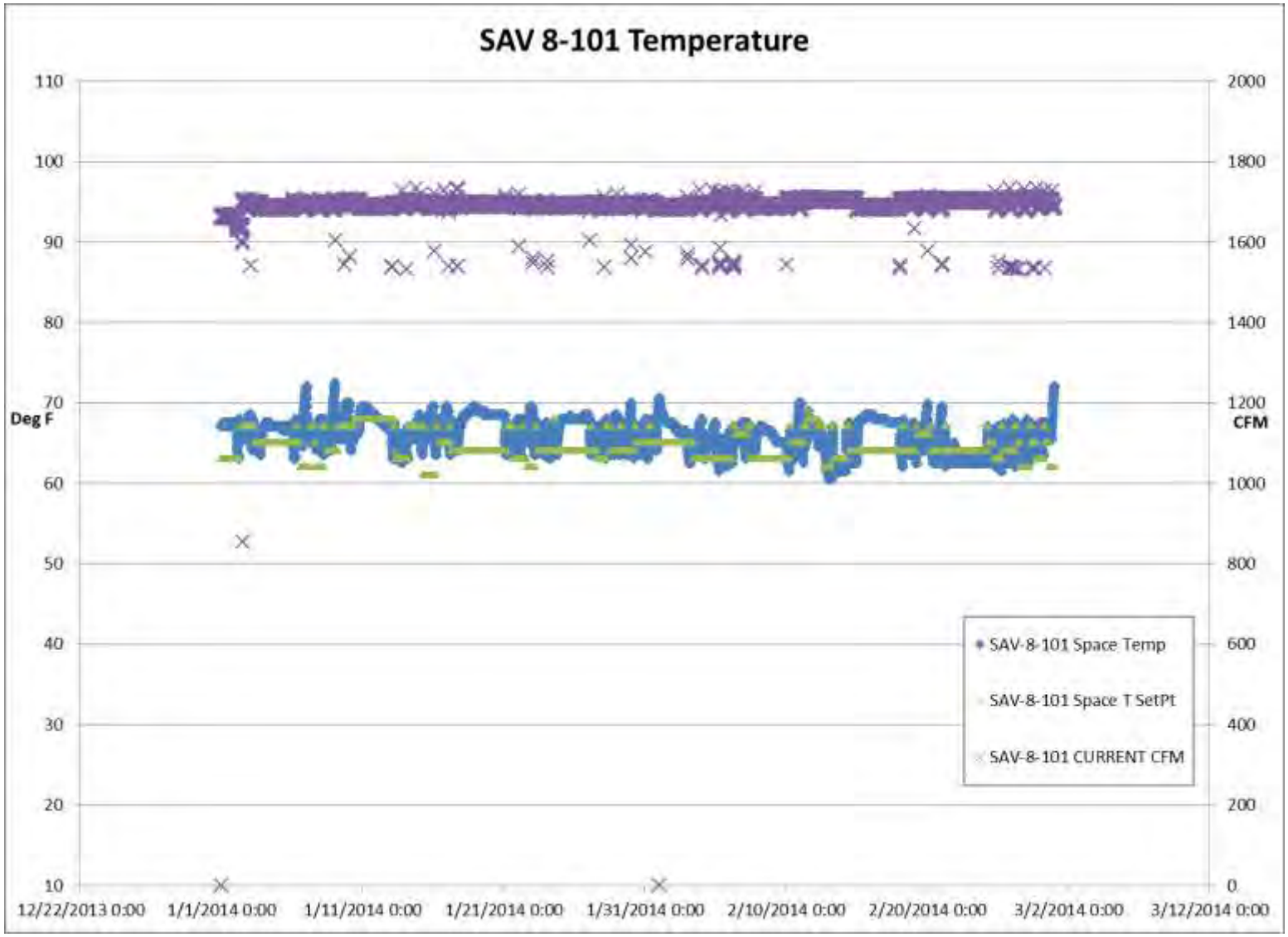
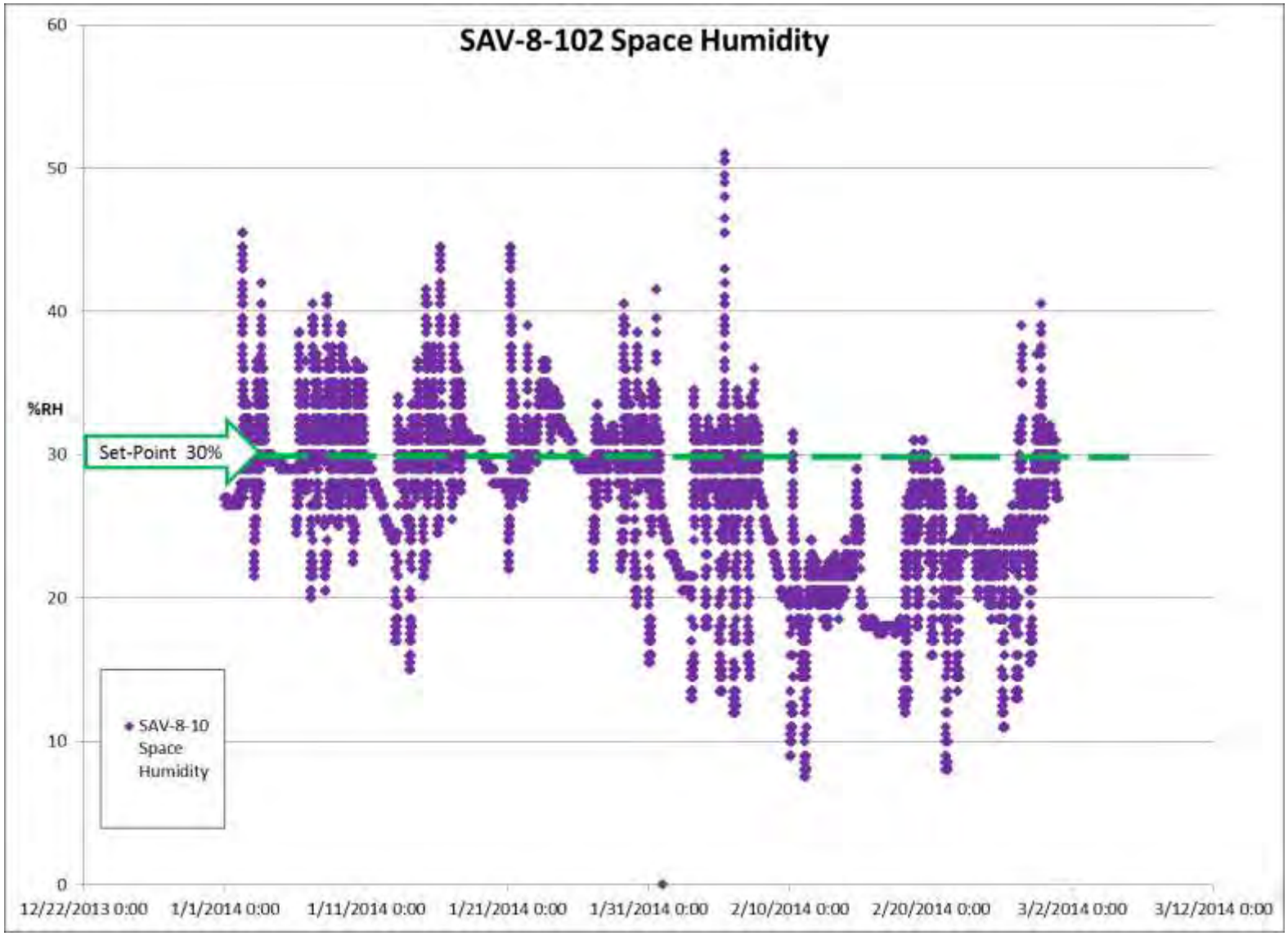
3/12/2014 0:00


SAV 8-101 Temperature
Deg F
CFM
110
100
90
80
70
60
50
40
30
20
10
2000
1800
1600
1400
1200
1000
800
600
400
200
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-8-101 Space Temp
SAV-8-101 Space T SetPt
SAV-8-101 CURRENT CFM


SAV-8-102 Space Humidity
%RH
60
50
40
30
20
10
0
Set-Point 30%
SAV-8-10 Space Humidity
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
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1/31/2014 0:00
2/10/2014 0:00
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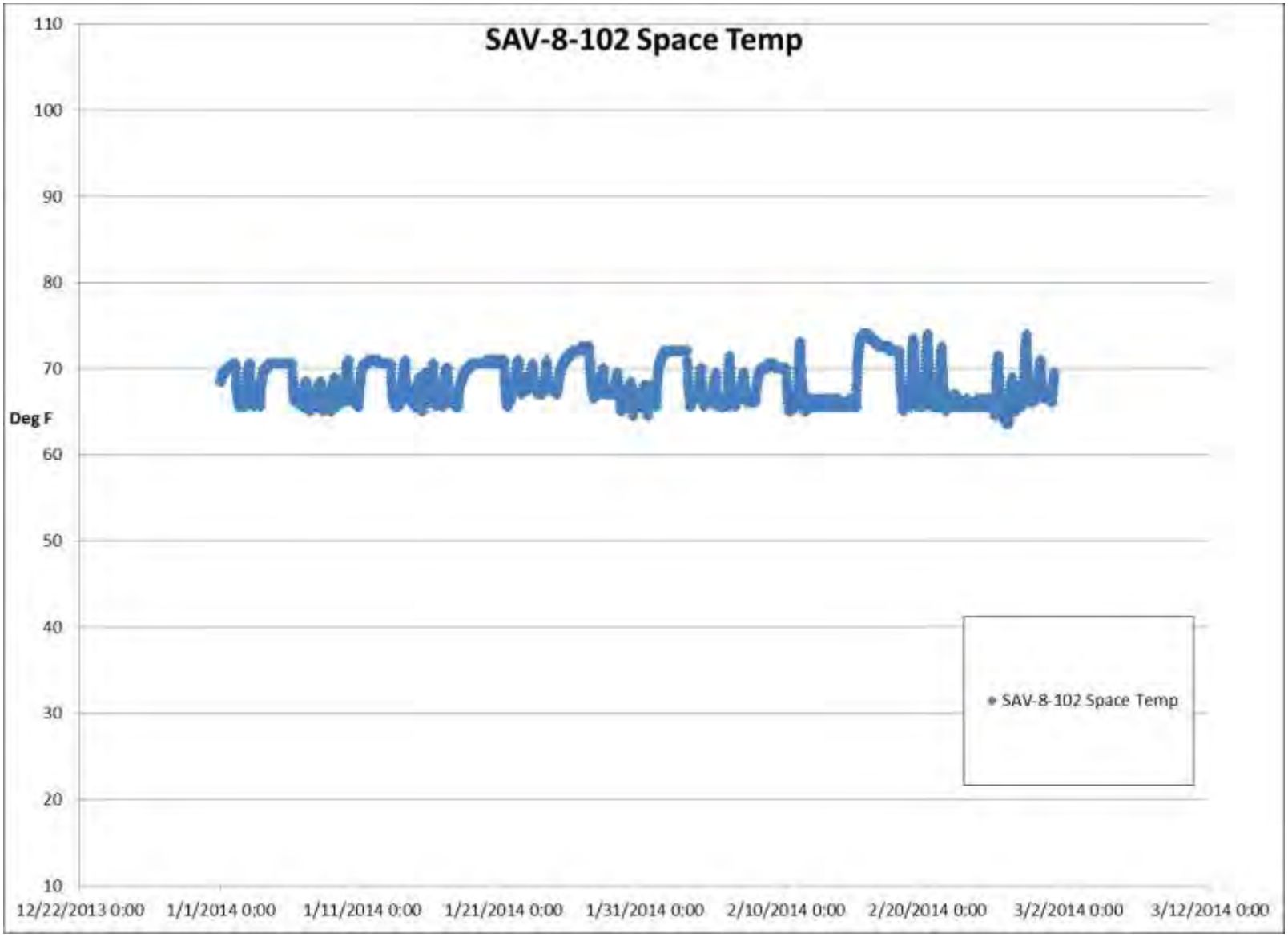
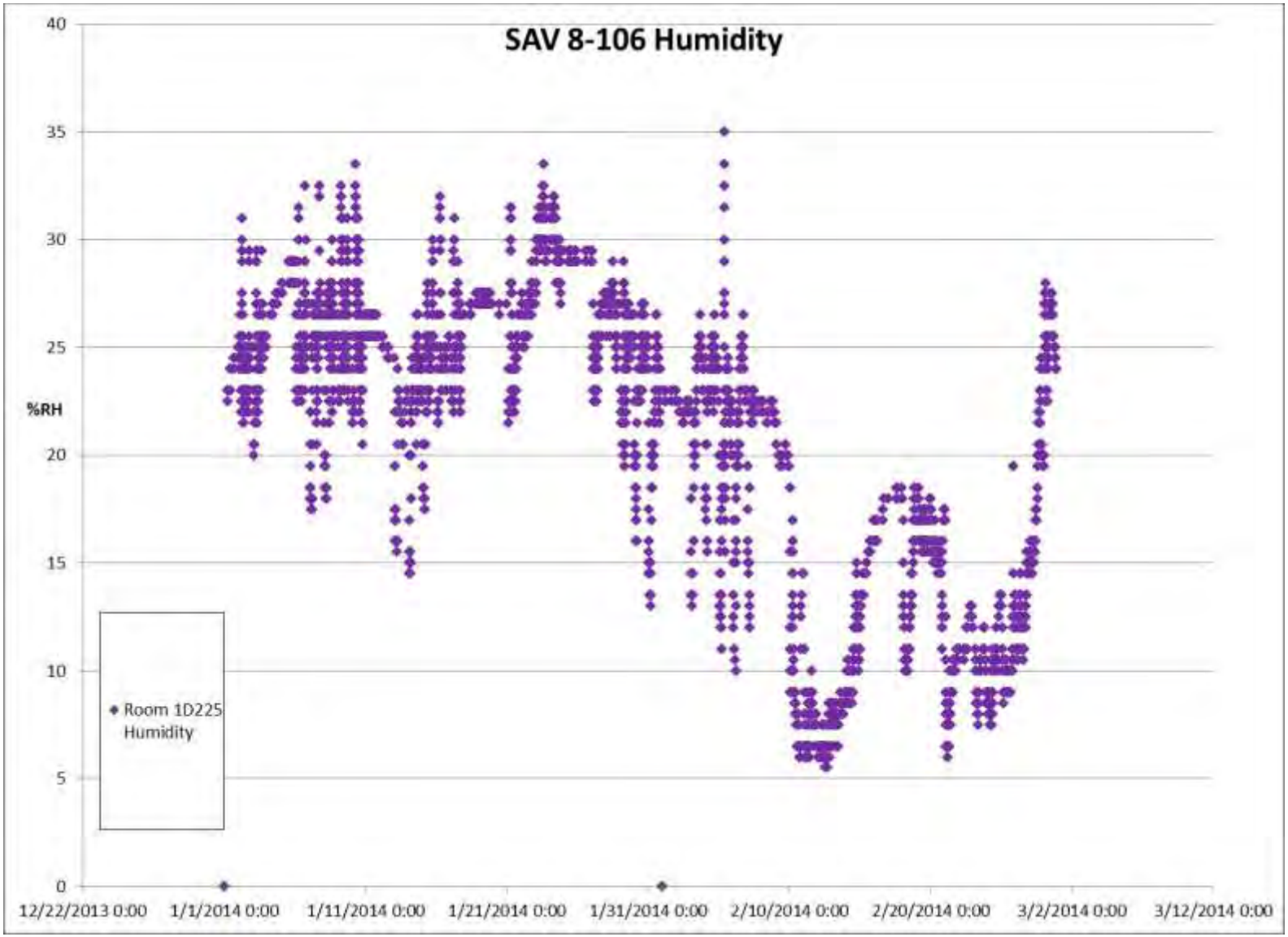
3/12/2014 0:00


SAV-8-102 Space Temp
Deg F
110
100
90
80
70
60
50
40
30
20
10
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-8-102 Space Temp


SAV 8-106 Humidity
%RH
40
35
30
25
20
15
10
5
0
Room 1D225 Humidity
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
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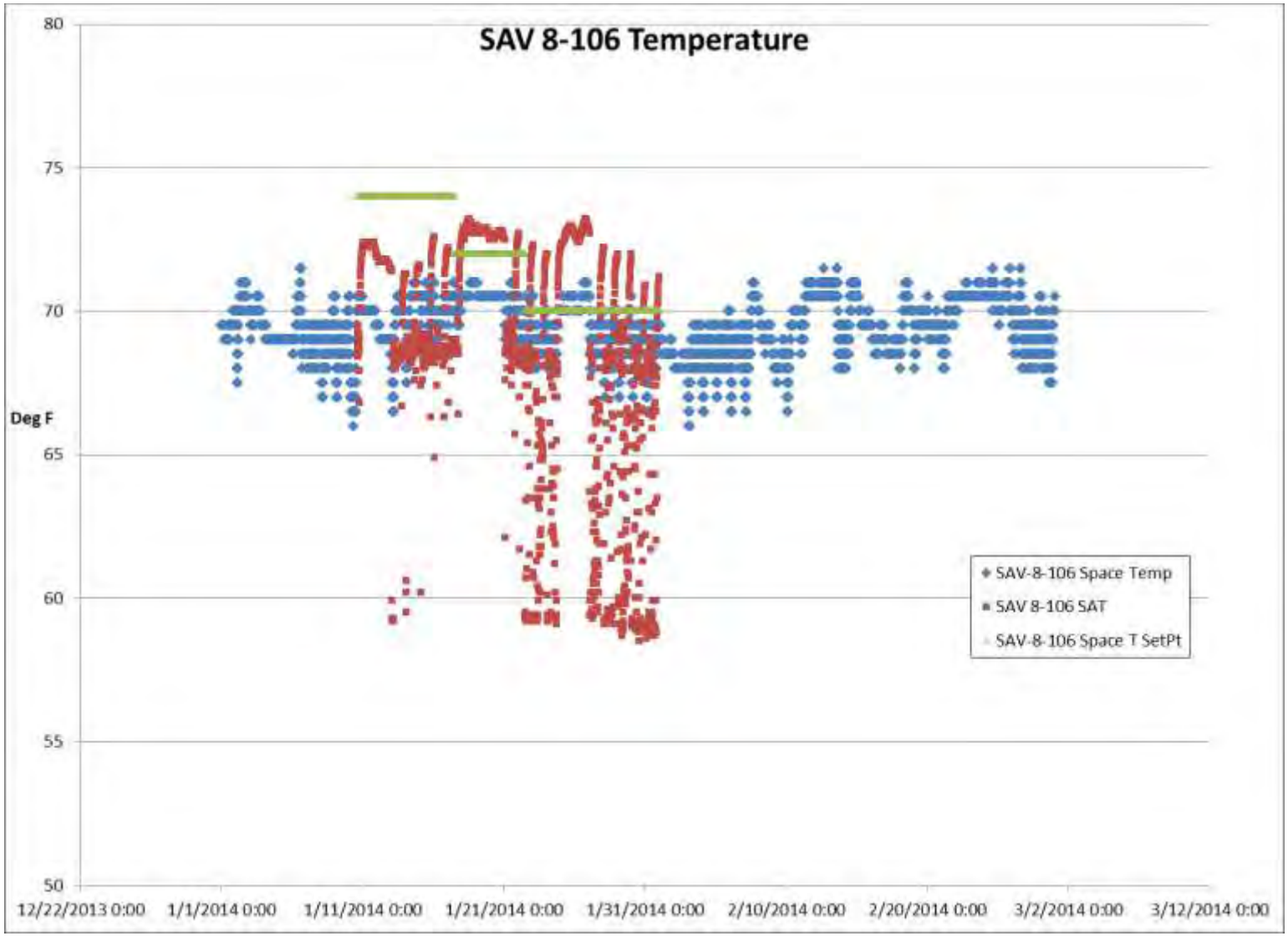
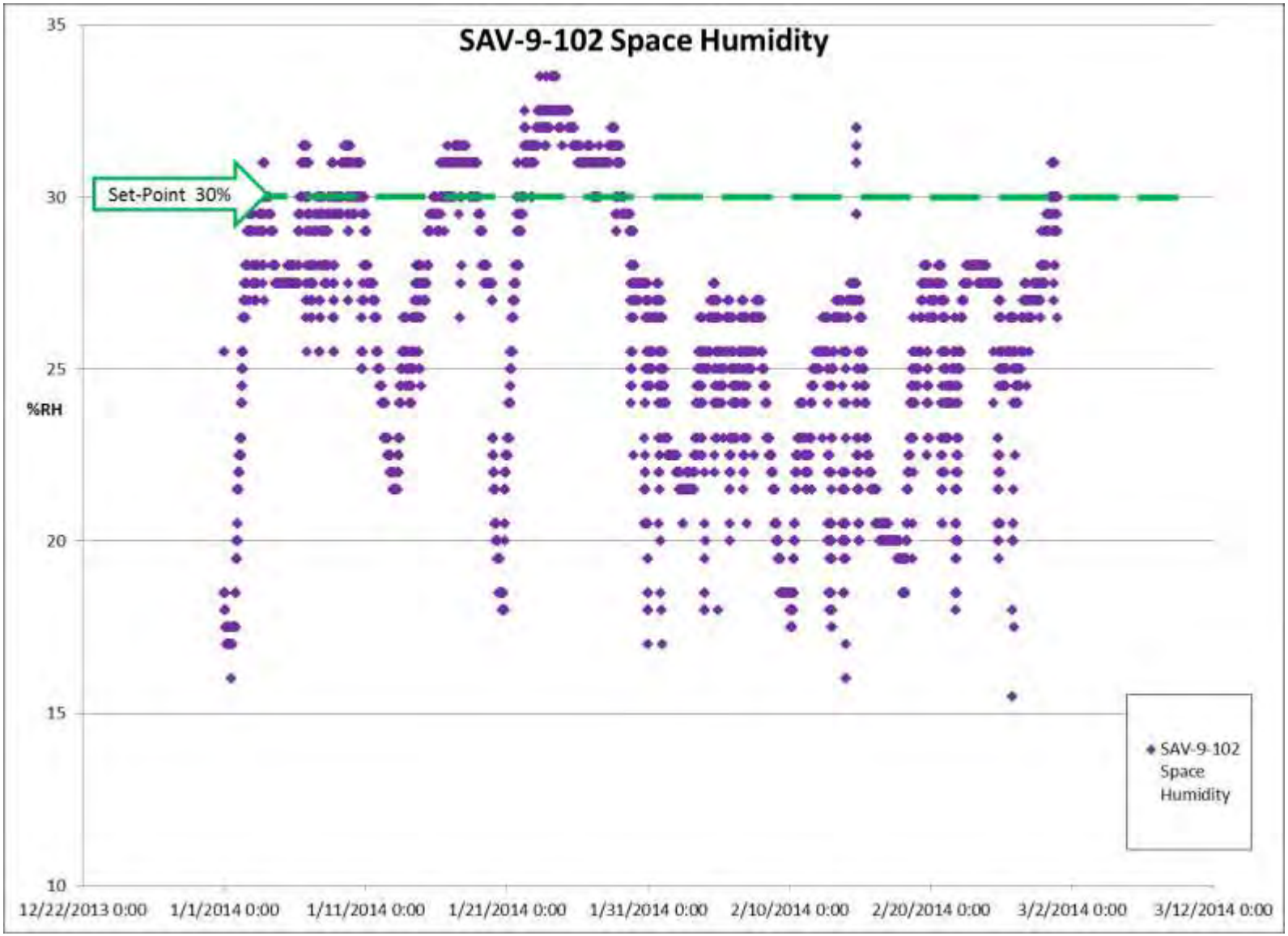
3/2/2014 0:00
3/12/2014 0:00


SAV 8-106 Temperature
Deg F
80
75
70
65
60
55
50
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-8-106 Space Temp
SAV 8-106 SAT
SAV-8-106 Space T SetPt


SAV-9-102 Space Humidity
Set-Point 30%
%RH
35
30
25
20
15
10
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
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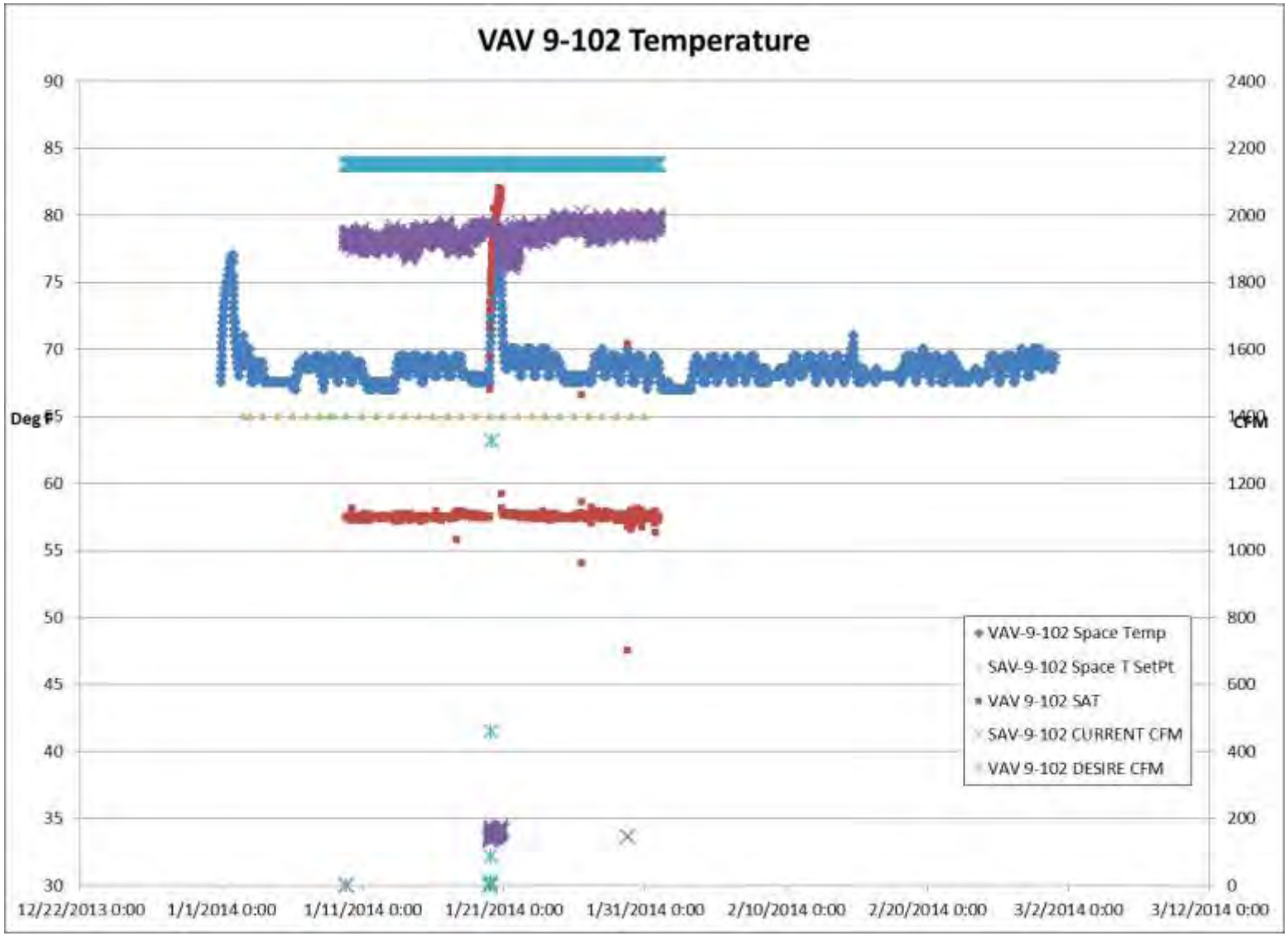
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
SAV-9-102 Space Humidity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Deg F
CFM
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85
80
75
70
65
60
55
50
45
40
35
30
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
12/22/2013 0:00
1/1/2014 0:00
1/11/2014 0:00
1/21/2014 0:00
1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
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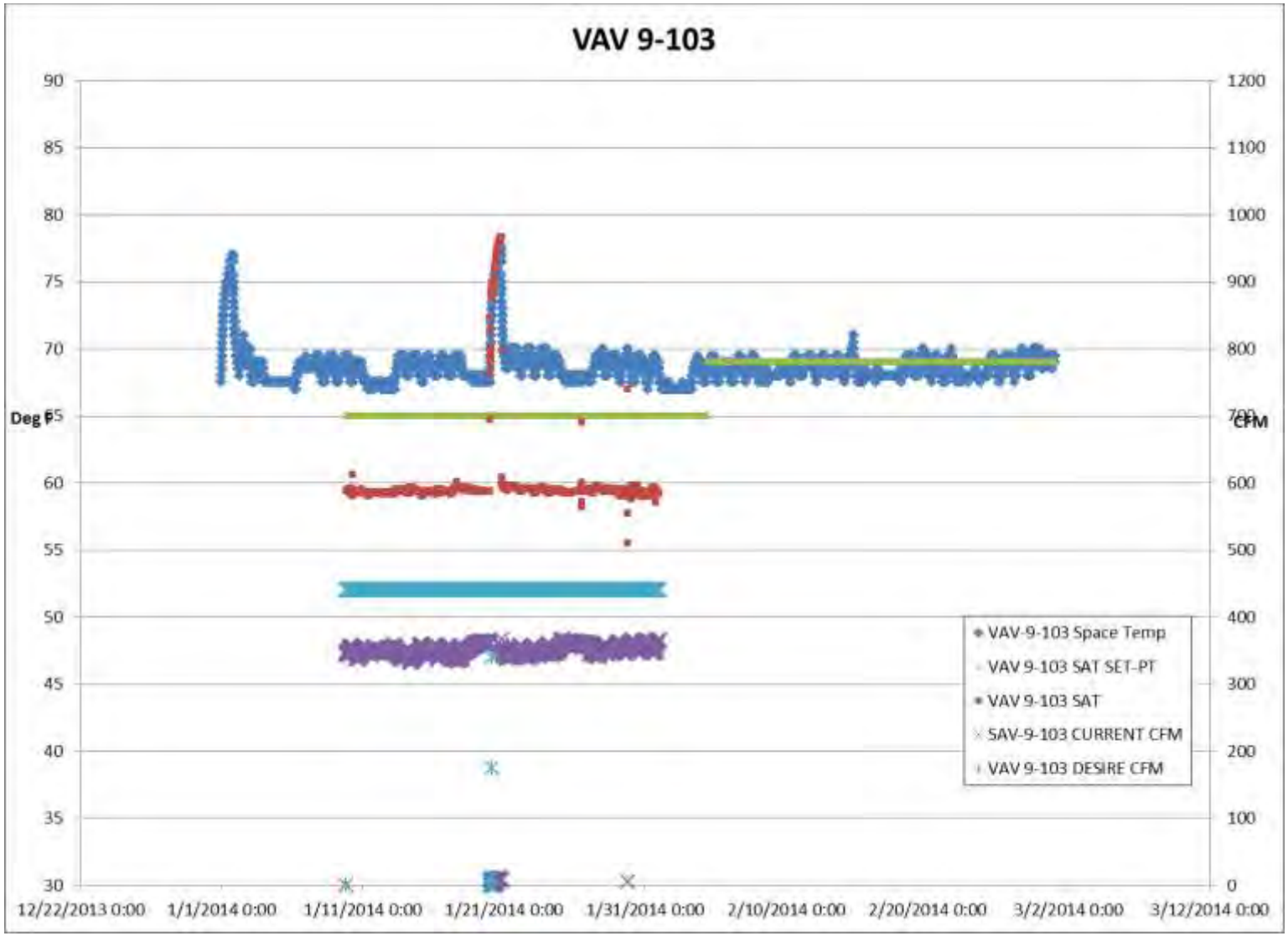
SAV-9-102 Space T SetPt
VAV 9-102 SAT
SAV-9-102 CURRENT CFM
VAV 9-102 DESIRE CFM


VAV 9-103
Deg F
CFM
90
85
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1/31/2014 0:00
2/10/2014 0:00
2/20/2014 0:00
3/2/2014 0:00
3/12/2014 0:00
VAV-9-103 Space Temp
VAV 9-103 SAT SET-PT
VAV 9-103 SAT
SAV-9-103 CURRENT CFM
VAV 9-103 DESIRE CFM

Appendix-G

For Final RCx Report

Systems Test Procedures and Testing Plan

&

Testing Results Report

VISN 20 Alaska VA Healthcare System

Systems Functional Testing Plan

JANUARY 28, 2013

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Functional Testing Plan

1.1 INTRODUCTION

As part of its RCx efforts at VISN 20, DAV Energy presents the following functional testing plan. DAV Energy plans to use this plan to perform functional testing activities. DAV Energy aims to identify issues, confirm compliance with the CFR, identify improvement opportunities and highlight problems that may require more rigorous and focused investigation. This is being completed under **Key Deliverable 8 Systems Functional Testing Plan**.

This report provides a summary of the HVAC systems and equipment to be tested. It includes functional test and point to point testing procedures, and planned TAB measurements.

The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	In Progress
4	Building Occupant Interviews & Goals	In Progress
5	Facility Performance Analysis & Performance Baseline	In Progress
6	Systems Diagnostic Monitoring Plan	In Progress
7	Systems Diagnostic Monitoring Report	3/26/2014
8	**Systems Test Procedures and Testing Plan**	In Progress
9	Systems Testing Report	4/9/2014
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Systems Testing Process

2.1 SYSTEMS TESTING OBJECTIVES

The objective of this Systems Test Procedures and Testing Plan is to organize the activities that will take place during the diagnostic testing portion of the RCx project. This includes the HVAC systems and equipment to be tested, the control points to be verified, sequences of operation to be confirmed and TAB measurements to be completed where applicable.

System testing includes point to point and functional testing. The point to point testing is used to verify that what is displayed on the operator control workstation is what is actually happening in the field. These points include air and water temperatures, valve operation, motor start/stop, and motor status. In addition, the calibration of sensors will be verified. The functional sequence testing is used to operate the equipment through its programmed sequence of control and verify equipment operation.

The objectives of the system testing include the following:

- Identify sensors whose values do not correspond to measured conditions, indicating a need for calibration or replacement.
- Assess equipment condition to identify deferred maintenance issues.
- Verify the current operating conditions and the operating sequence of control to assess system performance.
- Identify system components that do not respond to commands and are in need of repair or replacement.
- Identify systems that do not respond to control set-points or cannot maintain set-points.
- Confirm operating issues from field observations.
- Identify operating set-points for temperatures, pressures, humidity, speeds, and flow rates where available.
- Identify issues which could have potential energy savings such as incidents of simultaneous heating and cooling, inadequate or faulty economizer operation, excessive variable frequency drive (VFD) speeds, and other incidents of non-optimal operation.

2.2 SCHEDULE

This section sets forth the intended detailed schedule of diagnostic testing tasks to be carried out at the Anchorage VA Medical Center.

Table 2-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 through 1/10/2014 March 2014	Yes	Functional Testing was Completed in January of 2014 with potential wrap up testing in March to investigate items found during trend analysis
Onsite TAB Measurements	March 2014	Yes	Anticipate bringing in TAB contractor in March of 2014 to take selected measurements.
Prepare Deficiencies Log	1/6/2014 through 4/9/2014	Partial	Ongoing during functional testing and completed in the office after testing is finished.
Prepare Systems Testing Report and Deliver to VA for approval	4/9/2014	No	This report will summarize findings from the testing.

2.3 APPROACHES, LIMITATIONS, & PRIORITIES

This section describes the available approaches to testing, limitations that may apply, and criteria considered in establishing priorities.

Where there are large quantities of equipment controlled by the BAS or local controls, sample sizes can be guided by industry standards such as "M&V Guidelines: Measurement and Verification for Federal Energy Projects, Version 3.0" Appendix A Sampling Guidelines. The sample size will vary based on the total population of systems or components being evaluated. Smaller populations will require a larger test sample.

System testing will include the following:

- Major equipment on the BAS or with local control will be tested with a sampling rate of 100%. Major equipment includes dedicated chilled water systems, building central chilled water plant equipment, and building central heating water plant equipment. It also includes fans, pumps, and air handling units with motors 5HP or greater. It does not include the central campus chilled water plant or steam plant located at Elmendorf AFB.

- A sample of small Equipment and Terminal units with BAS or local control will be tested Small equipment includes pumps and exhaust fans. Terminal units include VAV boxes, CV boxes, reheat coils, steam radiators, unit heaters, fan coil units, dual duct mixing boxes and cabinet unit heaters.

3.0 System Testing Plan

This section describes the testing procedures planned for major equipment types. System test procedures were developed based on documented and ideal sequences of operation, manufacturer data and O&M instructions, and established testing procedures from the commissioning industry. Point to point and system testing forms can be found in **Appendix A**.

3.1 OVERVIEW OF POINT TO POINT TESTING

Calibration of DDC sensors will be verified and damper linkages and control valves will be inspected and operated through their full range to verify smooth operation. Analog and digital inputs and outputs are all included. Point to point checklists will catalog the control points on the DDC system, as well as other devices.

Temperatures will be measured as close to the sensor as possible. If temperature sensor wells are not available near the chilled water/hot water temperature sensors, temperatures will be taken using contact probes.

Damper and valve positions will be stroked through their full ranges (open to closed) by overriding control points.

3.1.1 Cooling System

Sensors and components included in the point to point testing will vary for each chilled water plant and can be found in the testing plan in **Appendix A**. The following control points are typically included in the point to point testing:

- Chilled Water Supply Temperature
- Chilled Water Return Temperature
- Pump Start/Stop & VFD speed Command
- Pump Status
- Chilled Water Valves

3.1.2 Heating System

Sensors and components included in the point to point testing will vary for each heating plant and can be found in the testing plan in **Appendix A**. The following control points are typically included in the point to point testing:

- Heating Supply Glycol Temperatures
- Heating Glycol Return Temperatures
- Pump Start/Stop & VFD speed Command
- Converter Hot Water Valves
- Heating Valve Command Response

3.1.3 Air Handling Units

Sensors and components included in the point to point testing will vary per air handling unit and can be found in the testing plan in **Appendix A**. The following control points are typically included in the point to point testing:

- Supply Air Temperature
- Return Air Temperature
- Mixed Air Temperature
- Outside Air Temperature
- Zone Temperature (where applicable as a controlling point for AHU)
- Fan Status
- Fan Start/Stop
- Outside/Return/Exhaust Air Dampers
- Chilled Water Valve
- Hot Water Valve
- Fan Speed

3.1.4 Terminal Units

Sensors and components included in the point to point testing can be found in the testing plan in **Appendix A**. The following sensor points are typically included in the point to point testing:

- Space Temperature
- Discharge Air Temperature
- Heating Valve response
- Primary Air Damper (verified full range of motion using airflow)

3.2 OVERVIEW OF FUNCTIONAL TESTING

The following equipment at the Anchorage VA Medical Center will be tested:

- All Air Handler Units with the exception or AHU-10 which is used only when the generator operates.
- A sampling of VAV boxes and their respective spaces.
- Snowmelt Systems
- Heating/Chilled Water Components (pumps, valve, heat exchangers, controls)

3.3 OVERVIEW OF SYSTEM CONDITION ASSESMENT

A condition assessment of the HVAC systems will be performed during the diagnostic testing. Observations documenting issues affecting HVAC system

operation will be compiled in the Issues Log and included in the System Testing Report. This section summarizes the inspections to be performed.

- Airside Equipment Inspection, to assess whether:
    - Outside and return air damper linkages are connected and functioning properly.
    - Control valve actuators are functioning properly.
    - Control sensors locations are appropriate.
    - Control sensors are calibrated.
    - Belts are in good working condition.
    - Coils and filters are clean and free of debris.
    - Routine preventative maintenance has been performed.
- Chilled / Hot Water System Inspection, to assess whether:
    - Control valve actuators are functioning properly.
    - Control sensors are calibrated.
    - Control sensor locations are appropriate.
    - Routine preventative maintenance has been performed.
- Terminal Unit Inspection, to assess whether:
    - Routine preventative maintenance has been performed.
    - Control sensors are calibrated.
    - Control sensor locations are appropriate.
    - Control valve and damper actuators are functioning properly (if installed).
- BAS Inspection to:
    - Analyze BAS capabilities and available control points.
    - Evaluate equipment control through the BAS.
    - Determine if BAS includes required control points for additional energy conservation opportunities.
    - Determine if the existing BAS provides significant capability for ensuring sustainability of energy savings.

3.4 OVERVIEW OF TAB MEASUREMENTS

Air and water flow measurements will be performed on select mechanical equipment. These measurements will be used to evaluate operational issues and identify system issues. The following systems are planned to have TAB measurements taken.

- AHU-08
    - Cooling CHG Coil Flow Measurement
    - Pre-Heat Coil HGS Flow Measurement
    - Heating Coil HGS Flow Measurement
    - Air-Flow Measurement

- AHU-09
    - Cooling CHG Coil Flow Measurement
    - Pre-Heat Coil HGS Flow Measurement
    - Heating Coil HGS Flow Measurement
    - Air-Flow Measurement

VISN 20 Alaska VA Healthcare System

Systems Testing Report

JANUARY 28, 2013

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Executive Summary

1.1 INTRODUCTION

This testing report prepared by DAV Energy Solutions Inc for the VISN 20 Alaska Health care Systems provides a summary of the systems that were tested during the point to point and functional testing process, a summary of findings and the issues identified. Deviations between the Testing Plan as it was originally outlined and the actual execution of the equipment testing process are also addressed. Completed testing forms, issues log, and supporting documents are presented in the appendices. This is being completed under **Key Deliverable 9 Testing Report**.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs,
4. Identify energy or capital improvement projects for implementation in the future.

The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	**CURRENT**
10	Repair Report Summary	4/16/2014
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	4/16/2014

The content of these deliverables is summarized in the RCx Plan.

2.0 Systems Testing Process

2.1 SYSTEMS TESTING OBJECTIVES

The objective of this Systems Test Procedures and Testing Plan is to organize the activities that will take place during the diagnostic testing portion of the RCx project. This includes the HVAC systems and equipment to be tested, the control points to be verified, sequences of operation to be confirmed and TAB measurements to be completed where applicable.

System testing includes point to point and functional testing. The point to point testing is used to verify that what is displayed on the operator control workstation is what is actually happening in the field. These points include air and water temperatures, valve operation, motor start/stop, and motor status. In addition, the calibration of sensors will be verified. The functional sequence testing is used to operate the equipment through its programmed sequence of control and verify equipment operation.

The objectives of the system testing include the following:

- Identify sensors whose values do not correspond to measured conditions, indicating a need for calibration or replacement.
- Assess equipment condition to identify deferred maintenance issues.
- Verify the current operating conditions and the operating sequence of control to assess system performance.
- Identify system components that do not respond to commands and are in need of repair or replacement.
- Identify systems that do not respond to control set-points or cannot maintain set-points.
- Confirm operating issues from field observations.
- Identify operating set-points for temperatures, pressures, humidity, speeds, and flow rates where available.
- Identify issues which could have potential energy savings such as incidents of simultaneous heating and cooling, inadequate or faulty economizer operation, excessive variable frequency drive (VFD) speeds, and other incidents of non-optimal operation.

2.2 SCHEDULE

This section sets forth the intended detailed schedule of diagnostic testing tasks to be carried out at the Anchorage, Alaska VA Outpatient Clinic.

Table 2-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 through 1/10/2014 March 2014	Yes	Functional Testing was Completed in January of 2014 with potential wrap up testing in March to investigate items found during trend analysis
Onsite TAB Measurements	April 2014	Yes	Anticipate bringing in TAB contractor in April of 2014 to take selected measurements.
Prepare Deficiencies Log	1/6/2014 through 4/9/2014	Partial	Ongoing during functional testing and completed in the office after testing is finished.
Prepare Systems Testing Report and Deliver to VA for approval	4/9/2014	No	This report will summarize findings from the testing.

2.3 SYSTEM TESTING EXECUTION

Field testing was performed on a large portion of the equipment in the buildings. This included 100% of the major equipment such as chillers, boilers, fans, pumps and air handling units and a sample of smaller terminal equipment. The main findings discovered during testing are summarized in the following Results Section.

The field testing included the following tasks:

- Controls point-to-point testing. The point to point testing included verification of inputs and outputs on the DDC system such as air and water temperatures, valve operation, motor start/stop, and motor status. When the actual operation or feedback from a sensor, control valve, or damper varied from the indication in the controls system, the variance was noted. Appendix A contains the detailed point to point test results including all recorded spot measurements.
- Sensor calibration checks. As part of point to point testing, sensor calibration checks were performed according to the System Test Procedures and Testing Plan. Appendix A contains all recorded spot measurements.
- Controls functional testing. The functional performance testing was used to determine how the equipment is currently operating. These tests evaluated the control of the major airside equipment and assessed the central plant equipment operation. It also included testing of a sample of the small packaged equipment

and terminal units to evaluate proper operation. Appendix A contains the detailed functional performance test results.

- System condition assessment. A condition assessment of the HVAC systems was performed during the diagnostic testing. Observations documenting issues affecting HVAC system operation were compiled in the Issues Log presented in Appendix B. Observations were not documented for systems where operation was acceptable based on the provided sequences of operation and system operation data gathered from site surveys and facility personnel interviews.

An issues log can be found in Appendix B. It identifies the items that did not pass the point-to-point, sensor calibration checks, functional testing, system condition assessment or other measurements. The detailed testing approach and a summary of equipment included in the testing were provided in the System Test Procedures and Testing Plan.

3.0 System Testing Results

The following section presents issues found during the point to point testing, functional testing, and equipment condition assessment. All issues, including the locations and equipment affected, are summarized in the Issues Log in **Appendix B**.

3.1 IDENTIFIED ISSUES SUMMARY

Overall there were very few issues to be notes throughout the building. After a thorough investigation the systems were found to be in excellent condition which is unusual in RCx studies. One issue was identified through testing. The following list summarizes the identified issue, including the locations and equipment affected, are also summarized in the Issues Log found in Appendix B.

- During testing is was discovered that the PHC control valve on AHU #8 may not be able to fully close.
    - Sensors Passed point to point testing within one degree.
    - Additional investigation by a TAB specialist is warranted, therefore we have brought in a subcontractor to make the investigation by measurement of the delta pressure across the PHC with the valve commanded closed.
    - A likely cause of this issue is deposits inside the Griswold valve cartridge preventing it from fully seating in the closed position. The corrective action for this likely cause is replacement of the Griswold valve cartridge.
    - This issue effects AHU #8 only.

3.2 COOLING SYSTEM / CHILLED WATER PLANT

Cooling Plant equipment condition and operation was assessed using observations, point to point testing and functional testing. Testing activities indicated that the programmed chilled water supply temperature set points and cooling system lockouts were being observed for the majority of the systems. In some instances, there are opportunities to further automate system control and improve the energy efficiency of the building operation. The most frequent issues identified through the testing process are presented in the following sections.

Point to point testing was used to check the calibration of DDC sensors, valves, VFDs, set-points, etc. associated with chilled water plant control. The following list summarizes the testing results. A detailed list of each point checked and the test associated in **Appendix A**. A list of the findings and proposed resolution is available in the Issues Log in **Appendix B**. There were no failures or issues discovered in this system.

Per VA request the pumps could be point-to-point tested, but not functionally tested since changing the fluid delta pressure would set off alarms at the Elmendorf side of the system. Point to Point testing procedure used on CHGP-13 is as follows:

- Pump 13A was commanded to 60%
  - **Drive display indicated 62% which is within acceptable limits**
- Pump 13A was commanded to 80%
  - **Drive display indicated 82% which is within acceptable limits**
- Pump 13B was commanded to 60%
  - **Drive display indicated 60%**
- The CHG bypass valve was commanded to close
  - **The valve was visually observed to fully close within 5 minutes**

3.3 SNOWMELT SYSTEM

The following parameters were tested for the snowmelt system:

- Point to Point Testing:
  - East Slab surface Temp
    - **Pass: within +/- 3 degrees using handheld IR thermometer**
  - East Slab Moisture Detection
    - **Pass: visual observation by pouring water on sensor**
  - West Slab Surface Temp
    - **Pass: within +/- 3 degrees using handheld IR thermometer**
  - West Slab Moisture Detection
    - **Pass: visual observation by pouring water on sensor**
  - Snowmelt HX Valve Closes Fully
    - **Pass: visual observation**

- Functional Testing:
  - Snowmelt HX Loop Idle temperature
    - **Pass: Measurement within +/-3 degrees using handheld IR thermometer**
  - Adjust the HGS set-point Up
    - **Bypass valve visually observed - Modulates to maintain set-point**
  - Adjust the HGS set-point Down
    - **Bypass valve visually observed - Modulates to maintain set-point**
  - Override the slab temp below set-point
    - **As slab temp rises, HGS valve observed to adjust to maintain slab rate of temperature increase below 0.2Deg F per minute**

3.4 RE-CIRCULATING AHU TESTING PROCEDURES & RESULTS

The following procedure was performed where applicable to functionally test the Air Handling Units.

- **Simulate a Call for heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Return Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Visually check that the OA & RA Dampers are set for minimum OSA
    - **In all cases this was found to be true**
  - Visually observe the heating coil valve modulates to maintain SAT
    - **In all cases the heating valve was found to be functioning normally**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for no heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Return Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Visually check that the OA & RA Dampers are set for minimum OSA
    - **In all cases this was found to be true**
  - Visually check that the heating coil valve is fully closed within 5 minutes
    - **In all cases the heating valve was found to be functioning normally and able to fully close**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when both the Airside Economizer and Mechanical Cooling are enabled**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Return Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**

- Visually observe that the OA & RA & EA Dampers are set to maintain the SAT set-point
    - **In all cases the dampers were visually observed to modulate fully and correctly**
- Once the OA & RA & EA dampers are 100% open, mechanical cooling should modulate to maintain the SAT set-point.
    - **Due to winter conditions the unit's freeze alarm would be triggered and the SAT would be far too low for occupied conditions long before the OA damper is fully opened.**
- Visually observe the heating coil valve is fully closed
    - **In all cases the heating valve was found to be able to fully close**
- Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when the Airside Economizer is disabled and Mechanical Cooling is enabled**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to the minimum airflow position
        - **In all cases the dampers were visually observed to operate correctly**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the Cooling Coil valve modulates to maintain SAT set-point
        - **In all cases the cooling valve was found to be operating normally**

- **Simulate conditions when there is no call for cooling**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Return Fan is running in Auto
        - **In all cases this was found to be true**
    - Visually observe that the OA & RA & EA Dampers are set to the minimum airflow position
        - **In all cases the dampers were visually observed to operate correctly**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the cooling coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Test Supply Fan Functionality**
  - Override the duct static pressure set-point to 1.2” W.C.
    - **In all cases the fan was found to be able to maintain 1.2” W.C**
  - Override the duct static pressure set-point to 1.9” W.C.
    - **In all cases EXCEPT AHU #6 Supply Fan, the fan was able to maintain this pressure.**
    - **AHU #6 Supply Fan only able to maintain a maximum of 1.3” W.C.**
  - Override the duct static pressure set-point to 1.5” W.C.
    - **In all cases EXCEPT AHU #6 Supply Fan, the fan was able to maintain this pressure.**
    - **AHU #6 Supply Fan only able to maintain a maximum of 1.3” W.C.**

- **Test Humidification System Functionality**
  - Simulate a call for humidity by overriding the set-point
    - **In all cases the humidification system was visually observed to start and modulate normally to maintain the set-point**
  - Simulate the conditions when there is no call for humidity
    - **In all cases the humidification system was visually observed to stop completely**

- **Test SAT Reset Functionality**
  - Override the number of zones requesting DAT decrease
    - **In all cases the SAT was observed to decrease to the minimum set-point**
  - Override the number of zones requesting DAT increase
    - **In all cases the SAT was observed to increase to the maximum set-point**
  - Override the number of zones requesting DAT decrease to 6 and the number of zones requesting DAT increase to 6
    - **In all cases the SAT was observed to increase to the maximum set-point**

- **Test Duct SP Reset Functionality**
  - Override the number of zones requesting duct static pressure decrease
    - **In all cases the DSP was observed to decrease to the minimum set-point**
  - Override the number of zones requesting duct static pressure increase
    - **In all cases the DSP was observed to increase to the maximum set-point**

3.5 SINGLE-PASS AHU TESTING PROCEDURES & RESULTS

The following procedure was testing was performed where applicable to functionally test the Air Handling Units.

- **Simulate a Call for heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Check that the Humidity Valve is running in Auto
    - **In all cases this was found to be true**
  - Visually check that the PHC valve modulates to maintain SAT
    - **In all cases this was found to be true**
  - Visually observe the heating coil valve modulates to maintain SAT once the PHC valve is 100% open
    - **In all cases the heating valve was found to be functioning normally**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for no heating**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Check that the Humidity Valve is running in Auto
    - **In all cases this was found to be true**
  - Visually check that the PHC valve closes fully
    - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**
    - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
  - Visually check that the Cooling Coil valve is fully closed
    - **In all cases the cooling valve was found to be able to fully close**

- **Simulate a Call for cooling when both the Airside Economizer and Mechanical Cooling are enabled**
  - Check that the Supply Fan is running in Auto
    - **In all cases this was found to be true**
  - Check that the Exhaust Fan is Running
    - **In all cases this was found to be true**
  - Visually check that the PHC valve closes fully
    - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**

        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually observe the Cooling Coil valve is modulate to maintain SAT set-point
        - **In all cases the cooling valve was observed to modulate normally**

- **Simulate conditions when there is no call for cooling**
    - Check that the Supply Fan is running in Auto
        - **In all cases this was found to be true**
    - Check that the Exhaust Fan is Running
        - **In all cases this was found to be true**
    - Visually check that the PHC valve closes fully
        - **In all cases EXCEPT AHU #8 PHC valve this was found to be true.**
        - **PHC #8 may not fully close, see Appendix A and B for more details. This will be investigated by the TAB specialist.**
    - Visually observe the heating coil valve is fully closed
        - **In all cases the heating valve was found to be able to fully close**
    - Visually check that the cooling coil valve is fully closed
        - **In all cases the cooling valve was found to be able to fully close**

- **Test Supply Fan Functionality**
    - Override the duct static pressure set-point to 1.2” W.C.
        - **In all cases the fan was found to be able to maintain 1.2” W.C**
    - Override the duct static pressure set-point to 1.9” W.C.
        - **In all cases the fan was found to be able to maintain 1.9” W.C**
    - Override the duct static pressure set-point to 1.5” W.C.
        - **In all cases the fan was found to be able to maintain 1.5” W.C**

- **Test Humidification System Functionality**
    - Simulate a call for humidity by overriding the set-point
        - **In all cases the humidification system was visually observed to start and modulate normally to maintain the set-point**
    - Simulate the conditions when there is no call for humidity
        - **In all cases the humidification system was visually observed to stop completely**

- **Test SAT Reset Functionality**
    - Override the number of zones requesting DAT decrease
        - **In all cases the SAT was observed to decrease to the minimum set-point**
    - Override the number of zones requesting DAT increase
        - **In all cases the SAT was observed to increase to the maximum set-point**

- Override the number of zones requesting DAT decrease to 6 and the number of zones requesting DAT increase to 6
    - **In all cases the SAT was observed to increase to the maximum set-point**

- **Test Duct SP Reset Functionality**
    - Override the number of zones requesting duct static pressure decrease
        - **In all cases the DSP was observed to decrease to the minimum set-point**
    - Override the number of zones requesting duct static pressure increase
        - **In all cases the DSP was observed to increase to the maximum set-point**

3.6 VAV TERMINAL BOX FUNCTIONAL TEST

The following procedure was used to functional test the VAV boxes:

- The space temp set-point is adjusted above the current space temp
    - zone is expected to go into heating mode to compensate.
        - **VAV box is visually observed to open HGS valve within 5 minutes.**
        - **VAV box is visually observed to modulate the air damper to the heating position (if not already in heat mode) within 5 minutes.**
        - **Discharge air temperature is measured with IR thermometer to increase by 2 degrees or more**.
- The space temp set-point is adjusted below the current space temp
    - zone is expected to go into cooling mode to compensate
        - **VAV box is visually observed to fully close HGS valve within 5 minutes.**
        - **VAV box is visually observed to modulate the air damper to the fully open position within 5 minutes.**
        - **Discharge air temperature is measured with IR thermometer to decrease by 2 degrees or more.**

All VAV boxes functionally tested were found to be within parameters, and responded normally to the tests which are designed to test both the control routine and the physical equipment functionality. No Issues discovered in the VAV boxed through functional testing.

4.0 Appendix A: Functional Testing Results

4.1 AIR HANDLING UNIT FUNCTIONAL TEST RESULTS

4.1.1 AHU #1 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #1. The Tables below present the test procedure and the results of the testing procedure for AHU #1.

Table 4-1: AHU 1 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-1 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	5800 CFM	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-2: AHU 1 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-1 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	5800 CFM	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-3: AHU 1 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-4: AHU 1 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	N/A	N/A	
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-5: AHU 1 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Re-Enabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-6: AHU 1 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-7: AHU 1 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-8: AHU 1 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-9: AHU 1 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

Notes for AHU #1:

1. When cooling mode is released and the sequence then calls for heat, the heating valve opens while the airside economizer is still open

4.1.2 AHU #2 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #2. The Tables below present the test procedure and the results of the testing procedure for AHU #2.

Table 4-10: AHU 2 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-2 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-11: AHU 2 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-2 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-12: AHU 2 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-13: AHU 2 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-14: AHU 2 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Re-Enabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-15: AHU 2 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-16: AHU 2 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-17: AHU 2 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-18: AHU 2 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-19: AHU 2 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.3 AHU #3 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #3. The Tables below present the test procedure and the results of the testing procedure for AHU #3.

Table 4-20: AHU 3 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-3 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for	Yes	Pass	Functional Test was Completed 1/9/2014

Minimum OSA			
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-21: AHU 3 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-3 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-22: AHU 3 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-23: AHU 3 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-24: AHU 3 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-25: AHU 3 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-26: AHU 3 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-27: AHU 3 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-28: AHU 3 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The Duct SP Increases to the Maximum Set-Point

4.1.4 AHU #4 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #4. The Tables below present the test procedure and the results of the testing procedure for AHU #4.

Table 4-29: AHU 4 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-4 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-30: AHU 4 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-4 On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-31: AHU 4 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-32: AHU 4 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-33: AHU 4 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-34: AHU 4 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there	Yes	Pass	Humidity Valve Closes

is No Call for Humidity			

Table 4-35: AHU 4 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-36: AHU 4 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.5 AHU #5 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #5. The Tables below present the test procedure and the results of the testing procedure for AHU #5.

Table 4-37: AHU 5 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-38: AHU 5 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-39: AHU 5 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-40: AHU 5 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	After 15 minutes of cooling valve fully open, economizer at 10%, the SAT reached 59F. Fan speed 93%. Delta T of coil is 7 Degrees. CGS Temp is 53F at the unit.

Table 4-41: AHU 5 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-42: AHU 5 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	1.3"W.C.	Fail	Can only maintain 1.3" W.C at 100% Fan Speed.
Override Duct SP Set-Point to 1.5" W.C.	1.3"W.C.	Fail	Can only maintain 1.3" W.C at 100% Fan Speed.

Table 4-43: AHU 5 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-44: AHU 5 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-45: AHU 5 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.6 AHU #6 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #6. The Tables below present the test procedure and the results of the testing procedure for AHU #6.

Table 4-46: AHU 6 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-47: AHU 6 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Return Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Humidifier to Auto	No		Not Simulated – Cannot complete due to available control in BAS
OA & RA Dampers set for Minimum OSA	No		Not Simulated – Cannot complete due to available control in BAS
Heating Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS
Cooling Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS

Table 4-48: AHU 6 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Return Fan On	No		Not Simulated – Cannot complete due to available control in BAS
OA & RA & EA Dampers set to Maintain the SAT Set-Point	No		Not Simulated – Cannot complete due to available control in BAS
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	No		Not Simulated – Cannot complete due to available control in BAS
Heating Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS
Cooling Coil Valve Modulates to	No		Not Simulated – Cannot complete due to available

Maintain SAT Set-Point			control in BAS

Table 4-49: AHU 6 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	No		Not Simulated – Cannot complete due to available control in BAS
Return Fan On	No		Not Simulated – Cannot complete due to available control in BAS
OA & RA & EA Dampers set to the Minimum Airflow Position	No		Not Simulated – Cannot complete due to available control in BAS
Heating Coil Valve Fully Closed	No		Not Simulated – Cannot complete due to available control in BAS
Cooling Coil Valve Modulates to Maintain SAT Set-Point	No		Not Simulated – Cannot complete due to available control in BAS

Table 4-50: AHU 6 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-51: AHU 6 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to .75" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 0.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-52: AHU 6 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-53: AHU 6 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

4.1.7 AHU #7 Functional Test Results

The following procedure was used to functional test the 100% OSA AHUs such as AHU #7. The Tables below present the test procedure and the results of the testing procedure for AHU #7.

Table 4-54: AHU 7 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-7 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidity Valve to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Once Pre-Heat Valve is 100% Open, then Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-55: AHU 7 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-7 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve is Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-56: AHU 7 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to	Yes	Pass	Functional Test was Completed 1/9/2014

Maintain SAT Set-Point			

Table 4-57: AHU 7 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-58: AHU 7 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-59: AHU 7 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-60: AHU 7 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-61: AHU 7 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones	Yes	Pass	The Duct SP Decreases to the Minimum

Requesting Duct SP Decrease			Set-Point
Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.8 AHU #8 Functional Test Results

The following procedure was used to functional test the 100% OSA AHUs such as AHU #8. The Tables below present the test procedure and the results of the testing procedure for AHU #8.

Table 4-62: AHU 8 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-9 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidity Valve to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Once Pre-Heat Valve is 100% Open, then Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-63: AHU 8 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-9 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve is Fully Closed	No	Fail	See Appendix A for notes
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-64: AHU 8 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	See Appendix A for notes

Table 4-65: AHU 8 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-66: AHU 8 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-67: AHU 8 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-68: AHU 8 Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-69: AHU 8 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point

Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.9 AHU #9 Functional Test Results

The following procedure was used to functional test the 100% OSA AHUs such as AHU #9. The Tables below present the test procedure and the results of the testing procedure for AHU #9.

Table 4-70: AHU 9 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-11 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidity Valve to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Modulates to Maintain SAT	5800 CFM	Pass	Functional Test was Completed 1/9/2014
Once Pre-Heat Valve is 100% Open, then Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-71: AHU 9 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
EF-11 On	Yes	Pass	Functional Test was Completed 1/9/2014
Humidifier to Auto	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve is Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-72: AHU 9 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-73: AHU 9 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Exhaust Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Pre-Heat Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-74: AHU 9 Functional Test – Fan Testing

Fan Testing	Value	Pass/Fail	Comments
Override Duct SP Set-Point to 1.2" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.9" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point
Override Duct SP Set-Point to 1.5" W.C.	Yes	Pass	Supply Fan VFD Modulates to Maintain the Duct SP at Set-Point

Table 4-75: AHU 9 Functional Test – Humidity Testing

Humidity Testing	Value	Pass/Fail	Comments
Simulate a Call for Humidity	Yes	Pass	Humidity Valve Modulates to Maintain Humidity Set-Point
Simulate Conditions when there is No Call for Humidity	Yes	Pass	Humidity Valve Closes

Table 4-76: AHU 9Functional Test – SAT Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting DAT Decrease	Yes	Pass	The SAT Decreases to the Minimum SAT Set-Point
Override the Number of Zones Requesting DAT Increase	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point
Override the Number of Zones Requesting DAT Decrease to 6 and the Number of Zones Requesting DAT Increase to 6	Yes	Pass	The SAT Increases to the Maximum SAT Set-Point

Table 4-77: AHU 9 Functional Test – Duct SP Reset Testing

SAT Reset Testing	Value	Pass/Fail	Comments
Override the Number of Zones Requesting Duct SP Decrease	Yes	Pass	The Duct SP Decreases to the Minimum Set-Point

Override the Number of Zones Requesting Duct SP Increase	Yes	Pass	The SAT Increases to the Maximum Set-Point

4.1.10 AHU #11 Functional Test Results

The following procedure was used to functional test the Re-Circulating AHUs such as AHU #11. The Tables below present the test procedure and the results of the testing procedure for AHU #11.

Table 4-78: AHU 11 Functional Test – Simulate a Call for Heating

Simulated Call for Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Modulates to Maintain SAT	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-79: AHU 11 Functional Test – Simulate No Call for Heating

Simulated Call for No Heat	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA Dampers set for Minimum OSA	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-80: AHU 11 Functional Test – Simulate a Call for Cooling when both the Airside Economizer and Mechanical Cooling are Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to Maintain the SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014
Once the OA & RA & EA Dampers are 100% open, mechanical cooling is enabled to Maintain the SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	N/A	N/A	Could not test due to winter conditions, SAT would drop below acceptable levels and unit would freeze up before dampers 100% open

Table 4-81: AHU 11 Functional Test – Simulate a Call for Cooling when the Airside Economizer is Disabled and Mechanical Cooling is Enabled

Simulated Call for Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	OA & EA Dampers Fully Closed
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Modulates to Maintain SAT Set-Point	Yes	Pass	Functional Test was Completed 1/9/2014

Table 4-82: AHU 11 Functional Test – Simulate Conditions when there is No Call for Cooling

Simulated Call for No Cooling	Value	Pass/Fail	Comments
Supply Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
Return Fan On	Yes	Pass	Functional Test was Completed 1/9/2014
OA & RA & EA Dampers set to the Minimum Airflow Position	Yes	Pass	Functional Test was Completed 1/9/2014
Heating Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014
Cooling Coil Valve Fully Closed	Yes	Pass	Functional Test was Completed 1/9/2014

4.2 PUMPING SYSTEM

Per VA request the pumps could be point-to-point tested, but not functionally tested since changing the fluid delta pressure would set off alarms at the Elmendorf side of the system. The Point to Point testing procedure used on pumps is as follows:

Table 4-83: Pump 1 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump 1A to 77.1%	80.7%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump 1B to 63.4%	65.0%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-84: Pump 2 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-85: Pump 3 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-86: Pump 4 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-87: Pump 5 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-88: Pump 6 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-89: Pump 7 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Table 4-90: Pump 8 Point to Point Test

Simulated Call for Heat	Observed Value	Pass/Fail	Comments
Command Pump to 50% Speed	50%	Pass	Pump responded by changing speed (Value as observed on VFD readout)
Command Pump to 100% Speed	100%	Pass	Pump responded by changing speed (Value as observed on VFD readout)

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON		PASS	AK	1/8/2014	
Supply Fan S/S			ON		PASS	AK	1/8/2014	
EF-1 S/S			ON		PASS	AK	1/8/2014	

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON		PASS	AK	1/8/2014	
Supply Fan Status			ON		PASS	AK	1/8/2014	
EF-1 Status			ON		PASS	AK	1/8/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed		0	N/A	50	100	PASS	AK	1/8/2014	
RF VFD Speed			30-30	50	100	PASS	AK	1/8/2014	1
Economizer		0	0	50	100	PASS	AK	1/8/2014	
Humidity		0	50	50	100	PASS	AK	1/8/2014	
Heating Vavle		100	0	50	100	PASS	AK	1/8/2014	
Cooling Valve		0	0	50	100	PASS	AK	1/8/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72	73.7	°F	2	-1.7		PASS	AK	1/8/2014	
Mixed Air Temperature		57.7	53.9	°F	5	3.8		PASS	AK	1/8/2014	
Supply Air Temperature		59.7	59	°F	2	0.7		PASS	AK	1/8/2014	
Outside Air Temperature		10	11.4	°F	2	-1.4		PASS	AK	1/8/2014	
GHS Temp		190	190	°F	2	0		PASS	AK	1/8/2014	
GHR		181	180	°F	2	1		PASS	AK	1/8/2014	
EF-1 Duct Static Pressure											
Supply Air Humidity											

NOTES
1. Due to building operations, the fan was tested at min 30% Speed.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt	55			
	Min SAT Set-Pt (and corresponding VAV requests)	55			
	Max SAT Set-Pt (and corresponding VAV requests)	60			
	Supply DSP Set-Pt	1.3			
	Min DSP Set-Pt (and corresponding VAV requests)				
	Max DSP Set-Pt (and corresponding VAV requests)				
	EF-1 Duct Static Pressure				
	Space Humidity Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	RF VFD Speed				
	EF-1 Fan Speed				
	Economizer				
	EA Damper				
	Humidity				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On	YES	PASS	AK	1/9/2014	
	Return Fan On	YES	PASS	AK	1/9/2014	
	EF-1 On	YES	PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA	5800 CFM	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On	YES	PASS	AK	1/9/2014	
	Return Fan On	YES	PASS	AK	1/9/2014	
	EF-1 On	YES	PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Heat Valve Closed	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
Release Override Commands						
	All Overrides are Released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			2
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			2
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					3
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		N/A			
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint	YES	PASS	AK	1/9/2014	
Simulate a call for cooling where the economizer is re-enabled and mechanical cooling is enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			2
Simulate the conditions where there is no call for cooling					1
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve is closed	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

NOTES
1. SEE SCREEN SHOT. WHEN COOLING MODE IS RELEASED AND THE SEQUENCE STARTS CALLING FOR HEAT, THE HEATING VALVE OPENS WHILE THE ECONOMIZER IS STILL OPEN.
2. Not tested, OA temperature is below freezing and freeze stat alarm temperature and building is occupied.
3. Since OA temp is below freezing, this was tested by locking out economizer.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-1 and EF-1

Functional Testing

OCCUPIED HUMMIDITY CONTROL		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for hummidity					
	Hummidity Valve modulates to maintain hummidity Set-Pt	YES	PASS	AK	1/9/2014	
	Simulate the conditions where there is no call for hummidity					
	Hummidity Valve Closes	YES	PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released	YES				

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON		PASS	AK	1/8/2014	
Supply Fan S/S			ON		PASS	AK	1/8/2014	
EF-2 S/S			ON		PASS	AK	1/8/2014	

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON		PASS	AK	1/8/2014	
Supply Fan Status			ON		PASS	AK	1/8/2014	
EF-2 Status			ON		PASS	AK	1/8/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/31	52	100	PASS	AK	1/8/2014	1
RF VFD Speed			38/38	52	100	PASS	AK	1/8/2014	1
Economizer			0	50	100	PASS	AK	1/8/2014	
EA Damper			0	50	100	PASS	AK	1/8/2014	
Humidity			0	50	100	PASS	AK	1/8/2014	
Heating Vavle			0	50	100	PASS	AK	1/8/2014	
Cooling Valve			0	45	100	PASS	AK	1/8/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72.2	72.3	°F	1	-0.1		PASS	AK	1/8/2014	
Mixed Air Temperature				°F				PASS	AK	1/8/2014	
Supply Air Temperature		62.9	64.3	°F	1	-1.4				1/8/2014	
Supply Air Temperature		65.6	68	°F	1	-2.4				11/22/2014	
Supply Air Humidity											

NOTES
1. Due to building operations, the fan was tested at min 30% Speed.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
AHU Control Set-Points					
	Supply Air Temperature Set-Pt	65	JTWB	1/9/2014	
	Min SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
	Max SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
	Supply DSP Set-Pt	1.2	JTWB	1/9/2014	
	Min DSP Set-Pt (and corresponding VAV requests)	1	JTWB	1/9/2014	
	Max DSP Set-Pt (and corresponding VAV requests)	1.4	JTWB	1/9/2014	
	EF-2 Duct Static Pressure	0.483	JTWB	1/9/2014	
	Space Humidity Set-Pt	30%	JTWB	1/9/2014	
	Filter Dirty Set-Pt	1.25	JTWB	1/9/2014	
	Low Temperature Set-Pt.				can not find
	High Duct Static Pressure Set-Pt				can not find
As-Found Conditions					
	SF VFD Speed	64.40%	JTWB	1/9/2014	
	RF VFD Speed	30%	JTWB	1/9/2014	
	EF-14 Fan Speed	82.40%	JTWB	1/9/2014	
	Economizer	59.70%	JTWB	1/9/2014	
	EA Damper	same as above	JTWB	1/9/2014	same as above?
	Humidity	36.80%	JTWB	1/9/2014	
	Heating Vavle	54%	JTWB	1/9/2014	
	Cooling Valve	0%	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On	YES	PASS	JTWB	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-2 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On	YES	PASS	JTWB	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-2 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heat Valve Closed	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released	YES	PASS	JTWB	1/9/2014	
	Supply Fan, EF-2 & Return Fan to Auto	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Heat Valve Set to Auto	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
	Humidification Set to Auto	YES	PASS	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			1
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					3
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint	YES	PASS	AK	1/9/2014	
Simulate a call for cooling where the economizer is re-enabled and mechanical cooling is enabled					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		N/A			
Simulate the conditions where there is no call for cooling					
Supply fan is on	YES	PASS	AK	1/9/2014	
Return fan is on	YES	PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
Hot water valve is closed	YES	PASS	AK	1/9/2014	
Chilled water valve is closed		N/A			
Release all system overrides					
All overrides are released		YES			

NOTES
1. Not tested, OA temperature is below freezing and freeze stat alarm temperature and building is occupied.
3. Since OA temp is below freezing, this was tested by locking out economizer.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	YES	PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	YES	PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt	YES	PASS	AK	1/9/2014	1
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES				

NOTES
1 HUMIDIFIER VERY SLOW TO RESPOND

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-2 and EF-2

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint	YES	PASS	AK	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint	YES	PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released	YES	PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON		PASS	AK	1/9/2014	
Supply Fan S/S			ON		PASS	AK	1/9/2014	
EF-3 S/S			ON		PASS	AK	1/9/2014	

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON		PASS	AK	1/9/2014	
Supply Fan Status			ON		PASS	AK	1/9/2014	
EF-3 Status			ON		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/31	52	100	PASS	AK	1/9/2014	
RF VFD Speed			30/31	52	100	PASS	AK	1/9/2014	
Economizer			0	30	100	PASS	AK	1/9/2014	1
EA Damper			0	50	100	PASS	AK	1/9/2014	
Humidity			0	50	100	PASS	AK	1/9/2014	
Heating Vavle			0	50	100	PASS	AK	1/9/2014	
Cooling Valve			0	45	100	PASS	AK	1/9/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72.5	74.6	°F		-2.1		PASS	AK	1/9/2014	
Mixed Air Temperature		49.4	56	°F		-6.6		PASS	AK	1/9/2014	2
Supply Air Temperature		64.7	64	°F		0.7		PASS	AK	1/9/2014	
Return Duct Static Pressure											
Supply Duct Static Pressure											
EF-3 Duct Static Pressure											
Supply Air Humidity											

NOTES
1 RA DAMPER AT 50, OA DAMPER AT 30
2. Bad stratification MA box

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt	65	JTWB	1/9/2014	
		Min SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
		Max SAT Set-Pt (and corresponding VAV requests)	65	JTWB	1/9/2014	
		Supply DSP Set-Pt	1	JTWB	1/9/2014	
		Min DSP Set-Pt (and corresponding VAV requests)				
		Max DSP Set-Pt (and corresponding VAV requests)				
		EF-3 Duct Static Pressure				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
	As-Found Conditions					
		SF VFD Speed				
		RF VFD Speed				
		EF-3 Fan Speed				
		Economizer				
		EA Damper				
		Humidity				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On	YES	PASS	AK	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-3 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On	YES	PASS	JTWB	1/9/2014	
	Return Fan On	YES	PASS	JTWB	1/9/2014	
	EF-3 On	YES	PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA	YES	PASS	JTWB	1/9/2014	
	Humidifier Valve Auto	YES	PASS	JTWB	1/9/2014	
	Heat Valve Closed	YES	PASS	JTWB	1/9/2014	
	Cooling Valve is Closed	YES	PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			1
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		N/A			2
	Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	JTWB	1/9/2014	
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on	YES	PASS	AK	1/9/2014	
	Return fan is on	YES	PASS	AK	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	AK	1/9/2014	
	Hot water valve is closed	YES	PASS	AK	1/9/2014	
	Chilled water valve is closed	YES	PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released	YES				

NOTES
1. OAT below freezing, I closed the economizer manually, then cooling valve opened & modulates
2. OAT below freezing, economizer never at 100%

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-3 and EF-3

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		PASS	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					
EF-4 S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON					
Supply Fan Status			ON					
EF-4 Status			ON					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/32	52	100	P			
RF VFD Speed			30/31	52	100	P			
Economizer			0	50	100	P			
EA Damper			0	50	100	P			
Humidity			0	50	100	P			
Heating Vavle			0	50	100	P			
Cooling Valve			0	45	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		71.2	73.7			-2.5					
Mixed Air Temperature		40.3	36.6			3.7					
Supply Air Temperature		62.1	62.5			-0.4					
Outside Air Temperature											
Return Duct Static Pressure											
Supply Duct Static Pressure											
EF-4 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt				
	Min SAT Set-Pt (and corresponding VAV requests)				
	Max SAT Set-Pt (and corresponding VAV requests)				
	Supply DSP Set-Pt				
	Min DSP Set-Pt (and corresponding VAV requests)				
	Max DSP Set-Pt (and corresponding VAV requests)				
	EF-4 Duct Static Pressure				
	Space Humidity Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	RF VFD Speed				
	EF-4 Fan Speed				
	Economizer				
	EA Damper				
	Humidity				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	AK	1/9/2014	
	Return Fan On		PASS	AK	1/9/2014	
	EF-4 On		PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On		PASS	AK	1/9/2014	
	Return Fan On		PASS	AK	1/9/2014	
	EF-4 On		PASS	AK	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Heat Valve Closed		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
Release Override Commands						
	All Overrides are Released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers modulate to maintain the SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		N/A			1
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		N/A			1
	Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					4
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	JTWB	1/9/2014	
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint	YES	PASS	JTWB	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on	YES	PASS	JTWB	1/9/2014	
	Return fan is on	YES	PASS	JTWB	1/9/2014	
	OA/RA/EA dampers are at the minimum outside airflow position	YES	PASS	JTWB	1/9/2014	
	Hot water valve is closed	YES	PASS	JTWB	1/9/2014	
	Chilled water valve is closed	YES	PASS	JTWB	1/9/2014	
	Release all system overrides					
	All overrides are released		YES			

NOTES
1. Not tested, OA temperature is below freezing and freeze stat alarm temperature and building is occupied.
4. Since OA temp is below freezing, this was tested by locking out economizer.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt					
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes					
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-4 and EF-4

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint					
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint					
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					
EF-5 S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON					
Supply Fan Status			ON					
EF-5 Status			ON					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/31	50	100	P	AK	1/8/2014	
RF VFD Speed			30/31	50	100	P	AK	1/8/2014	
Economizer			0	50	100	P	AK	1/8/2014	
EA Damper			0	50	100	P	AK	1/8/2014	
Humidity			0	50	100	P	AK	1/8/2014	
Heating Vavle			0	55	100	P	AK	1/8/2014	
Cooling Valve			0	50	100	P	AK	1/8/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		72.3	71.2			1.1				11/22/2013	
Mixed Air Temperature		47	56.5			-9.5				11/22/2013	
Supply Air Temperature		59.7	59			0.7				11/22/2013	
Outside Air Temperature											
Return Duct Static Pressure											
Supply Duct Static Pressure											
EF-5 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt	60			
		Min SAT Set-Pt (and corresponding VAV requests)	60 (5)			
		Max SAT Set-Pt (and corresponding VAV requests)	60 (5)			
		Supply DSP Set-Pt	0.7			
		Min DSP Set-Pt (and corresponding VAV requests)	1.1 (2)			
		Max DSP Set-Pt (and corresponding VAV requests)	.7 (7)			
		EF-5 Duct Static Pressure				
		Space Humidity Set-Pt	30			
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
	As-Found Conditions					
		SF VFD Speed	76			
		RF VFD Speed	74			
		EF-5 Fan Speed				
		Economizer	13			
		Humidity	32			
		Heating Vavle	0			
		Cooling Valve	0			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

OCCUPIED HEATING			VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating						
		Supply Fan On		P			
		Return Fan On		P			
		OA & RA Dampers set for Min OSA		P			
		Humidifier Valve Auto		P			
		Heating Valve Modulates to Maintain Supply Air Temp		P			
		Cooling Valve is Closed		P			
	Simulate NO Call for Heating						
		Supply Fan On		P			
		Return Fan On		P			
		OA & RA Dampers set for Min OSA		P			
		Humidifier Valve Auto		P			
		Heat Valve Closed		P			
		Cooling Valve is Closed		P			
	Release Override Commands						
		All Overrides are Released		P			
		Supply Fan, EF-5 & Return Fan to Auto		P			
		OA & RA Dampers set for Min OSA		P			
		Heat Valve Set to Auto		P			
		Cooling Valve is Closed		P			
		Humidification Set to Auto		P			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on		PASS	AK	1/9/2014	
Return fan is on		PASS	AK	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint		PASS	AK	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled		n/a			
Hot water valve is closed		PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		n/a			
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
Supply fan is on		PASS	AK	1/9/2014	
Return fan is on		PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	AK	1/9/2014	
Hot water valve is closed		PASS	AK	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint					1
Simulate the conditions where there is no call for cooling					
Supply fan is on		PASS	AK	1/9/2014	
Return fan is on		PASS	AK	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	AK	1/9/2014	
Hot water valve is closed		PASS	AK	1/9/2014	
Chilled water valve is closed		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

NOTES
1. AFTER 15 MIN OF COOLING VALVE FULLY OPEN, ECONOMIZER AT 10%, MAT AT 67, THE SAT IS 59 AND THE SETPOINT IS 55, FAN SPEED 93%. ONLY 7 DEGREES OF COOLING ON THE COIL. COOLING SUPPLY TEMP IS 53 AT UNI

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.2 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		FAIL	JTWB	1/9/2014	can only maintain 1.
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		FAIL	JTWB	1/9/2014	can only maintain 1.
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	AK	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-5 and EF-5

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON VAV HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON VAV BOXES	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ON					
Supply Fan Status			ON					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/32	50	100	PASS			
RF VFD Speed			30/32	50	100	PASS			
Economizer			NOTE 1	50	100	PASS			1
Humidity			0	50	100	PASS			
Heating Vavle			0	50	100	PASS			
Cooling Valve			0	50	100	PASS			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		67.2	70.7			-3.5				11/22/2013	
Mixed Air Temperature		58.4	50			8.4				11/22/2013	
Supply Air Temperature		64.2	64.9			-0.7				11/22/2013	
Outside Air Temperature											

NOTES
1. 1/4" GAP ON RIGHT SIDE OF OA DAMPER WHEN COMMANDED CLOSED.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt				
		Min SAT Set-Pt (and corresponding space temp deviation)				
		Max SAT Set-Pt (and corresponding space temp deviation)				
		Supply DSP Set-Pt				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
		Return Duct Hugh CO2 Set-Pt				
	As-Found Conditions					
		SF VFD Speed				
		RF VFD Speed				
		Economizer				
		Humidity				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	Return Fan On		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Humidifier Valve Auto		PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On					1
	Return Fan On					1
	OA & RA Dampers set for Min OSA					1
	Humidifier Valve Auto					1
	Heat Valve Closed					1
	Cooling Valve is Closed					1
Release all system overrides						
	All overrides are released		PASS	JTWB	1/9/2014	

NOTES
1 NOT SIMULATED - cannot simulate due to avaiable controls in BAS

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on					1, 2
Return fan is on					1, 2
OA/RA/EA dampers modulate to maintain the SAT setpoint					1, 2
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled					1, 2
Hot water valve is closed					1, 2
Chilled water valve modulates to maintain SAT setpoint					1, 2
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
Supply fan is on					1, 2
Return fan is on					1, 2
OA/RA/EA dampers are at the minimum outside airflow position					1, 2
Hot water valve is closed					1, 2
Chilled water valve modulates to maintain SAT setpoint					1, 2
Simulate the conditions where there is no call for cooling					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	JTWB	1/9/2014	
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve is closed		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		yes			

NOTES	
1 NOT SIMULATED - cannot simulate due to avaiable controls in BAS	(this unit's controls are different than the other units)
2 Manual setpoint of 55F commanded to observe unit in cooling mode (both with and without economizer)	Heating valve closes, economizer opens.
	If economizer is locked shut then cooling valve will open

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 0.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 0.75 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released					

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-6

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON SPACE TEMPEARTURE DEVIATION	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override space temperature above setpoint with 1 deg					1
The SAT setpoint decreases to the minimum SAT setpoint					
Override space temperature below setpoint with 1 deg					1
The SAT setpoint increases to the maximum SAT setpoint					
Override space temperature below setpoint with 2 deg					1
The SAT setpoint increases to the maximum SAT setpoint					
Release all system overrides					
All overrides are released		yes			

NOTES
1 Not possible, no space temperature feedback to override

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan S/S								
EF-7 S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan Status								
EF-7 Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			35/36.3	75/77.5	100/100	PASS	AK	1/9/2014	
EF-7 Fan Speed			35/36.5	75/78	100/100	PASS	AK	1/9/2014	
Humidity			0	50	100	PASS	AK	1/9/2014	
Pre-Heat Vavle			0	45	100	PASS	AK	1/9/2014	
Heating Vavle			0	50	100	PASS	AK	1/9/2014	
Cooling Valve			0	50	100	PASS	AK	1/9/2014	

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Pre Heat Air Temperature		62.6	63.6	°F		-1		PASS	JTWB	11/22/2013	
Supply Air Temperature		60.7	59	°F		1.7		PASS	JTWB	1/9/2014	
Outside Air Temperature		10	11.4	°F		-1.4		PASS	JTWB	11/22/2013	
Supply Duct Static Pressure											
EF-7 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt				
		Min SAT Set-Pt (and corresponding zone requests)				
		Max SAT Set-Pt (and corresponding zone requests)				
		Supply DSP Set-Pt				
		Min DSP Set-Pt (and corresponding zone requests)				
		Max DSP Set-Pt (and corresponding zone requests)				
		EF-7 Duct Static Pressure				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
	As-Found Conditions					
		SF VFD Speed				
		EF-7 Fan Speed				
		OA Damper				
		EA Damper				
		Humidity				
		Pre-Heat Valve				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 & EF-7

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating					
	Supply Fan On		PASS	AK	1/9/2014	
	EF-7 On		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Pre-Heat Valve Modulates to Maintain Supply Air Temp		PASS	AK	1/9/2014	
	Once Pre-Heat is 100% Open, Heating Valve Modulates to Maintain Supply Air Temp		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
	Simulate NO Call for Heating					
	Supply Fan On		PASS	AK	1/9/2014	
	EF-7 On		PASS	AK	1/9/2014	
	Humidifier Valve Auto		PASS	AK	1/9/2014	
	Pre-Heat Valve is Closed		PASS	AK	1/9/2014	
	Heating Valve is Closed		PASS	AK	1/9/2014	
	Cooling Valve is Closed		PASS	AK	1/9/2014	
	Release Override Commands					
	All Overrides are Released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 &EF-7

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on		PASS	AK	1/9/2014	
	EF-7 is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		PASS	AK	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on		PASS	AK	1/9/2014	
	EF-7 is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve is closed		PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 &EF-7

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	AK	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-7 &EF-7

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON ZONE HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		pass	JTWB	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES	JTWB	1/9/2014	

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON ZONE REQUESTS	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		pass	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan S/S								
EF-9 S/S								
DX Stage #1 S/S								
DX Stage #2 S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan Status								
EF-9 Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/32	50	100	P			
Humidity			0	50	100	P			
Pre-Heat Vavle			0	50	100	P			
Heating Vavle			0	50	100	P			
Cooling Valve			0	50	100	P			
EF-9 VFD SPEED			30/32	50	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Pre Heat Air Temperature		52.5	55			-2.5					
Supply Air Temperature		55.2	59.7			-4.5					
Outside Air Temperature		10	11			-1					
After DX Temperature		48.8	48.5			0.3					*Potential CHW C

NOTES
HOBO OA, PREHEAT, AFTER DX

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt				
		Min SAT Set-Pt (and corresponding zone requests)				
		Max SAT Set-Pt (and corresponding zone requests)				
		Supply DSP Set-Pt				
		Min DSP Set-Pt (and corresponding zone requests)				
		Max DSP Set-Pt (and corresponding zone requests)				
		EF-9 Duct Static Pressure				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
		OR Max Humidity				
	As-Found Conditions					
		SF VFD Speed				
		EF-7 Fan Speed				
		OA Damper				
		EA Damper				
		Humidity				
		Pre-Heat Valve				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	EF-9 On		PASS	JTWB	1/9/2014	
	Humidifier Valve Auto		PASS	JTWB	1/9/2014	
	Pre-Heat Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Once Pre-Heat is 100% Open, Heating Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	EF-9 On		PASS	JTWB	1/9/2014	
	Humidifier Valve Auto		PASS	JTWB	1/9/2014	
	Pre-Heat Valve is Closed		FAIL	JTWB	1/9/2014	1
	Heating Valve is Closed		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released		PASS	JTWB	1/9/2014	
	All Commands reture to Auto		PASS	JTWB	1/9/2014	

NOTES
1 When I attempted to take away the call for heating the unit stays in heat mode, DAT set-pt goes to a value between the upper and lower DAT limits. Pre-heat valve modulates to maintain the new DAT set-pt.
As found conditions were the DAT upper and lower limit equal 55.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling					1
	Supply fan is on					
	EF-9 is on					
	Pre-Heat water valve is closed					
	Hot water valve is closed					
	Chilled water valve modulates to maintain SAT setpoint					
	Simulate the conditions where there is no call for cooling					2
	Supply fan is on					
	EF-9 is on					
	Pre-Heat water valve is closed					
	Hot water valve is closed					
	Chilled water valve is closed					
	Release all system overrides					
	All overrides are released	yes				

NOTES
1 could not get any zones to call for cooling on AHU set-pt screen, however 7 VAVs were in cooling mode. Therfore could not test 1/9/14 evening (18:28)
2 even with no call for heating or cooling (deadband) the unit remains in heat mode, operates normally to maintain upper limit DAT set-pt

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	MIN 1.13" WC	FAIL	JTWB	1/9/2014	creates alarm
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		pass	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		PASS	JTWB	1/9/2014	

OCCUPIED DEHUMMIDIFICATION CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for de hummidification					
DX Stage #1 to meet Space Humidity Set-Pt					1
DX Stage #2 to meet Space Humidity Set-Pt					1
Simulate the conditions where there is no call for hummidity					
DX Off					
Release all system overrides					
All overrides are released	yes				

NOTES
1 Condensing unit is secured for the winter, not possible to test de-humidification.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON ZONE HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON ZONE REQUESTS	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint					
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint					
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan S/S								
EF-11 S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan Status								
EF-11 Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			35/36.8	75/78	100/100	PASS			
EF-11 Fan Speed			35/36.3	75/77	100/100	PASS			
Humidity			0	50	100	PASS			
Pre-Heat Vavle			0	50	100	PASS			
Heating Vavle			0	50	100	PASS			
Cooling Valve			0	50	100	PASS			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Pre Heat Air Temperature		49.8	54.6	°F		-4.8				11/22/2013	
Supply Air Temperature		55	65.7	°F		-10.7				11/22/2013	
Outside Air Temperature											
Supply Duct Static Pressure											
EF-11 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt				
	Min SAT Set-Pt (and corresponding zone requests)				
	Max SAT Set-Pt (and corresponding zone requests)				
	Supply DSP Set-Pt				
	Min DSP Set-Pt (and corresponding zone requests)				
	Max DSP Set-Pt (and corresponding zone requests)				
	EF-11 Duct Static Pressure				
	Space Humidity Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	EF-7 Fan Speed				
	OA Damper				
	EA Damper				
	Humidity				
	Pre-Heat Valve				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating					
	Supply Fan On	YES	PASS	AK	1/9/2014	
	EF-11 On	YES	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Pre-Heat Valve Modulates to Maintain Supply Air Temp	5800 CFM	PASS	AK	1/9/2014	
	Once Pre-Heat is 100% Open, Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
	Simulate NO Call for Heating					
	Supply Fan On	YES	PASS	AK	1/9/2014	
	EF-11 On	YES	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Pre-Heat Valve is Closed	YES	PASS	AK	1/9/2014	
	Heating Valve is Closed	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
	Release Override Commands					
	All Overrides are Released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		PASS	AK	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve is closed		PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	AK	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON ZONE HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		pass	JTWB	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON ZONE REQUESTS	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		pass	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ONON					
Supply Fan Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/30	50	100	P			
RF VFD Speed			30/30	52	100	P			
Economizer			0	50	100	P			
Heating Vavle			0	50	100	P			
Cooling Valve			0	50	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		74.5	75			-0.5				1/8/2014	
Mixed Air Temperature		67	72			-5				1/8/2014	
Supply Air Temperature		68.6	68.5			0.1				1/8/2014	
Space Tempearture											

NOTES
p

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt				
	Space Temperarture Set-Pt				
	Supply DSP Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	RF VFD Speed				
	Economizer				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	Return Fan On		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	Return Fan On		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Heat Valve Closed		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released		PASS	JTWB	1/9/2014	
	Supply Fan & Return Fan to Auto		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Heat Valve Set to Auto		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint		PASS	JTWB	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled					not checked
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint					not checked
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	JTWB	1/9/2014	OA/EA dampers full
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for cooling					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	JTWB	1/9/2014	OSA @ 2x the min, u
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve is closed		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		yes			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: ACU-15

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Baseboard S/S								
Supply Fan S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Baseboard Status								
Supply Fan Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: ACU-15

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
Heating Vavle									
Cooling Valve									

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Supply Air Temperature											
Outside Air Temperature											
Space Tempearture											
Return Air Temperature											

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Space Temperarture Set-Pt				
	As-Found Conditions				
	Heating Vavle				
	Cooling Valve				
	BB				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: ACU-15

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating					
	Supply Fan On					
	Heating Valve Modulates to Maintain Space Temp					
	BB Modulates to maintain Space Temp Set-Pt					
	Cooling Valve is Closed					
	Simulate NO Call for Heating					
	Supply Fan On					
	BB OFF					
	Heat Valve Closed					
	Cooling Valve is Closed					
	Release Override Commands					
	All Overrides are Released					

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling					
	Supply fan is on					
	BB is OFF					
	Hot water valve is closed					
	Chilled water valve modulates to maintain Apace Temp setpoint					
	Simulate the conditions where there is no call for cooling					
	Supply fan is on					
	BB is OFF					
	Hot water valve is closed					
	Chilled water valve is closed					
	Release all system overrides					
	All overrides are released					

NOTES

VAV Terminal Units
Point-to-Point & Functional Testing

					SUPPLY AIR TEMPERATURE					HOT WATER VALVE			DAMPER			SPACE TEMPERATURE					COMMAND VAV TO FULL HEATING						COMMAND VAV TO FULL COOLING						
					Meas	DDC	Error	Re-cal'd	PASS	0% Command	100% Command	PASS	0% Command	100% Command	PASS	Meas	DDC	Error	Re-cal'd	PASS	DDC Status					PASS	DDC Status					PASS	
EQUIPMENT TAG	AREA SERVED	TERMINAL UNIT TYPE	CTRL VALVE 2-WAY/3-WAY	ASSOCIATED EQUIPMENT	(°F)	(°F)	(°F)	YES/NO	YES/NO	Observ Position	Observ Position	YES/NO	Observ Position	Observ Position	YES/NO	(°F)	(°F)	(°F)	YES/NO	YES/NO	Asspciated BB in Heating?	Damper Position (%)	Airflow Setpoint (cfm)	Airflow (cfm)	HW Valve Position (%)	YES/NO	Associated BB OFF?	Damper Position (%)	Airflow Setpoint (cfm)	Airflow (cfm)	HW Valve Position (%)	YES/NO	NOTES
VAV-1-102																																	
VAV-1-122																																	
VAV-1-206																																	
VAV-1-218																																	
VAV-1-130																																	
VAV-1-222																																	
VAV-1-204																																	
VAV-2-103																																	
VAV-2-112																																	
VAV-2-124																																	
VAV-2-203																																	
VAV-2-205																																	
VAV-2-211																																	
VAV-2-214																																	
VAV-2-218																																	
VAV-3-105																																	
VAV-3-106																																	
VAV-3-110																																	
VAV-3-117																																	
VAV-3-204																																	
VAV-3-207																																	
VAV-3-212																																	
VAV-3-216																																	
VAV-4-104																																	
VAV-4-114																																	
VAV-4-219																																	
VAV- 4-209																																	
VAV-5-107																																	
VAV-5-117																																	
VAV-5-114																																	
VAV-5-205		VAV Box														72	72	0	n/a	PASS								FULL OPEN	1500	1300	0	YES	MATCHES THE MEA
VAV-5-207		VAV Box			64	64				0	100		0	100		72.4	72				y	72	750	806	100								
VAV 5-218		VAV Box			72.8	71																											
VAV-5-209																																	
VAV-5-221																																	
VAV-5-224																																	
SAV-8-111																																	
SAV-8-131																																	
SAV-8-103																																	
VAV-9-102																																	
VAV-9-103																																	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Cooling HX

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
CHGP-13 A S/S								
CHGP-13 B S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
CHGP-13 A Status								
CHGP-13 B Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Cooling HX

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
CHGP-13 A VFD Speed				60/62.3	80/82	PASS			
CHGP-13 B VFD Speed				59.7		PASS			
ByPass Valve			0/0			PASS			

e

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
CHGS Temperature											
CHGR Temperature											
Well Supply Temperature											
Well Return Temperature											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Cooling HX

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	Control Set-Points				
	CHGS Temperature Set-Pt				
	Differential Pressure Set-Pt				
	As-Found Conditions				
	CHGP-13 A VFD Speed				
	CHGP-13 B VFD Speed				
	ByPass Valve				

HX		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Adjust the CHGS Temperature setpoint up					
	By-Pass Valve Modulates to Maintain Setpoint					
	Adjust the CHGS Temperature setpoint down					
	By-Pass Valve Modulates to Maintain Setpoint					
	Release all system overrides					
	All overrides are released					

CHGP-13 A		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Disable the Pump					
	Pump is disabled					
	Enable the Pump					
	Pump is enabled					
	Release all system overrides					
	All overrides are released					
	Override the differential pressure below setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Override the differential pressure above setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Release all system overrides					
	All overrides are released					

CHGP-13 B		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Disable the Pump					
	Pump is disabled					
	Enable the Pump					
	Pump is enabled					
	Release all system overrides					
	All overrides are released					
	Override the differential pressure below setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Override the differential pressure above setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Release all system overrides					
	All overrides are released					

NOTES

PUMPS

Point-to-Point & Functional Testing

		Point to Point					VFD Speed							FTP								
		S/S - On	S/S - Off	Diff Pressure		PASS	0% Command		50% Command		100% Command		PASS	Enable	Disable		Above Set-Pt		Below Set-Pt		PASS	
EQUIPMENT TAG	AREA SERVED	Observ Position	DDC Status	Observ Position	DDC Status	YES/NO	Observ Position	DDC Status	Observ Position	DDC Status	Observ Position	DDC Status	YES/NO	Observ Position	DDC Status	Diff Pressure Set-Pt	Observed - Pump Modulates to Meet Set-Pt	DDC Status	Observed - Pump Modulates to Meet Set-Pt	DDC Status	YES/NO	NOTES
Heated Glycol Pump 1A (VFD Spd)	Clinic Primary Heating Loop										80.7	77.1	Y									
Heated Glycol Pump 1B (VFD Spd)	Clinic Primary Heating Loop										65	63.4	Y									
Heated Glycol Pump 2A (VFD Spd)	AHU-1, 2 & 7 Heating Coils																					
Heated Glycol Pump 2B (VFD Spd)	AHU-1, 2 & 7 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 3A (VFD Spd)	AHU-1, 2 & 7 Re-Heat & Perim Heat																					
Heated Glycol Pump 3B (VFD Spd)	AHU-1, 2 & 7 Re-Heat & Perim Heat								50	50	100	100	Y									
Heated Glycol Pump 4A (VFD Spd)	AHU-3, 4 & 8 Re-Heat & Perim Heat																					
Heated Glycol Pump 4B (VFD Spd)	AHU-3, 4 & 8 Re-Heat & Perim Heat								50	50	100	100	Y									
Heated Glycol Pump 5A (VFD Spd)	AHU-3, & 8 Heating Coils																					
Heated Glycol Pump 5B (VFD Spd)	AHU-3, & 8 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 6A (VFD Spd)	AHU-5, & 9 Heating Coils																					
Heated Glycol Pump 6B (VFD Spd)	AHU-5, & 9 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 7A (VFD Spd)	AHU-4, 5 & 9 Re-Heat & Perim Heat																					
Heated Glycol Pump 7B (VFD Spd)	AHU-4, 5 & 9 Re-Heat & Perim Heat								50	50	100	100	Y									
Heated Glycol Pump 8A (VFD Spd)	AHU-4, & 6 Heating Coils																					
Heated Glycol Pump 8B (VFD Spd)	AHU-4, & 6 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 9A (Status)	Radiant Floor Tertiary Loop												Y									
Heated Glycol Pump 9B (Status)	Radiant Floor Tertiary Loop												Y									
Heated Glycol Pump 10A (VFD Spd)	AHU-11 Heat, Re-Heat & Perim Heat												Y									
Heated Glycol Pump 10B (VFD Spd)	AHU-11 Heat, Re-Heat & Perim Heat												Y									

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Heated Glycol Pump 11A (S/S)								
Heated Glycol Pump 11B (S/S)								
Heated Glycol Pump 12A (S/S)								
Heated Glycol Pump 12B (S/S)								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Heated Glycol Pump 11A (Status)								
Heated Glycol Pump 11B (Status)								
Heated Glycol Pump 12A (Status)								
Heated Glycol Pump 12B (Status)								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
HX Valve			0	50	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Glycol Temperature								PASS			
East Slab Surface Temp								PASS			
East Slab Core Temp								PASS			
East Moisture Detection								PASS			
West Slab Surface Temp								PASS			
West Slab Core Temp								PASS			
West Moisture Detection								PASS			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	Control Set-Points				
	Idle Mode Set-Pt.				
	Idle Slab Temp Set-Pt.				
	Moisture Sensor				
	Melt Slab Set-Pt				
	OSA Warm Cutout				
	OSA Cold Cutout				
	Glycol Max Temp Set-Pt.				
	Glycol Min Temp Set-Pt.				
	As-Found Conditions				
	Heated Glycol Pump 11A (Status)				
	Heated Glycol Pump 11B (Status)				
	Heated Glycol Pump 12A (Status)				
	Heated Glycol Pump 12B (Status)				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Functional Testing

Snowmelt System	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override OAT< Idel Set-Pt					
East Pump ON					
West Pump ON					
West Slab is at Idle Slab Temp Set-Pt					
East Slab is at Idle Slab Temp Set-Pt					
Override OAT> Warm Weather Ct-Off					
East Pump OFF					
West Pump OFF					
Override OAT< Idel Set-Pt					
East Pump ON					
West Pump ON					
West Slab is at Idle Slab Temp Set-Pt					
East Slab is at Idle Slab Temp Set-Pt					
Override Moisture Sensor (Pour Water on Moisture Sensor)					
East Pump ON					
West Pump ON					
West Slab is at Melt Slab Temp Set-Pt					
East Slab is at Melt Slab Temp Set-Pt					
Override OAT< Cold Weather Ct-Off					
East Pump OFF					
West Pump OFF					

HX Valve	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Adjust the HGS Temperature setpoint up					
By-Pass Valve Modulates to Maintain HGS Temp Setpoint					
Adjust the HGS Temperature setpoint down					
By-Pass Valve Modulates to Maintain HGS Temp Setpoint					
Release all system overrides					
All overrides are released					

HGS Temp Set Point Reset	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override slab temperature below Set-Pt					
As slab temperature rises, HGS Temperature is adjusted to maintain slab rate of tempearture					
increase below 0.2°F per minute					
Release all system overrides					
All overrides are released					

NOTES

5.0 Appendix B: Issues Log

Please see the following page for the Issues Log

#	MECH EQUIPMENT NAME	BUILDING AREA	DESCRIPTION	COMMENTS	DATE NOTED
1	ACU-15	Stairs 2, SE Corner A-wing	The stair located in the south east corner of the A-wing get extremely hot with the solar load. There seems to be no circulation of air, the RA and SA is located next to each other and the RA opening of the fan coil unit is not ducted to the RA plenum	See Tab "Issue 1" for drawings	11/22/2013
2	EF-13		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %		11/22/2013
3	AHU-9	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	Issue: Not able to cool space. Installed Coil is 51.7 MBH (submittals) and design size is tupposed to be 57 MBH Hypothises: cooling CHW coil is undersized. Observations: CHG temperature is too high, Primary Chilled Well Water Flowrate Too Low Assessment: TAB the coil to try to fix one of the three issues Mike Kief (FSI) agrees with this assessment. Also, the ductwork is not optimized for the fridges in the lab. Solution: re-position	11/22/2013
4	AHU-4	2nd Fl	Most comfort complaints are due to the thermostat located in another person's office. Areas where open offices were converted to individual offices are hard to control. Some of them will experience simultaneous heating and cooling as they have baseboard from one system while the air is supplied from different system, being the VAV. Part of the remodel included long runs of flex duct which reduces the airflow.	Solution: use multiple thermostats and balance using logic to determine if the baseboard should be enabled. Mike Kief (FSI) brought our attention to this problem.	11/22/2013
5		Learning Lab	The learning lab 2D116 has 12 computers and gets too warm when fully occupied.	Mike Kief (FSI) agrees with this assessment. This VAV box was functionally tested, and works as intended. VAV box probably not designed to absorb the load in this space.	11/22/2013
6	UH's	Penthouses	The unit heaters will freeze up in the penthouses.	Mike Kief (FSI) agrees with this assessment.	11/22/2013

7	AHU-8 and 9		The water contains a lot of minerals and the AHU chilled water coils will fill up with mineral deposits when the humidification is running. The static pressure goes way up and it really reduces the airflow distributed to the spaces. We clean the coils, and are testing different cleaners, but we are worried about the longevity of the coils. In addition the humidification dispersion units in AHU-8 and 9 freeze up when it's cold, and we have to remove them to let them defrost.	Mike Kief (FSI) brought our attention to this problem. TAB contractor to test the coil capacity.	11/22/2013
8	AHU-3 and 9		There are issues with evenly distributed airflow over the preheat coil in units 9 and the heating coil in AHU-3. A few pieces of cardboard is being used to re distribute airflow.	Mike Kief (FSI) agrees with this assessment.	11/22/2013
9	Chilled Water HX		Elmendorf limits the chilled water flow in the summer to prevent the underground wells from drying up. As a result, the chilled water temperature to the air handling units is between 50-52 deg F instead of 46 deg F per mechanical drawings.	Mike Kief (FSI) agrees with this assessment.	11/22/2013
10	VAV boxes	first floor (mostly)	Griswald balancing valve cartridges are becoming clogged with metalic debris, mostly on first floor.	Mike Kief (FSI) agrees with this assessment.	1/8/2014
11	AHU-3		Bas stratification in the mixing box, can cause coil freeze up and a problem for the atomizing humidifier.	Building staff remidies this with some cardboard in the unit.	1/10/2014
12	AHU-5		1. AFTER 15 MIN OF COOLING VALVE FULLY OPEN, ECONOMIZER AT 10%, MAT AT 67, THE SAT IS 59 AND THE SETPOINT IS 55, FAN SPEED 93%. ONLY 7 DEGREES OF COOLING ON THE COIL. COOLING SUPPLY TEMP IS 53 AT UNIT.	Possibly a clogged griswald valve. Check with Mike Kief if he has noticed that unit has problems meeting load.	1/10/2014
13	AHU-5		1. 1/4" GAP ON RIGHT SIDE OF OA DAMPER WHEN COMMANDED CLOSED.		1/10/2014
14	VAV 1-203		Space Temperature Sensor Failure		3/1/2014
15	VAV 1-221		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014
16	VAV 3-215		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014
17	VAV 4-216		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014

18	VAV 5-220		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014
19	SAV 8-106		Humidity Issue, not being maintained at set-point	Further investigation warranted.	3/1/2014
20	VAV 9-102		Low CFM	Further investigation warranted.	3/1/2014
21	AHU-1		The Supply fan starts 4 hours early, should start at 6:00 am but it is starting at 2:00 am. No apparent reason.	Solution: Re-Schedule Fan to start at 6:00 am. The cooling valve is likely enabled starting at 6:00 am	3/1/2014
22	AHU-2		Fan speed does not appear to modulate with OSA temp	Potentially not an issue since the baseboard heat should take care of night time heating.	3/1/2014
23	AHU-2		Supply Fan does not shut down at night, 24/7 operation. Static pressure of 1" is maintained during off hours, when occupied SP of 1.05" to 1.37" maintained. Supply fan runs on weekend.	Solution: Schedule Supply Fan to match occupied schedule	3/1/2014
24	AHU-2		Winter Schedule shuts down @ 7:15 pm, Summer Schedule shuts down @ 10:15 pm. Supply Fan runs on weekend.	Solution: curtail unnessecary runtime	3/1/2014
25	AHU-3		Fan speed does not appear to modulate with OSA temp	Potentially not an issue since the baseboard heat should take care of night time heating.	3/1/2014
26	AHU-3		Supply fan operates longer hours than return fan. The Supply fan starts 4 hours early, should start at 6:00 am but it is starting at 2:00 am.	Solution: curtail unnessecary runtime	3/1/2014
27	AHU-4		Supply and Return Fan are 24/7. They run a lower static pressure when unoccupied, but fans are running 24/7.		3/1/2014
28	AHU-4		Supply fan runs longer hours in the summer than the winter	Solution: curtail unnessecary runtime	3/1/2014
29	Compressor		Still neet to check the air compressor runtime versus actual humidifier demand and AHU runtimes		3/1/2014

Appendix-H

For Final RCx Report

2014 TAB Report

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10 -Wasilla, Alaska 99654
Phone: (907) 373-1090
Fax: (907) 373-3586

TEST AND BALANCING REPORT

Subject Job: VA Clinic
Anchorage, Alaska

Architect:

Engineer:

Contractor: DAV Energy Solutions
1804 Garnet Ave.
San Diego, California 92109

Certified By: Ronald D. Neffendorf
Ronald D. Neffendorf
Certification Number 2955
Expires March 31, 2016

Alaska Air Balancing
NEBB
RONALD D. NEFFENDORF
CERTIFICATION
2955
Exp. 3/31/16
Air and Hydronic Systems

Date: April 14, 2014

The data presented in this report is a record of the system measurements and final adjustments that have been obtained in accordance with the current edition of the NEBB procedural standards for the testing, adjusting, and balancing of the environmental systems. Any variances from the design quantities, which exceed NEBB tolerances, are noted in the test-adjust-balance report project summary (Job Inspection Report).

3060 Lazy Eight Court #10-Wasilla, Alaska 99654
Phone: (907) 373-1090

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A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla, Alaska 99654
Phone: (907) 373-1090
April 14, 2014

JOB INSPECTION REPORT
VA Clinic
Anchorage, Alaska

AHU-7

1. Air flow was determined to be 7,718 cfm.

2. Refer to static pressure profile sheet for static readings.

AHU-8

1. Air flow was determined to be 7,580 cfm.

2. PHC ΔT: EWT 191°, LWT 175°.

3. Flow Rate: 33 gpm at time of testing.

4. Mix Air Temp: This is a 100% outside air unit.

5. Refer to static pressure sheet for static readings.

6. PHC currently has a 51 gpm Griswold installed. Original design was 36 gpm. This valve currently has no pressure drop and gpm was determined from a redundant Bell and Gossett balancing valve.

AHU-9

1. Air flow was determined to be 2,905 cfm.

2. CC ΔT Water: EWT 50°, LWT 54°.

3. CC Flow Rate: 7.0 gpm per Griswold.

4. Mix Air Temp.: This is an 100% outside air unit.

5. CC ΔT Air: EAT 42°, LAT 51°.

6. Refer to static pressure profile sheet for static readings

7. General note for CC: Entering air temperature was colder than glycol as a result the glycol was acting as a heating source rather than a cooling source.

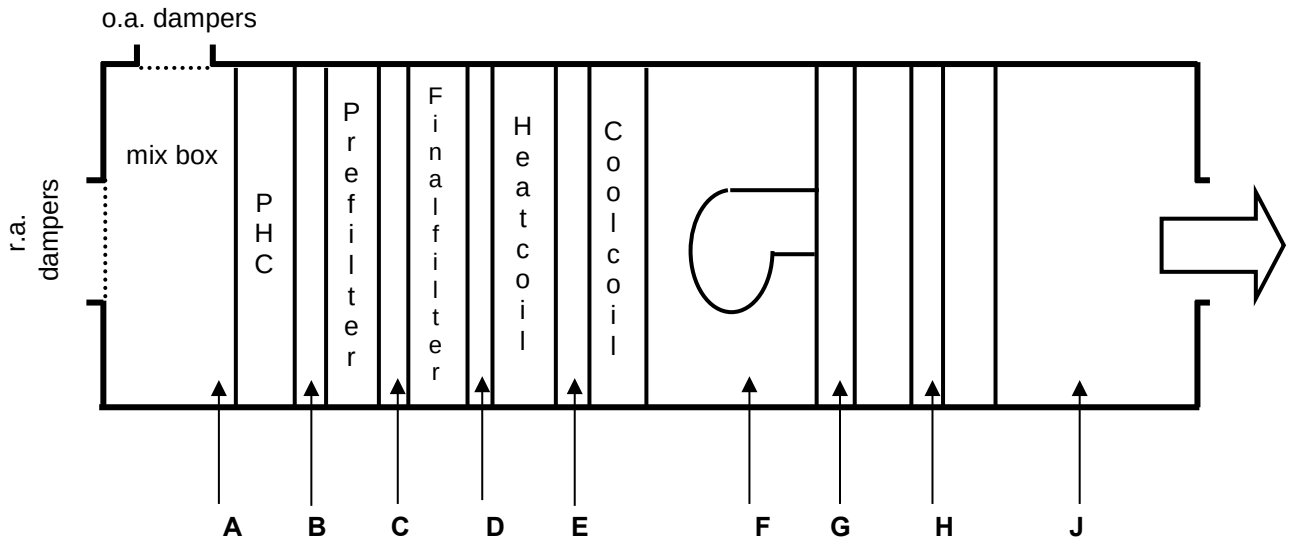
ALASKA AIR BALANCING CO.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

STATIC PRESSURE PROFILE

PROJECT NAME : New VA Clinic
LOCATION : Anchorage, Alaska



Unit	A	B	C	D	E	F	G	H	J
AHU-7	-0.27	-0.49	-0.76	-1.76	-1.92	-2.81			1.83

Remarks: _____

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

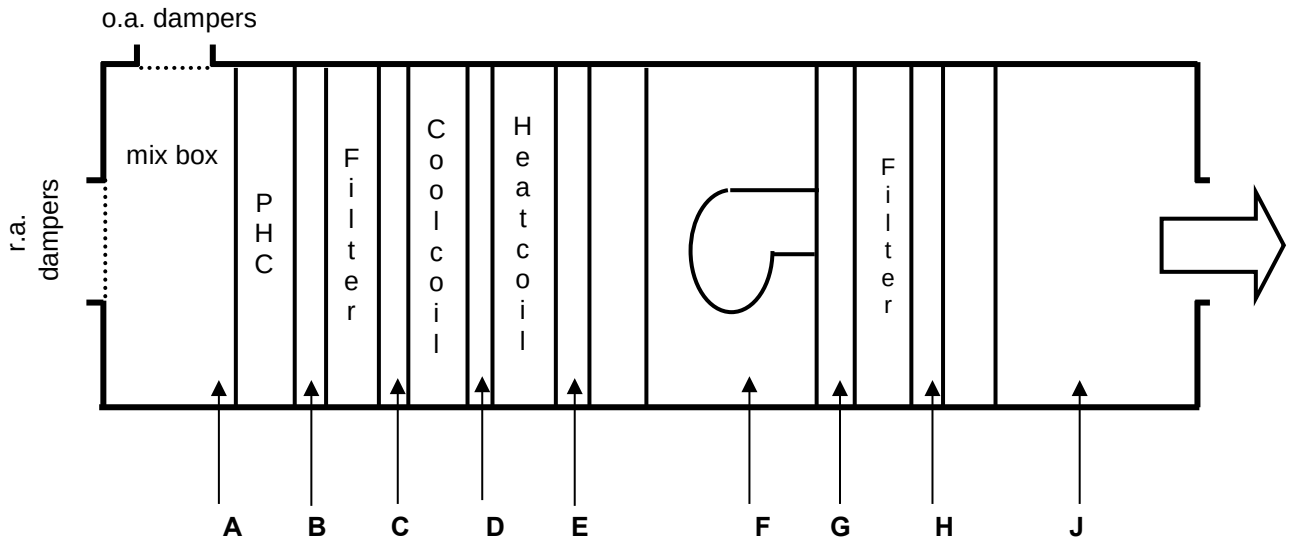
ALASKA AIR BALANCING CO.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

STATIC PRESSURE PROFILE

PROJECT NAME : New VA Clinic
LOCATION : Anchorage, Alaska



Unit	A	B	C	D	E	F	G	H	J
AHU-8	-0.36	-0.46	-1.07	-2.15	-2.36	3.67			3.15

Remarks: _____

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

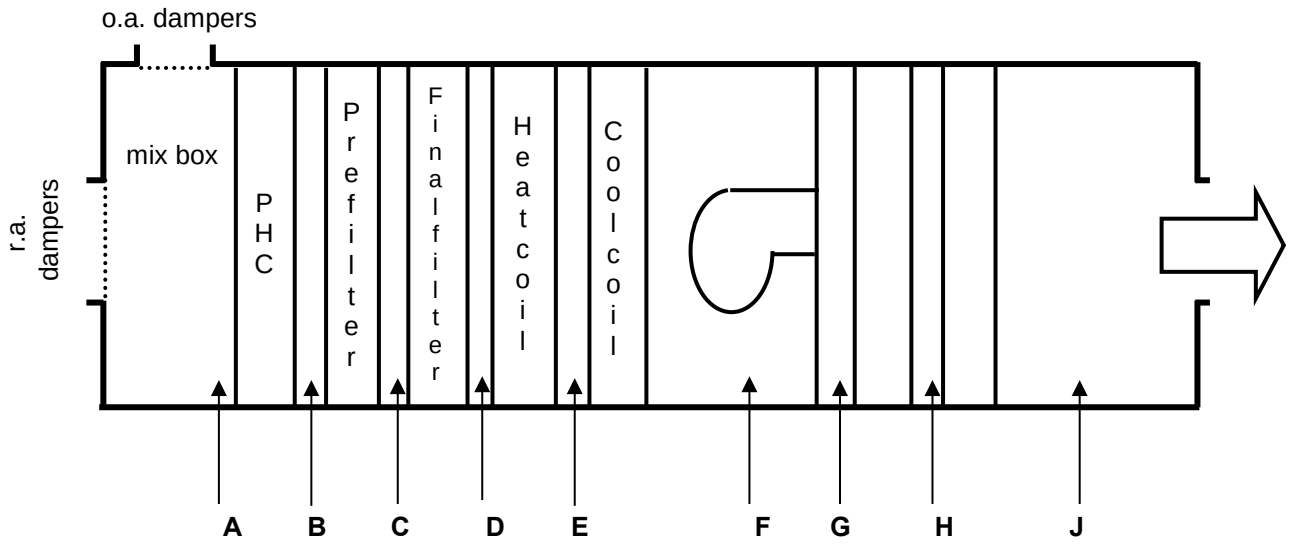
ALASKA AIR BALANCING CO.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

STATIC PRESSURE PROFILE

PROJECT NAME : New VA Clinic
LOCATION : Anchorage, Alaska



Unit	A	B	C	D	E	F	G	H	J
AHU-9	-0.27	-0.34	-0.59	-1.50	-1.63	-2.54			1.35

Remarks: _____

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

AIR BALANCING REPORT - CONSTANT VOLUME

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

Location & Room No.	Outlet Size	Outlet AK	Veloc. Req'd	**Design CFM**	OUTLET READINGS Initial Reading	Final Reading	**Final CFM**
*** AHU-7**							
** Fan Traverse (60 Hertz)	55 x 36	13.75	526	**7230**	522		**7178**
Ebtron Sensor at time of reading	30 x 30	6.25	1157	**7230**	880		**5500**
***** AHU-8**							
** Fan Traverse (54 Hertz)	56 x 39	15.15	512	**7760**	500		**7580**
Ebtron Sensor at time of reading	30 x 30	6.25	1242	**7760**	1130		**7062**
*** AHU-9**							
** Fan Traverse (60 Hertz)	37 x 27	6.37	478	**3050**	456		**2905**
Ebtron Sensor at time of reading	22 x 22	3.36	908	**3050**	875		**2940**

Remarks: * Fans run at 60 hertz all the time.
** Fan totals are per original design cfm's.
*** Per maintenance, fan always runs at this speed.

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

WATER BALANCING REPORT

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

Unit	Location & Room No.	Type	Size Inches	Design GPM	Degree Setting	Press. Drop	Final GPM
	* AHU-8 PHC (39 Hertz)	B & G	CB 2	51.00	0.0	1.6	33.00
	AHU-8 PHC (48 Hertz)	B & G	CB 2	51.00	0.0	3.2	46.00
		Griswold	3C22	51.00	No Pressure Drop		N/A
					Entering	**Leaving**	
					PSI	**PSI**	
	AHU-9 CC	Griswold	IRI2PNFF	7.00	30.0	28.0	7.00

Remarks: * 51 gpm is per new griswold installed. Old design is 36 gpm. See job inspection report.

TAB Technician: Joe Sullivan

Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

HEAT COIL DATA SHEET

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

System	PHC-8							
Location	AHU-8							
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM	7760	* 7580						
GPM	** 51.0	** 33.0						
EWT Degrees F.	186	191						
LWT Degrees F.	156	175						
EAT DB Degrees F.	-18	25						
LAT DB Degrees F.	45	54						

System								
Location								
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM								
GPM								
EWT Degrees F.								
LWT Degrees F.								
EAT DB Degrees F.								
LAT DB Degrees F.								

Remarks: * At time of traverse.
** Original griswold was 36 gpm. New griswold is 51 gpm. No drop on griswold valve.
GPM determined on redunant B & G valve.
Generla Note: Coil has a 2 psi drop, 11 psi entering and 9 psi leaving.

TAB Technician: Joe Sullivan

Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

COOLING COIL DATA SHEET

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

System	CC-9							
Location	AHU-9							
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM	3050	* 2905						
GPM	N/A	7.0						
EWT Degrees F.	N/A	50						
LWT Degrees F.	N/A	54						
EAT DB Degrees F.	N/A	42						
LAT DB Degrees F.	N/A	50						

System								
Location								
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM								
GPM								
EWT Degrees F.								
LWT Degrees F.								
EAT DB Degrees F.								
LAT DB Degrees F.								

Remarks: * At time of traverse.
Generla Note: Coil has a 1 psi drop, 32 psi entering and 31 psi leaving.
EAT was colder than EWT, causing LAT to rise instead of decrease.

TAB Technician: Joe Sullivan

Date Balanced: 4/11/14

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla, Alaska 99654
Phone: (907) 373-1090

TERMS & ABBREVIATIONS

AC or ACU: Air Conditioner or Air Conditioning Unit
AH or AHU: Air Handler or Air Handler Unit
AVG: Average
BHP: Brake Horsepower
CAV: Constant Air Volume
CBV: Calibrated Balancing Valve
CC: Cooling Coil
CFM: Cubic Feet per Minute
CH: Chiller
CHWS: Chilled Water Supply
CHWR: Chilled Water Return
CP: Circulating Pump
CR: Ceiling Register
CRAC: Computer Room Air Conditioner
CRU: Computer Room Unit
CT: Cooling Tower
CU: Condenser Unit
CUH: Cabinet Unit Heater
CWS: Condenser Water Supply
CWR: Condenser Water Return
D.A.: Duct Area
DAT: Discharge Air Temperature
DB: Dyr Bulb
DD: Direct Drive
DDC: Direct Digital Controls
Des.: Design
Dia.: Diameter
Disch.: Discharge
EA: Exhaust Air
EAT: Entering Air Temperature
Economizer: Controls and components that allow an air handler to logically utilize outdoor air for cooling as opposed to the use of mechanical cooling.
EF: Exhaust Fan
EG: Exhaust Grille
EMCS: Energy Management Control System
ERU: Energy Recovery Unit
E.S.P.: External Static Pressure
F.C.: Flow Coefficient
HRC: Heat Recovery Coil
EWT: Entering Water Temperature
FCU: Fan Coil Unit
FD: Fire Damper
FLA: Full Load Amperage: Maximum amperage a motor can draw.
Flow Hood: Instrument that captures air and converts the reading to cfm.
FPB: Fan Powered Box
FPM: Feet per Minute
FR: Field Report Data
FTU: Fan Terminal Unit
GPM: Gallons per Minute
HC: Heat Coil
TDH: Pressure Difference across the entering and leaving side of the pump
TDH: Pressure Difference across the entering and leaving side of the pump
HEPA: High Efficiency Particulate Arrestance
HP: Horsepower
HVAC: Heating Ventilation and Air Conditioning
HWS: Heating Water Supply
HWR: Heating Water Return
HX: Heat Exchanger
HZ: Hertz, cycle per second
In.: Inches
In w.g.: Inches of water gauge
A.K.: Correction factor to the free area need to calculate cfm
KW: Kilowatts
LAT: Leaving Air Temperature
LWG: Low Wall Grille
LWR: Low Wall Register
LWT: Leaving Water Temperature
MAU: Make-up Air Unit
MBH: 1,000 BTUH
N/A: Not Available
OSA: Outside Air
OBD: Opposed Blade Damper
△P: Pressure Drop
PH: Phase
PSI: Pounds per Square Inch
RA: Return Air
RAT: Return Air Temperature
RF: Return Fan
RH: Relative Humidity
RHC: Reheat Coil
RPM: Revolutions per Minute
RTU: Roof Top Unit
SA: Supply Air
SAT: Supply Air Temperature
S.F.: Service Factor
SF: Supply Fan
SFD: Smoke/Fire Damper
SP: Static Pressure
Sq. ft.: Square Feet
Suct.: Suction
SWG: Sidewall Grille
SWR: Sidewall Register
TAB: Test Adjust and Balance
TSP: Total Static Pressure: Difference between the entering and leaving static pressure of fan.
UH: Unit Heat
VAV: Variable Air Volume: box that contains a motorized damper that modulates airflow.
VD: Volume Damper
VFD: Variable Frequency Drive
Velgrid: Instrument that reads used velocity in feet per minute.
VVT: Variable Volume Terminal
WC: Water Column
W.G.: Water Gauges
WB: Wet Bulb

Appendix-J

For Final RCx Report

Minor & Major Recommended Corrective Action Report

VISN 20 Alaska VA Healthcare System

Simple Repair Report

APRIL 16, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126AA issued to DAV Energy Solutions, Inc. under DAV's GSA Comprehensive Professional Energy Services Blanket Purchase Agreement (BPA Task Order No. VA701-13-Q-0257). In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

Prepared by:

DAV Energy Solutions, Inc.
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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Executive Summary

1.1 INTRODUCTION

This Simple Repair Summary report, prepared by DAV Energy Solutions Inc. for the VISN 20 Alaska Health Care Systems, provides a summary of the systems testing during the monitoring periods and the discoveries made during those periods. Normally these repairs are identified during the functional testing period. However all equipment passed their functional tests and repair items were not identified until monitoring data was analyzed. This report summarizes the simple repairs that were identified during this period, along with our proposed methodology in completing these repairs within the project timeline. A “simple repair” is a defined as a repair that takes no more than 30 minutes to complete, and costs no more than $60 in materials. An Issues Log is presented in Appendix A.

This report is being completed under **Key Deliverable 10 Simple Repair Report**.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs,
4. Identify energy or capital improvement projects for implementation in the future.

The table on the following page summarizes the deliverables in the project and their status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Perf. Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	Complete
10	Repair Report Summary	**CURRENT**
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	Complete

The content of these deliverables is summarized in the RCx Plan.

2.0 Simple Repairs

2.1 SIMPLE REPAIR OVERVIEW

The RCx team used the following methods to identify HVAC system deficiencies:

- On-Site Observations
- Occupant Interviews
- System Condition Assessments
- Diagnostic Monitoring
- Point to Point Testing
- Functional Testing
- TAB Measurements

All deficiencies identified are documented in the Issues Log attached to this report as Appendix A.

Deficiencies are categorized as simple repairs if they can be completed in 30 minutes or less with $60 or less in materials cost. The objective of simple repairs is to improve the operation of the facility and to eliminate minor issues so they do not mask underlying major issues.

Please see below for a general summary of the deficiencies identified and those recommended for implementation as simple repairs:

- 32 total deficiencies were identified and investigated.
- 7 out of 32, or 21.9% of the deficiencies identified were categorized as simple repairs and slated for implementation by the RCx team under this project.
- 17 out of 32, or 53.1% of the deficiencies identified were categorized as Major or Minor Repairs and will be the responsibility of the VA to complete in the future if desired.
- 8 out of 32, or 25.0% of the total deficiencies identified were determined not to actually be issues after further investigation, and require no action.

2.2 SUMMARY OF SIMPLE REPAIRS PROPOSED

Simple repairs include minor maintenance tasks, system adjustments, set-point adjustments, and sensor calibration. Energy savings were not estimated for these repairs in this report. Some repairs will save energy while other repairs provide improvements with limited or no energy savings. For Measures with energy savings, the estimated amounts saved are provided in the following report, Deliverable #11.

The general summary of the simple repairs are summarized in the following list:

- **7 out of 32, or 21.9% of the simple repair issues have been targeted for action as follows:**
  - For EF-13, the BMS display shows speed in Hertz, correct units are %.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - Space Temperature sensor failure in VAV zone 1-203
    - *With approval from VA POC, this can be corrected under the RCx project scope*.
  - The Supply Fan for AHU-1 starts 4 hours early, starting at 2:00 AM daily instead of 6:00 AM as it should.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - Supply Fan for AHU-2 does not shut down at night, 24/7 operation. Static pressure of 1" is maintained during off hours, during occupied time periods a Static Pressure of 1.05" to 1.37" is maintained. The supply fan also runs on weekends. We recommend scheduling the Supply Fan to start 1 hour before the occupied schedule is to begin.
    - *This is a simple change and can be implemented by the controls operator within a few minutes (no cost estimated).*
  - Return Fan for AHU-2 winter schedule shuts down @ 7:15 pm, summer schedule shuts down @ 10:15 pm. The Supply Fan runs on the weekend. We recommend scheduling the Return Fan to start 1 hour before the occupied schedule, matching the supply fan.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - The Supply fan for AHU-3 operates longer hours than the Return fan. The Supply fan starts 4 hours early, should start at 6:00 am but it is starting at 2:00 am. Both Fans run on Saturdays for unknown reasons. We recommend scheduling the Fans to start 1 hour before the occupied schedule.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - The Supply and Return fans for AHU-4 currently run 24/7 in the summer and winter. We recommend scheduling the Supply and Return Fans to start 1 hour before the occupied schedule.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*

A full list of recommended repairs is shown in **Appendix A**.

2.3 ACTION PLAN FOR OTHER REPAIRS

The RCx team will complete repairs only where and when authorized by the VA staff according to the prioritization and goals of the VA. There were repairs that were identified during the testing and monitoring activities of the Investigation Phase that were not corrected as part of this project. These deficiencies require

the replacement of parts or additional diagnostic labor beyond the 30-minute guideline for a simple repair and/or $60 in material costs. These items were categorized as other repairs and are summarized as follows:

- Of the 32 total deficiencies identified, 17, or 53.1% were categorized as minor or major repairs and have been assigned for repair in the future as follows:
    - Out of the 32 deficiencies identified, 9, or 28.1% were classified as minor repairs.
        - Minor repairs include ducting for the stairwell FCU, control system programming to average space temperatures for better controls and a preventative maintenance program for the Griswold valves.
    - Out of the 32 deficiencies identified, 8, or 25.0% were classified as Major repairs.
        - Major repairs include investigating and repairing the air leaks in the compressed air system for the humidification, Coil Replacements, repositioning the return registers in the Lab and RO Water Filtration System for the Humidification.

These issues are addressed in more detail in the Minor and Major Recommendations Report, Deliverable 11.

2.4 SCHEDULE

This section sets forth the detailed schedule of diagnostic testing tasks carried out at the Anchorage, Alaska VA Outpatient Clinic.

Table 0-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 to 1/10/2014 & 4/11/2014	Yes	Functional Testing was Completed in January of 2014.
Onsite Air Flow & Water Flow Measurements	4/11/2014	Yes	A certified TAB contractor was utilized for these select measurements.
Prepare Deficiencies Log	11/22/2013 to 4/16/2014	Partial	Ongoing during functional testing and completed in the office.
Prepare Simple Repair Report and Deliver to VA for approval	4/16/2014	No	This report will summarize Simple Repairs.

All issues, including the locations and equipment affected, are summarized in the Issues Log in **Appendix A**.

Appendix-J

Minor & Major Recommended Corrective Action Report

VISN 20 Alaska VA Healthcare System

Minor & Major Repair Recommendations

APRIL 16, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

Prepared by:

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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
RA	Return Air
TAB	Testing and Balancing

1.0 Introduction

As part of its RCx efforts at VISN 20, DAV Energy presents the following report summarizing the Major & Minor Recommendations found during the RCx investigation. This includes recommended improvement opportunities for Indoor Environmental Quality (IEQ), infection control, operation and maintenance procedures, energy benchmarking and metering, energy efficiency projects, and other applicable capital improvements.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs, and
4. Identify energy or capital improvement projects for implementation in the future.

This is being completed under **Key Deliverable 11 Minor & Major Recommendations Report**. The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	Complete
10	Repair Report Summary	Complete
11	**Minor and Major Repair Recommendations Report**	**Current**
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	Complete

The content of these deliverables is summarized in the RCx Plan.

2.0 Major and Minor Recommendations

2.1 SUMMARY OF RECOMMENDATIONS

During the course of site observations, staff interviews, functional performance testing, and diagnostic monitoring, various major and minor recommendations were identified. These items were evaluated for the campus. Findings for each evaluated recommendation are categorized and presented based on the following VA project objectives:

- Indoor Environmental Quality Opportunities.
- Infection Control Improvement Opportunities.
- O&M Enhancements.
- Energy Benchmarking and Metering Enhancements.
- Energy Efficiency Opportunities.
- Other Facility Improvement Opportunities.

The summary of the repair recommendations for the Anchorage Clinic is presented in the following list. A detailed description of each recommended measure is given in the following sections. **Appendix A** contains a detailed Issues Log, while **Appendix B** shows a basic overall measure list.

- Regarding ACU-15 in the South-East Stairwell: Install Return Air (RA) ductwork the remaining 6 inches through wall and install a register.
    - On the other side of the wall is intended RA plenum location, which is under the stairs. This will allow the cooling and heating system to function more effectively by supplying the air at the top of the stairs and returning it to the FCU at the bottom. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.

- Regarding the BAS: the units for EF-13 are shown in Hz but they should be in % of full speed.
    - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-9 supplying the Lab: Re-Position the return air ductwork to better capture the heat created by the refrigeration units in the space.
    - Potentially replace the cooling coil in AHU-9 with a larger coil designed to work at a low delta temperature.

- Regarding areas with higher than average occupant comfort complaints such as the portion of the second floor served by AHU-4: Use multiple thermostats and logic to average the values in order to determine if the baseboard radiant heat should be enabled.
    - Most occupant comfort complaints come from areas where the thermostat controlling the VAV zone is located in someone else’s office. Also some areas have been converted to open office cubical areas and are conditioned from more than one zone. Combined with a thermostat in an office with a closed door or a bookshelf in front of the thermostat, and we have a recipe for poorly controlled spaces.

- Regarding the Learning Lab 2D116: this space has 12 computers and has complaints of being too warm when fully occupied. The airflow should be increased to the space if possible.
    - This space was not designed to accommodate a computer lab with a classroom type setting that becomes fully occupied for periods of time. Although the team functionally tested the VAV box, it was found to be operating correctly.

- Regarding the Unit Heaters in the penthouses: the complaint is that they can freeze up in extreme winter conditions. To remedy this the units can be operated for extended hours temporarily when extremely cold conditions are forecast
    - A more in-depth solution would be to write a control routine to periodically open the unit's HW valve without the fan running if the temperature drops below a minimum level.

- Regarding the Humidification System: there is very little filtration for the humidification system, and as a result of the hard water the rate of scale build up on the AHU coils is unusually high. To remedy the problem we recommend installing a RO system to serve all humidifiers. To prevent freezing in the winter some small measure of pre-heating may be required.
    - To prevent this, a reverse osmosis water filtration system should have been part of the original design. If AHU coil capacities are suspected of becoming reduced due to scale build up then coils should be replaced on an as needed basis.

- Regarding AHU-9: Stratification in the mixing box, can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in unit 9.
    - Suggested actions to alleviate this condition are to increase the coil capacity, or to reduce airflow to the zones in an effort to reduce load on the AHU during severe weather conditions.

- Regarding the limited flow and temperature from the Elmendorf chilled water system: the Clinic experiences a low delta T in the CHG cooling loop due to flow that is below design and entering temperature above design on the chilled well water system provided by Elmendorf. Potential remedies include removing load from the CHG loop where possible.
    - For example, running the DX unit for AHU #8, Placing the IT closet cooling on DX split systems, and using auxiliary DX units for other AHUs

- Regarding the compressed air system: the RCx study determined that the amount of compressed air produced significantly exceeds the amount of compressed air needed to run all humidification systems at full. Substantial air leaks are suspected and should be investigated and corrected.
    - Air compressor was data logged and determined to be producing more than the maximum design CFM for all humidifiers combined.

- Regarding AHU-5: During functional testing it was discovered that the CHG temperature should be much lower than actual temperature per design. To remedy the situation the CHG supply temperature must be lowered or the coil must be replaced with a coil that can function at a low delta temperature.

- The coil is designed for a 22 Degree delta temperature, with a 46F supply temperature; however a supply temperature of 53F to the coil was measured. At the elevated CHG temperature the coil will never be able to perform as designed.

- Regarding VAV box Griswold valves becoming clogged with metallic debris: a preventative maintenance program should be instituted to check and replace valve cartridges periodically. Focus should be made on spaces which exhibit above average heating time, or complaints of being too cold.
  - Evidence of a valve clogged with metallic debris was shown to the team, however all VAV box functional tests were passed. First Floor VAV boxes are more likely be bad.

- Regarding AHU-3 freezing up: Stratification in the mixing box can cause the coil to freeze up and presents a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in unit 9. Ways to alleviate this problem include an OSA reset to keep dampers at a minimum position when conditions are colder than a threshold, and increasing the size of the preheat coil.
  - Staff remedy this problem by placing cardboard over parts of the coil that freeze.

- Regarding the space temperature sensor for the VAV 1-203 space: the sensor has obviously failed and should be replaced. The whole thermostat will most likely need to be replaced with a new unit.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-1 Supply Fan Schedule: it was discovered that the supply fan starts at 2:00 am daily. To improve energy efficiency this fan should be scheduled to start at 6:00 am M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-2 Supply Fan Schedule: it was discovered that the supply fan does not shut down at night. A static pressure of 1” W.C. is maintained at night, higher when occupied hours. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-2 Return Fan Schedule: it was discovered that the return fan does not shut down at night. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-3 Supply Fan Schedule: it was discovered that the supply fan does not shut down at night. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.
- Regarding AHU-4 Supply Fan and Return Fan Schedule: it was discovered that the fans do not shut down at night. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.

- This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding the Lobby Lighting: although not a HVAC deficiency the Lobby Lighting was observed to be operating when daylight was much more than sufficient. To save energy, an Ambient Lighting Sensor should be used to secure the Lobby Lighting when ambient light levels exceed a predetermined threshold due to the large amount of windows and skylights.

- Regarding the IT closet cooling: To reduce load on the Chilled Glycol loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs have the CHG coils supplemented with DX evaporator coils served by mini-split system type air conditioning units with air cooled condenser and premium efficiency compressor. This will reduce load on the Chilled Glycol loop in addition to providing redundant cooling.

- Regarding Metering the district provided cooling that the Clinic purchases from Elmendorf: no accurate metering exists to measure the BTU’s flow rate and delta temperature of the provided chilled well water loop. We recommend installing a BTU meter to measure the Chilled Well Water Loop.
  - This is a benchmarking improvement opportunity.

- Regarding Metering the district provided heating that the Clinic purchases from Elmendorf: no accurate metering exists to measure the BTUs of heat provided. We recommend installing a BTU meter to measure the heating energy.
  - This is a benchmarking improvement opportunity.

Estimated construction/installation costs have been prepared for all recommendations. Energy savings were estimated for the recommendations in the Energy Efficiency Opportunities category to determine the benefit/cost ratios. Energy savings were calculated using spreadsheet analysis. Calculations for Energy Efficiency Opportunities have been documented and information is included in **Appendix C**.

2.2 INDOOR ENVIRONMENTAL QUALITY OPPORTUNITIES

Indoor environmental quality (IEQ) refers to the quality of a building’s environment in relation to the health and wellbeing of those who occupy space within it. IEQ is determined by many factors. The RCx team focused on IEQ factors associated with the HVAC systems including indoor temperatures, relative humidity, and ventilation levels that affect how individuals respond to the indoor environment. The results of the evaluation are presented in the following sections.

2.2.1 Occupant Comfort Improvements

SE STAIRWELL ACU-15: CONNECT RETURN AIR DUCT TO SPACE

The return air duct to the SE stairwell FCU was never finished. The duct should be connected the remaining 6 inches through the wall into the stairwell area. Please see photo at right showing where the duct should penetrate the wall and have a register installed.

The stairwell is enclosed on one side by glass windows and acts like a greenhouse in the summer, trapping heat and making the stairwell quite uncomfortable in the summer. Currently, there is no return duct connecting the FCU to the space. Supply air is delivered at the top of the stairwell near the second floor landing. If the return plenum were connected at the bottom of the stairwell better circulation would allow the FCU to effectively remove the heat as designed. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.

The benefits of this recommended corrective action include the following:

- Improved air circulation and optimized cooling in the stairwell

This measure would be implemented by a mechanical contractor as part of a minor project. The estimated installation cost of this project is approximately $2,500.

REPOSITION RETURN AIR REGISTERS IN LAB

AHU-9 serves the Lab. The Lab space was not designed to accommodate the refrigeration units used. As a result the refrigeration units produce additional heat and the space becomes uncomfortably warm. Return air ductwork should be extended by 2 to 4 feet closer to the high cooling load equipment with registers directly above refrigeration equipment in an effort to better capture the heat produced and remove it from the Lab as quickly as possible. See photo at right. Additional airflow should also be sought through a balancing of the VAV box serving the space. AHU-9 cooling coil could be replaced at an additional expense if simpler remedies do not alleviate the comfort complaints. Supply airflow measurements were taken as part of the functional testing phase; however they showed that the system is operating as designed.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort in the Lab
- Ability to reliably control the space temperature in the Lab

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project to reposition the ductwork and registers is approximately $9,000. If the coils are to be resized the estimated expense will be approaching $50,000.

USE MULTIPLE THERMOSTATS TO BALANCE TEMPERATURE COMMAND TO OPTIMIZE BASEBOARD RADIANT HEATERS

In areas with higher than average occupant comfort complaints such as AHU-4 serving the second floor, we recommend using multiple thermostats and logic to average the values in order to determine if the baseboard radiant heat should be enabled. Most occupant comfort complaints come from areas where the thermostat controlling the VAV zone is located in an adjacent office or further. Also, some areas have been converted to open office cubical areas and are conditioned from multiple zones. Combined with a thermostat in an office with a closed door or a bookshelf in front of the thermostat, and we have a recipe for poorly controlled spaces. With the control routines in place, it is possible to be simultaneously heating and cooling the same space if there are more than one VAV box and baseboard radiant heaters serving an open office area.

This corrective action is recommended for the following systems:

- All areas with above average occupant comfort complaints that have been used as open office areas.
- Spaces served by AHU-4 on the second floor are noted to display this issue.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort
- Energy and savings from reducing simultaneous heating and cooling

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is approximately $50,000.

INCREASE AIRFLOW TO THE LEARNING LAB 2D116

The learning lab is set up similar to a classroom with 12 computers. Occupants complain that the space is too warm when fully occupied for training sessions, etc. This space was not designed to contain 12 computers and support a dense occupant load such as during a training session. In order to improve occupant comfort we recommend increasing the airflow to the VAV box serving the space.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort

This measure would be implemented by a mechanical contractor as part of a TAB project. The estimated installation cost of this project is approximately $900.

REDUCE LOAD ON CHILLED GLYCOL LOOP

Because of the limited chilled water flow and temperature from the Elmendorf chilled water system the Clinic experiences a higher Chilled Glycol Cooling supply temperature as a result of the chilled water flow that is below design and entering chilled water temperature above the original design. This issue will only become worse over time.

Potential remedies include removing load from the Chilled Glycol loop wherever possible. For example, running the DX system unit for AHU-8, placing the IT closet cooling on DX split systems and using auxiliary DX units for other AHUs similar to AHU-8.

In general, the supplied chilled water temperature to the Elmendorf side of the heat exchanger is too high. The clinic was designed for specific supply temperature and flow if the supply temperature and flow rate deviate from design the hospital cannot meet its cooling loads. In order to reduce the Chilled Glycol temperature, the well water flow rate must be increased and the entering well water temperature must be lowered on the primary side of the heat exchangers.

The benefits of this recommended corrective action include the following:

- Improved Occupant Comfort
- Adequate heat removal capacity will allow AHUs to be shut off at night without fear of the building temperature rising above their ability to cool.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is approximately $3,000 per ton of additional supplementary cooling.

REDUCE CHILLED GLYCOL LOOP TEMPERATURE OR INSTALL NEW COOLING COILS TO AHU -5

Related to the previous measure, AHU-5 was observed to be unable to meet Supply Air Temperature set-point during functional testing performed in January. In winter this can be corrected by lowering the MAT set-point and bringing in a larger percentage of outside air. In summer however, the cooling coil will not be able to keep up. CHG temp should be much lower (46°F per design documents). This is a 22°F coil per design drawings; however AHU-5 was being provided 53°F glycol. This is just one example; Chilled Glycol loop temperature was above design and will therefore affect all AHUs. This issue will only become worse over time.

Potential remedies include installing larger cooling coils in AHUs which are designed for the reduced delta temperature experienced, and also lowering the CHG loop temperature.

The benefits of this recommended corrective action include the following:

- Improved Occupant Comfort
- Adequate heat removal capacity will allow AHUs to be shut off at night without fear of the building temperature rising above their ability to cool.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in estimated to be $15,000 to $25,000 per air handler.

2.2.2 Indoor Air Quality Improvement

In general, no IAQ deficiencies were found. O&M opportunities to improve IAQ were not identified.

2.3 INFECTION CONTROL IMPROVEMENT OPPORTUNITIES

The following parameters were used to evaluate the opportunities to improve infection control:

- Cleanliness of filters.
- Operability of ventilation dampers.
- Calibration of critical space or AHU temperature control sensors.
- Calibration of critical humidity control sensors.
- Space pressurization.
- Air change rates.

In general, O&M opportunities to improve infection control were not identified. Filters were clean and were observed to be on a routine changing schedule. The majority of critical areas utilize 100% OA installations. Dampers were operable for units serving patient areas for the remaining equipment. Temperature sensors were point to point tested for the critical equipment.

2.4 O&M ENHANCEMENTS

The results of the site personnel interviews, functional performance testing and diagnostic monitoring were used to evaluate O&M opportunities. Recommended corrective actions to improve the existing preventative maintenance program and identify O&M personnel training opportunities were also evaluated. The results of the evaluation are presented in the following sections.

2.4.1 Preventive Maintenance Program

INSTITUTE A PM PROGRAM TO REPLACE VAV BOX GRISWOLD VALVE CARTRIDGES

A few VAV box Griswold valves have become clogged with metallic debris over time. A preventative maintenance program should be instituted to check and replace valve cartridges periodically. Focus should be placed on spaces which exhibit above average heating time, or complaints of too cold. Evidence of a valve clogged with metallic debris was shown to the team, however all VAV box functional tests were passed. First Floor VAV boxes are more likely be clogged.

The facilities maintenance service provider (FSI) brought this issue to the RCx team's attention.

This corrective action is recommended for the following systems and buildings:

- All VAV Terminal Units, especially the first floor units.

The benefits of this recommended corrective action include the following:

- Restore heating performance

This measure would be implemented by the existing HVAC maintenance service contractor. During unoccupied hours the contractor would check and replace VAV box heating Griswold valve cartridges. This is not a time critical issue and could be done in a slow methodical process. This measure would be added to the existing scheduled PM work. The estimated implementation cost of this project is $0.00, with an ongoing cost that depends on the rate at which the valves are checked.

2.4.2 O&M Personnel Training

The overall system maintenance on the campus is excellent; the O&M personnel evidently have more than satisfactory training and experience. The personnel have a good understanding of how preventative maintenance procedures and can significantly impact the overall campus energy use and system longevity.

- Filters are changed on a routine schedule in order to maintain static pressure
- Coils are cleaned on a regular basis. Water treatment options are being investigated that can increase the coil lifespan and reduce the number that need replacement, although the hard water is effecting coils already.
- The tension of fan belts is regularly checked, and bearings are greased regularly as well as other PM items.

The RCx team does not believe that the HVAC service contractor personnel need any additional training.

2.5 ENERGY BENCHMARKING AND METERING ENHANCEMENTS

Metering opportunities and additional HVAC BAS logging enhancements were considered for enhancing the energy benchmarking capability of the campus.

INSTALL BTU METERING TO MEASURE DISTRICT HEATING AND COOLING WATER LOOPS

District Provided Heating Water and Chilled Well Water Loops currently do not have working flow measurement devices in place. To properly benchmark the energy use at the Clinic building, the energy sources obtained from Elmendorf should be metered. BTU metering involves measurement of the flow as well as the entering and leaving fluid temperatures as provided to the Clinic building.

This corrective action is recommended for the following systems and buildings:

- Chilled Well Water Loop from Elmendorf.
- Heating Hot Water Loop from Elmendorf.

The benefits of this recommended corrective action include the following:

- Improved benchmarking capabilities

This measure would be implemented by a mechanical contractor. The estimated installation cost of this project is approximately $9,000 for both loops.

2.6 ENERGY EFFICIENCY OPPORTUNITIES

During the course of testing and monitoring, various energy conservation measures (ECMs) were identified that would produce economic benefit. Economic analysis was performed for these ECMs to determine the simple payback period. Energy savings were calculated using spreadsheet analysis. The energy use of the current equipment operation was determined from data gathered in the field. Savings were calculated based on anticipated operational changes for each measure. Electric rates are based on the current utility rates which are presented in the table below.

Table 2-1: Utility Rates

Electric Utility Rate: Large Commercial	
Aggregate Rate ($/kWh)	Aggregate Rate ($/kW)
$ 0.105	$ 13.64
Gas Utility Rate: JBEAR	
Average Aggregate Gas Rate	$0.800/therm

The following table presents all of the recommended energy conservation measures that were analyzed. A summary of each recommended measure is given in the following sections.

Table 2-2: ECM Savings and Cost Summary

LOG #	MECH EQUIPMENT NAME	RECOMMENDED MEASURE	MEASURE TYPE	ECM #	ENERGY SAVINGS (kWh/yr)	ENERGY $ SAVINGS ($/yr)	EST. MEASURE COST ($)	SIMPLE PAYBACK (yrs)
10	Compressor	Investigate compressed air system for leaks, stop leaks as found.	Major	1	70,192	$ 7,370	$ 2,000	0.3
22	AHU-1	Schedule AHU-1 Supply Fan to start at 6:00 am, Monday thru Friday.	Simple	2	12,750	$ 1,339	$ -	0.0
24	AHU-2	Schedule AHU-2 Supply Fan to start 1 hour before occupied schedule daily. Since this space is not supposed to be occupied on weekends, AHU-2 Supply Fan should be secured on the weekend as well as at night.	Simple	3	41,970	$ 4,407	$ -	0.0
25	AHU-2	Schedule AHU-2 Return Fan to start 1 hour before occupied schedule daily.	Simple	4	460	$ 48	$ -	0.0
27	AHU-3	Schedule AHU-3 Supply Fan to start 1 hour before occupied schedule daily. Since this space is not supposed to be occupied on weekends, AHU-3 Supply Fan should be secured on the weekend as well as at night.	Simple	5	25,184	$ 2,644	$ -	0.0
28	AHU-4	Schedule AHU-4 Supply Fan and Return Fan to start 1 hour before occupied schedule daily. Since this space is not supposed to be occupied on weekends, Fans should be secured on the weekend as well as at night.	Simple	6	82,939	$ 8,709	$ -	0.0
29	Lobby Lighting	Install an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights.	Minor	7	26,981	$ 2,833	$ 2,500	0.9
TOTAL					**260,476**	**$ 27,350**	**$ 4,500**	**0.2**

2.6.1 ECM-1: Locate & Stop Compressed Air Leaks

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- Compressed Air System (Non-Medical)

AS-FOUND CONDITIONS

Hypothesis: Suspected Air Leaks. 1. Because load was not satisfied by original compressors 1 & 2 (20hp). VA installed 60hp comp. 2. The System was data-logged found to have an average load of 28.4 kW, which is equivalent to 38.1 bhp. We expect to see at least 4 CFM/HP @ 100 psig. Therefore, the 60hp compressor would produce about 160 CFM @ 100 psig, where the Clinic only needs approximately 40 CFM @ 100 psig per the humidification system design. HP = 0.030*P*(R0.145-1) 3. Therefore, a substantial air leak(s) is present or the original system design is incorrect.

PROPOSED MODIFICATIONS

We propose that an in-depth investigation be made into sources of air leaks in the system. Leaks should be stopped. This work could be done by an outside specialist contractor or by the in-house HVAC maintenance contractor FSI as determined by contractual obligations.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-3: Estimated Energy and Cost savings

ECM 1: Locate and Stop Compressed Air Leaks											
#	Equipment	HP	Baseline Avg kW	Baseline kWh	Max. Req'd Airflow (ACFM)	Avg. kW (post)	kWh (post)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AC-1 Curtis: OL101HTID20-A4	10	0.0	-	-	0.0	-	-	$ -	see below	
2	AC-2 Curtis: OL101HTID20-A4	10	0.0	-	-	0.0	-	-	$ -	see below	
3	AC-3 Curtis: AF-280	60	28.4	96,101	41.1	7.7	25,908	70,192	$ 7,370	see below	
TOTAL				**96,101**	**41.1**	**7.7**	**25,908**	**70,192**	**$ 7,370**	**$ 2,000**	**0.3**

Notes:

1. Baseline kWh from data logging.
2. Blended electric rated used for financial savings. No Demand Savings shown.
3. Based upon theoretical equations the CFM per brake horsepower is approximately 6.4 CFM per Hp.
4. To be conservative 4.0 CFM per Hp is used in calculations.
5. Required Max Flow Rate is from Provided Design Drawings

2.6.2 ECM-2: Schedule AHU-1 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-1 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-1 starts 4 hours before the return fan. The fans should start at 6:00 am, which is one hour before building occupancy schedule begins. AHU-1 Supply fan was also observed to be running on the weekend. The supply fan for AHU-1 has a 50 hp motor and runs on a VFD at an average speed of 45 Hz during occupied periods and 31.2 Hz during unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing a reduced schedule for the Supply Fan that starts one hour before occupancy or at 6:00 am Monday thru Friday. Weekend runtime will be eliminated.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a "simple repair" under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-4: Estimated Energy and Cost savings

ECM 2: Schedule AHU-1 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-1 Supply Fan	50	31.2	8.2	1,560	12,750	$ 1,339	no cost	immediate
TOTAL						**12,750**	**$ 1,339**	**$ -**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed from 2:00 am to 6:00 am (≈ 31.2Hz)

2.6.3 ECM-3: Schedule AHU-2 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-2 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-2 does not shut down at night, i.e. 24/7 operation. Static pressure of 1" is maintained during off hours, when occupied static pressure of 1.05" to 1.37" is maintained. The Supply Fan for AHU-2 was also observed to be running on the weekend. The supply fan for AHU-2 has a 50 hp motor and runs on a VFD at an average occupied/unoccupied speed of 30.6 Hz.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be eliminated.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-5: Estimated Energy and Cost savings

ECM 3: Schedule AHU-2 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-2 Supply Fan	50	30.6	7.8	5,380	41,970	$ 4,407	no cost	immediate
TOTAL						**41,970**	**$ 4,407**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.4 ECM-4: Schedule AHU-2 Return Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-2 Return Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Return Fan for AHU-2 runs at a different schedule in the summer and the winter. During the winter the fans shuts down at 7:15 pm as expected, however last summer the fan was being shut down at 10:15 pm, presumably to cool the building. The Supply Fan for AHU-2 was also observed to be running on the weekend but the return fan does not, schedules for supply and return fans should match. The Return Fan for AHU-2 has a 20 hp motor and runs on a VFD at an average speed of 20 Hz.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Return Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-6: Estimated Energy and Cost savings

ECM 4: Schedule AHU-2 Return Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-2 Return Fan	20	20.4	1.2	390	460	$ 48	no cost	immediate
TOTAL						**460**	**$ 48**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.5 ECM-5: Schedule AHU-3 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-3 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-3 operates longer hours than the return fan. The Supply fan starts 4 hours early, it should start at 6:00 am but it is starting at 2:00 am. The Supply Fan for AHU-3 was also observed to be running on Saturdays. The supply fan for AHU-3 has a 50 hp motor and runs on a VFD at an average speed of approximately 44.4 Hz during occupied and 35.4 Hz during unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be curtailed.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-7: Estimated Energy and Cost Savings

ECM 5: Schedule AHU-3 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-3 Supply Fan	50	38.4	13.5	1,872	25,184	$ 2,644	no cost	immediate
TOTAL						**25,184**	**$ 2,644**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.6 ECM-6: Schedule AHU-4 Supply & Return Fans to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-4 Supply Fan
- AHU-4 Return Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan and the Return Fan for AHU-4 do not shut down at night, i.e. 24/7 operation. The fans run at a lower static pressure when unoccupied, but fans are running 24/7. A higher static is maintained for longer hours in the summer than in the winter. Both fans were observed to be running on weekends. The supply fan for AHU-4 has a 60 hp motor and runs on a VFD at an average speed of 38 Hz during occupied periods and 33.6 Hz during Unoccupied periods. The return fan for AHU-4 has a 25 hp motor and runs on a VFD at an average speed of 29.4 Hz during Unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be curtailed.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-8: Estimated Energy and Cost savings

ECM 6: Schedule AHU-4 Supply & Return Fans to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-4 Supply Fan	60	33.6	11.7	5,380	63,038	$ 6,619	no cost	immediate
1	AHU-4 Return Fan	25	29.4	3.7	5,380	19,902	$ 2,090	no cost	immediate
TOTAL						**82,939**	**$ 8,709**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.7 ECM-7: Install Ambient Lighting Controls on Lobby Lighting.

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- 400-watt Metal Halide Lighting Fixtures in Lobby
- 350-watt Metal Halide Lighting Fixtures in Lobby

AS-FOUND CONDITIONS

Although not a HVAC deficiency, the lobby lighting was observed to be operating when daylight was much more than sufficient. To save energy, an Ambient Lighting Sensor should be used to secure the lobby lighting when ambient light levels are sufficient due to the large amount of windows and skylights. The lighting fixtures are metal halide of 350 to 400-watts each, and are currently controlled by a time-schedule.

PROPOSED MODIFICATIONS

We recommend installation of an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights. The existing BAS can accommodate this change.

A controls contractor would be responsible for programming the strategy and performing functional testing of the strategy for the lighting system. The strategy parameters would be approved by the VA site team prior to implementation. The conservation strategy can be implemented with minimal impact on overall lighting system operation, and no system outages need to be scheduled.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-9: Estimated Energy and Cost savings

ECM 7: Install Ambient Lighting Controls on Lobby Lighting									
#	Fixture Description	Qty.	Fixt. Watts	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	MH 400-watt Lobby Lighting Fixtures "HA/500"	20	458	9.16	2,190	20,060	$ 2,106	see below	see below
2	MH 350-watt Lobby Lighting Fixtures "HB/400"	8	395	3.16	2,190	6,920	$ 727	see below	see below
TOTAL		**28**		**12.3**		**26,981**	**$ 2,833**	**$ 2,500**	**0.9**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.

2.7 OTHER FACILITY IMPROVEMENT OPPORTUNITIES

Several facility improvement measures (FIMs) were identified through the retro-commissioning process. A summary of each recommended measure is given below. These measures were not evaluated to the same level of detail as the EEMs. Costs estimates are included for select measures where appropriate. The following high level information can be used by the VA staff for capital budgeting and long range planning.

2.7.1 FIM-1: Change BAS units shown for EF-13 speed

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- BAS speed value for EF-13

AS-FOUND CONDITIONS

The BAS displays the units for the speed of EF-13 as Hz; however units should be changed to % of full speed because the values displayed are above 60 making it obvious that the speed is actually being reported as a percent. Units are only thing that is not correct.

PROPOSED MODIFICATIONS

As part of the “Simple Repair” scope of the RCx project the units displayed on the BAS can be changed from “Hz” to “%” for EF-13 speed. There would be no additional cost to the VA to make this change.

2.7.2 FIM-2: Run Penthouse Unit Heaters Extended Hours Temporarily During Extreme Cold Weather

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- All unit heaters in penthouses

AS-FOUND CONDITIONS

This Issue was brought to the attention of the RCx team by the HVAC service contractor. The unit heaters in the penthouses can freeze up in extreme winter conditions. During the winter that the RCx team was at the facility the conditions were mild and this problem was not observed. An additional check would be to measure the differential pressure over the heater coil, if low that could be why freezing; however the conditions under which the issue was described are extreme cold (negative temperatures) for prolonged periods of 2 weeks or more.

PROPOSED MODIFICATIONS

If this problem is expected to occur due to especially cold forecasted conditions, the unit heaters should be operated extended hours on a short term basis to keep the penthouses above freezing. A more in-depth solution would be to write a control routine to periodically open the unit's HW valve without the fan running if the temperature drops below a minimum level as a last ditch effort to prevent coil freeze up.

This modification can be implemented by the HVAC service contractor at no additional cost to the VA.

2.7.3 FIM-3: Install RO Water Filtration Equipment for Humidification System

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- All Humidification water supplies to Humidifiers in AHUs. Service to each Penthouse would be required.

AS-FOUND CONDITIONS

The water contains a high level of minerals and the AHU chilled water coils get coated with mineral deposits when the humidification is running. The mineral deposits result in an increase in static pressure with a reduction in airflow distributed to the spaces. FSI cleans the coils, and are testing different cleaners, but we are concerned about the longevity of the coils. In addition, when the OSA temperature drops below a threshold, the humidification dispersion units in AHU-

8 and 9 freeze up. This results in staff having to remove the dispersion units to let them defrost.

PROPOSED MODIFICATIONS

Install Reverse Osmosis filtration equipment to serve the humidification systems in all penthouses. If TAB contactor determines actual coil capacities are significantly below submitted coil capacity then coils should also be replaced on an as-needed basis if AHU cannot meet load. Installing RO filtration will significantly reduce the rate of scale build up but will not repair any impact already suffered.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $75,000 not including any coil replacements.

2.7.4 FIM-4: Replace Pre-Heat Coil on AHU-9 or Reduce Load when OSA conditions are Extreme

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-9

AS-FOUND CONDITIONS

Stratification in the mixing box can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in AHU-9.

PROPOSED MODIFICATIONS

Chang the preheat coil to increase capacity and possibly try to reduce airflow to certain downstream zones determined to be non-critical, if able to, in an effort to reduce load on the AHU during severe weather conditions.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $25,000.

2.7.5 FIM-5: Replace Heating Coil on AHU-3

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-3

AS-FOUND CONDITIONS

Stratification in the mixing box can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the Heating coil in AHU-3. Building staff remedies this with some cardboard placed over part of the heating coil in the unit, blocking the portion that gets hit with the most outside air to prevent it from freezing up.

PROPOSED MODIFICATIONS

Heating coil is too small or the amount of OSA is too large when conditions are severe. Recommended action is to increase size of heating coil and or reduce the amount of OSA to the minimum required by code when outside air temperature is severely cold.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $25,000.

2.7.6 FIM-6: Replace Thermostat in Zone VAV 1-203

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- Space Temperature Sensor (Thermostat) for zone VAV 1-203

AS-FOUND CONDITIONS

During monitoring data analysis it was discovered that the space temperature sensor had failed (reporting all zeroes).

PROPOSED MODIFICATIONS

The thermostat can be replaced under the “Simple Repair” scope of the RCx project at no additional cost to the VA.

2.7.7 FIM-7: Retrofit IT Equipment Cooling to DX Units

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- IT Equipment / Server Closet Cooling FCUs

AS-FOUND CONDITIONS

While not strictly a deficiency since the existing CHG loop FCUs were found to be functioning well to remove heat from IT equipment spaces, they could be removed from the CHG loop to reduce load on the loop.

There are two issues that provoke this recommendation, #1 is the reduced capacity of the chilled glycol system due to increased well water temperatures and flow rate restrictions placed on the clinic by Elmendorf's central plant, every means to reduce load on the CHG loop should be considered. And #2 is the fact that the main CHG pumps run at night only to serve the IT space fan coil units, if the pumps were shut down on nights and weekends then there would be considerable energy savings. During winter months the AHUs can cool the building with outside air, but when conditions are warmer the reduced flow and increased well water temperature mean that some of the AHUs are run at night to prevent heat from building up beyond what can be removed, requiring nighttime pumping as well.

PROPOSED MODIFICATIONS

To reduce load on the CHG loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs have the CHG coils replaced with DX evaporator coils served by rooftop mini-split system type air conditioning units with air cooled condenser and premium efficiency compressor. Each space would be served by a separate unit. If coil only retrofit is not practical then new indoor DX evaporator (mini split) units should be used.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $100,000.

Appendix-K

For Final RCx Report

CFR / VA Design Guide Summary

(see Appendix-C Section 2.4)

Appendix-L

For Final RCx Report

Out-Briefing Meeting Minutes

Appendix-M

For Final RCx Report

Equipment List

VISN 20 Alaska VA Healthcare System

Equipment List

APRIL 16, 2014

Prepared for:
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HVAC PUMP SCHEDULE																			
#	Draw #	Tag ID	Pump Manuf	Pump Model	IMP Dia	Location	Serves	Qty Motors	Hp	Pump % Eff	GPM	Temp. (°F)	Head (ft)	Mtr Manuf	Volt	Ph	Mtr Eff %	RPM	Note
1	MH003	P-1A/1B	Armstrong	4030	10.36	1C163	VA Clinic Primary Ht Loop	2	30	83%	779	188	92	TECO	480	3	94.1%	1750	VFD
2	MH003	P-2A/2B	Armstrong	4030 BF	7.57	3A102	AHU-1, 2 & 7 Heating Coils	2	3	57%	92	188	52	TECO	480	3	89.5%	1750	VFD
3	MH003	P-3A/3B	Armstrong	4030 BF	7.46	3A102	AHU-1, 2 & 7 Re-Heat & Perim Heat	2	5	65%	172	188	49	TECO	480	3	89.5%	1750	VFD
4	MH003	P-4A/4B	Armstrong	4030	6.78	3D101	AHU-3, 4 & 8 Re-Heat & Perim Heat	2	3	69%	125	188	41	Baldor	480	3	90.2%	1750	VFD
5	MH003	P-5A/5B	Armstrong	4030	7.55	3D101	AHU-3, & 8 Heating Coils	2	2	56%	70	188	55	TECO	480	3	86.5%	1750	VFD
6	MH003	P-6A/6B	Armstrong	4030 BF	6.65	3C101	AHU-5, & 9 Heating Coils	2	1	59%	41	188	35	Baldor	480	3	85.5%	1750	VFD
7	MH003	P-7A/7B	Armstrong	4030 BF	6.86	3C101	AHU-4, 5 & 9 Re-Heat & Perim Heat	2	3	74%	157	188	41	TECO	480	3	89.5%	1750	VFD
8	MH003	P-8A	Armstrong	4380	6.188	3B100	AHU-4, & 6 Heating Coils	1	1.5	64%	79	188	36	Baldor	480	3	86.5%	1750	VFD
9	MH003	P-8B	Armstrong	4380	6.188	3B100	AHU-4, & 6 Heating Coils	1	1.5	64%	79	188	36	WEG	480	3	84.0%	1750	VFD
10	MH003	P-9A	Armstrong	4380	8	1C163	Radient Floor Tertiary Loop	1	1	38%	17	125	45	Baldor	480	3	85.5%	1750	
11	MH003	P-9B	Armstrong	4380	8	1C163	Radient Floor Tertiary Loop	1	1	38%	17	125	45	WEG	480	3	85.5%	1750	
12	MH003	P-10A/10B	Armstrong	4030 BF	3.08	2F100	AHU-11 Heat, Re-Heat & Perim Heat	2	1	42%	35	188	41	Baldor	480	3	86.5%	1750	VFD
13	MH003	P-11A/11B	Armstrong	4030 BF	9	1C163	Entrance Snowmelt Tertiary Loop	2	5	60%	112	133	72	TECO	480	3	-	1750	
14	MH003	P-12A/12B	Armstrong	4030 BF	7.86	1C163	Patio Snowmelt Tertiary Loop	2	1.5	43%	33	133	57	Baldor	480	3	86.5%	3450	
15	MH003	P-13A/13B	Armstrong	4030 BF	10.18	1C163	Primary Cooling Loop	2	20	79%	511	46	100	TECO	480	3	93.0%	1750	VFD
16	MH003	P-14A/14B	Armstrong	4030 BF	8.35	CP01	Central Plant Pri Ht Loop	2	15	82%	728	190	50	Baldor	480	3	93.0%	1750	VFD
17	MH003	P-15A/15B	unk	unk	unk	1C16X	Charge Air Cooler Loop	2	3	58%	75	127	60	unk	480	3	unk	3450	

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HEAT EXCHANGER SCHEDULE												
#	Draw #	Tag ID	Location	Serves	Description	BtuH	Pri GPM	Sec GPM	Pri EGT	Pri LGT	Sec EGT	SEC LGT
1	MH003	HX-1A&B	Central Plant	Heating System	Plate&Frame HX	10,853,000	728	779	190	160	158	188
2	MH003	HX-2A&B	VA Mech Room	Cooling System	Plate&Frame HX	4,178,000	160	511	44	66	68	46
3	MH003	HX-3	VA Mech Room	Snow Melt	Plate&Frame HX	1,619,000	113	144	188	156	108	133
3		HWG-1	VA Mech Room	DHW	Tube in Shell	410 GPH			188	170	102	120
3		HWG-2	VA Mech Room	DHW	Tube in Shell	410 GPH			188	170	102	120
3		HWG-3	PH 3D101	Softened Hot Water Generator		37 GPH						
3		HWG-4	PH 3B100	Kitchen 170F Heater		49 GPH						

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AHU SCHEDULE																			
#	Draw #	Tag ID	Manufacturer	Model #	Location	Serves	Fan Type	Arrangement	Max Length (IN)	Hp	CFM Rated	TSP (in-W.C.)	Wheel Dia	Drive	Volt	Ph	Amps	RPM	Notes
1	MH-006	AHU-1	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3A102	General Clinic			606										
2	MH-006					SUPPLY	Plug	Front Discharge		50	32640	5.9	52.88	BELT	480	3	58.4	829	VFD
3	MH-006					RETURN	Centrifugal	Front Discharge		20	27490	0.9	36	BELT	480	3	24.0	822	VFD
4	MH-006	AHU-2	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3A100	General Clinic			560										
5	MH-006					SUPPLY	Plug	Front Discharge		50	32760	5.6	52.88	BELT	480	3	58.4	828	VFD
6	MH-006					RETURN	Centrifugal	Front Discharge		20	27620	0.9	36	BELT	480	3	24.0	835	VFD
7	MH-006	AHU-3	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3D101	General Clinic			556										
8	MH-006					SUPPLY	Plug	Front Discharge		50	32890	5.8	52.88	BELT	480	3	58.4	826	VFD
9	MH-006					RETURN	Centrifugal	Front Discharge		20	28210	0.9	36	BELT	480	3	24.0	830	VFD
10	MH-006	AHU-4	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3B100	General Clinic			633										
11	MH-006					SUPPLY	Plug	Front Discharge		60	35730	6.0	58.5	BELT	480	3	68.0	729	VFD
12	MH-006					RETURN	Centrifugal	Front Discharge		25	26070	0.9	40	BELT	480	3	31.0	725	VFD
13	MH-006	AHU-5	Silent-Aire Manufacturing Inc.	SA-800PL-IHCV-RFH	Penthouse 3C101	General Clinic			536										
14	MH-006					SUPPLY	Plug	Front Discharge		50	29040	6.2	43.44	BELT	480	3	58.4	1097	VFD
15	MH-006					RETURN	Centrifugal	Front Discharge		20	25650	0.9	33	BELT	480	3	24.0	418	VFD
16	MH-006	AHU-6	Silent-Aire Manufacturing Inc.	SA-540PL-IHCV-RFH	Penthouse 3B100	Lobby			212										
17	MH-006					SUPPLY	Plug	Front Discharge		25	12980	6.1	32.38	BELT	480	3	29.7	1370	VFD
18	MH-006					RETURN	Centrifugal	Front Discharge		10	11230	0.9	25	BELT	480	3	12.5	539	VFD
19	MH-006	AHU-7	Silent-Aire Manufacturing Inc.	SA-400PL-IHCM-FH	Penthouse 3A102	Dental			286										
20	MH-006					SUPPLY	Plug	Front Discharge		15	8250	4.5	21.56	BELT	480	3	18.1	2414	VFD
21	MH-006	AHU-8	Silent-Aire Manufacturing Inc.	SA-400PL-IHCM-FH	Penthouse 3D101	Surgery			271										
22	MH-006					SUPPLY	Plug	Front Discharge		15	8250	8.0	21.56	BELT	480	3	24.0	2546	VFD
23	MH-006	AHU-9	Silent-Aire Manufacturing Inc.	SA-240PL-IHCM-FH	Penthouse 3C101	Lab			254										
24	MH-006					SUPPLY	Plug	Front Discharge		7.5	3050	4.6	16.19	BELT	480	3	8.5	2779	VFD
25	MH-006	AHU-10	Silent-Aire Manufacturing Inc.		Enginer Generator Rm	Engine Generator			93										
26	MH-006					SUPPLY	Plug	Front Discharge		10	18960		25	BELT	480	3		431	
27	MH-006	AHU-11	Silent-Aire Manufacturing Inc.	SA-300BI-IHCV-R	Link Penthouse	Link			173										
28	MH-006					SUPPLY	Centrifugal	Bottom Down		7.5	4970	2.8	15	BELT	480	3	9.4	2185	VFD
29	MH-006					RETURN	Centrifugal	Front Discharge		5	4290	0.7	15	BELT	480	3	6.5	1817	VFD

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AHU HEATING / COOLING COIL SCHEDULE																	
#	Draw #	Tag ID	Serves	MBH	Pri GPM	CFM Rated	EAT Db	EAT Wb	LAT Db	LAT Wb	Pri EGT	Pri LGT	Fins/Ft	FPM	MAX APD	MAX WPD	Notes
1	MH-006	HC-1	AHU-1	353	25.3	32640	45		55		135	105	80	520	1	5	
2	MH-006	CC-1	AHU-1	610	62.6	32640	72	60	55	53	46	68	137	500	1	10	
3	MH-006	HC-2	AHU-2	357	25.6	32760	45		55		135	105	80	525	0.1	5	
4	MH-006	CC-2	AHU-2	615	63.6	32760	72	60	55	53	46	68	110	505	1	10	
5	MH-006	HC-3	AHU-3	326	23.3	32890	45		55		135	105	80	525	0.1	5	
6	MH-006	CC-3	AHU-3	615	63.6	32890	72	60	55	53	46	68	110	505	1	0	
7	MH-006	HC-4	AHU-4	534	38.3	35730	45		55		135	105	80	475	0.1	5	
8	MH-006	CC-4	AHU-4	697	72	35730	72	60	55	53	46	68	134	475	1	10	
9	MH-006	HC-5	AHU-5	329	23.6	29040	45		55		186	105	80	520	0.1	5	
10	MH-006	CC-5	AHU-5	543	54.6	29040	72	60	55	53	46	68	158	500	1	10	
11	MH-006	HC-6	AHU-6	704	50.3	12980	45		95		186	156	80	575	0.2	5	
12	MH-006	CC-6	AHU-6	243	25	12980	72	60	55	53	46	68	152	555	1	10	
13	MH-006	PHC-7	AHU-7	451	32.5	7230	-18		45		186	166	80	550	0.2	5	
14	MH-006	HC-7	AHU-7	118	8.4	7230	40		55		145	115	80	550	0.1	5	
15	MH-006	CC-7	AHU-7	156	15.5	7230	72	60	55	53	46	66	153	515	1	10	
16	MH-006	PHC-8	AHU-8	478	34.3	8360	-18		40		186	166	80	595	0.2	5	
17	MH-006	HC-8	AHU-8	124	8.9	8360	40		55		145	115	80	595	0.1	5	
18	MH-006	CC-8	AHU-8	158	18	8360	72	60	55	53	46	66	160	555	1.2	10	
19	MH-006	CC-8a	AHU-8	379		8360	65	63	47	47			138	594	1.6		+
20	MH-006	PHC-9	AHU-9	192	13.7	3050	-18		40		186	156	82	420	0.1	5	
21	MH-006	HC-9	AHU-9	90	3.6	3050	40		55		186	156	98	420	0.1	5	
22	MH-006	CC-9	AHU-9	57	6.5	3050	72	60	55	53	46	66	152	470	1	10	
23	MH-006	HC-11	AHU-11	145	10.4	4970	45		95		186	156	95	530	0.2	5	
24	MH-006	CC-11	AHU-11	53	11.7	4970	72	60	55	53	46	65	124	515	1	10	

+ Note: DX cooling coil capacity = 352 MBH

VISN 20 Alaska: Equipment List

FAN SCHEDULE												
#	Draw #	Tag ID	Location	Serves	Hp	TSP (in w.c.)	CFM Rated	Wheel Dia	Max BHP	Volt	Ph	RPM
1	MH-007	EF-1	Penthouse 3A102	General, Area A South	1.00	1.5	1990	13.5	0.9	480	3	1974
2	MH-007	EF-2	Penthouse 3A100	General, Area A North	1.50	1.5	3080	18	1.3	480	3	1444
3	MH-007	EF-3	Penthouse 3D101	General, Area D	1	1.5	2620	18	0.8	480	3	1192
4	MH-007	EF-4	Penthouse 3B100	General, Area B	3.00	1.5	6900	24.5	2.6	480	3	1030
5	MH-007	EF-5	Penthouse 3C101	General, Area C	1.00	1.5	1100	16.5	0.8	480	3	1931
6	MH-007	EF-6	illegible	illegible	0.50	0.9	2100	16	0.4	120	1	1023
7	MH-007	EF-7	Penthouse 3A100	Dentail Suite	3.00	1.5	5710	20	2.4	480	3	1318
8	MH-007	EF-8	Penthouse 3A106	Capture Hood	0.75	1.5	1070	12	0.6	480	3	2189
9	MH-007	EF-9	Penthouse 3D101	Surgery Suite	5.00	2.5	7105	24.5	4.2	480	3	1200
10	MH-007	EF-10	Penthouse 3D101	Capture Hood	0.33	1.5	490	10	0.2	120	1	2072
11	MH-007	EF-11	Penthouse 3C101	Laboratory	1.50	1.5	3260	18	1.3	480	3	1479
12	MH-007	EF-12	not used									
13	MH-007	EF-13	Penthouse 3A102	Procedure Rm. 1A253	0.75	1.5	540	10	0.7	480	3	3358
14	MH-007	EF-14	Penthouse 3A100	Procedure Rm. 1A153	0.75	1.5	540	10	0.7	480	3	3330
15	MH-007	EF-15	Penthouse 3C101	Med Gas Cyl Rm. 1C191	0.33	1.5	150	10	0.2	120	1	2224
16	MH-007	VF-1	Mech Room 1C163	Main Mechanical Room	0.75	0.25	3200	24.75	3	480	3	780
17	MH-007	VF-2	Penthouse 3A101	Electrical Room 3A101	0.125	0.25	440	12.5	0.1	120	1	1232
18	MH-007	VF-3	Penthouse 3C100	Electrical Room 3C100	0.125	0.25	500	12.5	0.1	120	1	1282
19	MH-007	VF-4	Penthouse 3D101	AHU Room 3D101	0.125	0.25	530	12.5	0.1	120	1	1305
20	MH-007	VF-5	Penthouse 3D100	Electrical Room 3D100	0.125	0.25	450	12.5	0.1	120	1	1241

VISN 20 Alaska: Equipment List

WATER COOLED AIR CONDITIONING UNIT SCHEDULE																				
#	Draw #	Tag ID	Location	Note	Capacity (MBH)	Flow (CFM)	ESP (In W.C.)	EAT (°F Db)	EAT (°F Wb)	LAT (°F Db)	LAT (°F Wb)	Flow (GPM)	EGT (°F)	LGT (°F)	MAX WPD (FT)	HP	V	PH	HZ
1	MH-010	ACU-1	TEL 1A191	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
2	MH-010	ACU-2	TEL 1A107	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
3	MH-010	ACU-3	TEL 1B134	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
4	MH-010	ACU-4	TEL 1C165	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
5	MH-010	ACU-5	TEL 1D127	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
6	MH-010	ACU-6	TEL 1D189	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
7	MH-010	ACU-7	TEL 2A191	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
8	MH-010	ACU-8	TEL 2B140	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
9	MH-010	ACU-9	TEL 2C102	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
10	MH-010	ACU-10	TEL 2C129	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
11	MH-010	ACU-11	TEL 2D127	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
12	MH-010	ACU-12	TEL 2D163	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
13	MH-010	ACU-13	COMPUTER 2C171	Free-Standing, Self-Contained, chilled-glycol, upflow unit. Provide with integral condensate pump. Provide filter box with 30% efficient filters. Provide with infrared steam generating humidifier, 17 lbs./hour capacity	10 TONS	5650	0.5	72	60	55	46	38	46	56	25	12	460	3	60
14	MH-010			Integral Hydronic Heating Coil. Horsepower includes a 3 HP supply fan and a 6.4 KW infrared humidifier. Fluid values are based on 40% ethylene glycol	65	5650		60		80		5	188	158	15				
15	MH-010	ACU-14	COMPUTER 2C171	Free-Standing, Self-Contained, chilled-glycol, upflow unit. Provide with integral condensate pump. Provide filter box with 30% efficient filters. Provide with infrared steam generating humidifier, 17 lbs./hour capacity	10 TONS	5650	0.5	72	60	55	46	38	45	55	25	12	460	3	60
16	MH-010			Integral Hydronic Heating Coil. Horsepower includes a 3 HP supply fan and a 6.4 KW infrared humidifier. Fluid values are based on 40% ethylene glycol	65	5650		60		80		5	188	158	15				
17	MH-010	ACU-15	STAIR 2	Provide upflow free standing vertical fan coil unit with 30% filters, cooling coil, condensate pump, and bottom return.	5 TONS	2000	0.35	84	62	55	50	17	46	56	5	3/4	460	3	60
18	MH-010	ACU-16	STAIR 3	Provide horizontal fan coil unit with 30% filters, cooling coil, and condensate pump	2 TONS	800	0.35	84	62	55	50	6	46	56	5	1/2	120	1	60

VISN 20 Alaska: Equipment List

AIR ATOMIZING HUMIDIFICATION SCHEDULE							
#	Draw #	Tag ID	Serves	GPM	ACFM	Air Flow	LBS/HR
1	MH-007	H-1	AHU-1	0.62	6	32540	310
2	MH-007	H-2	AHU-2	0.63	6	33040	314
3	MH-007	H-3	AHU-3	0.63	6.1	33330	317
4	MH-007	H-4	AHU-4	0.71	6.8	37310	355
5	MH-007	H-5	AHU-5	0.57	5.5	29960	285
6	MH-007	H-6	AHU-6	0.25	2.4	12980	123
7	MH-007	H-7	AHU-7	0.3	2.9	7230	152
8	MH-007	H-8	AHU-8	0.33	3.2	7890	166
9	MH-007	H-9	AHU-9	0.13	1	1630	50
10	MH-007	H-101	DUCT	0.12	0.6	880	30
11	MH-007	H-102	DUCT	0.06	0.6	800	30
12	MH-007	H-103	DUCT	0.01	0.1	1240	5

VISN 20 Alaska: Equipment List

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
1	MH-008	1-005	AHU-1	32640	461	Rectangle	102/100	2.66	0							
2	MH-008	1-010	1-005	15780	438	Rectangle	72/72	2.65	0							
3	MH-008	1-100	1-005	3150	2256	Round	16	2.19	1							
4	MH-008	1-105	1-100	680	1948	Round	8	2.11	0	VAV 1-205	680	360	360	0.5	0.4	35
5	MH-008	1-110	1-100	2470	2311	Round	14	2.01	0							
6	MH-008	1-115	1-110	300	2200	Round	5	1.79	0	VAV 1-204	300	140	140	0.5	0.4	35
7	MH-008	1-120	1-110	2170	2030	Round	14	1.98	0							
8	MH-008	1-125	1-120	470	2394	Round	6	1.72	0	VAV 1-203	470	230	230	0.5	0.4	35
9	MH-008	1-130	1-120	1700	2165	Round	12	1.77	0							
10	MH-008	1-135	1-130	300	2200	Round	5	1.52	0	VAV 1-202	300	140	140	0.5	0.4	35
11	MH-008	1-140	1-130	1400	1783	Round	12	1.82	0							
12	MH-008	1-145	1-140	750	2149	Round	8	1.63	0	VAV 1-208	750	500	500	0.5	0.4	35
13	MH-008	1-150	1-140	650	1862	Round	8	1.74	0							
14	MH-008	1-155	1-150	190	2177	Round	4	1.5	0	VAV 2-201	190	100	100	0.5	0.4	35
15	MH-008	1-160	1-150	460	2343	Round	6	1.45	1	VAV 1-207	460	170	170	0.5	0.4	35
16	MH-008	1-200	1-005	3310	2371	Round	16	2.14	2							
17	MH-008	1-205	1-200	200	2292	Round	4	2	0	VAV 1-212	200	140	140	0.5	0.4	35
18	MH-008	1-210	1-200	3110	2227	Round	16	2.13	0							
19	MH-008	1-215	1-210	690	1977	Round	8	1.96	0	VAV 1-209	690	410	410	0.5	0.4	35
20	MH-008	1-220	1-210	2420	2264	Round	14	2.05	0							
21	MH-008	1-225	1-220	360	1833	Round	6	1.04	2	VAV 1-206	360	180	180	0.5	0.4	35
22	MH-008	1-230	1-220	2060	1927	Round	14	2.04	1							
23	MH-008	1-235	1-230	230	1687	Round	5	1.94	0	VAV 1-215	230	140	140	0.5	0.4	35
24	MH-008	1-240	1-230	580	1662	Round	8	1.88	0	VAV 1-216	580	390	390	0.5	0.4	35
25	MH-008	1-245	1-230	1250	2292	Round	10	1.8	0							
26	MH-008	1-250	1-245	520	1490	Round	8	1.55	0	VAV 1-220	520	270	270	0.5	0.4	35
27	MH-008	1-255	1-245	730	2091	Round	8	1.81	0							
28	MH-008	1-260	1-255	530	1518	Round	8	1.83	0	VAV 1-221	530	360	360	0.5	0.4	35
29	MH-008	1-265	1-255	200	2292	Round	4	1.29	1	VAV 1-225	200	130	130	0.5	0.4	35
30	MH-008	1-300	1-005	5030	2306	Round	20	2.25	1							
31	MH-008	1-305	1-300	590	1690	Round	8	2.09	1	VAV 1-224	590	390	390	0.5	0.4	35
32	MH-008	1-310	1-300	2160	2021	Round	14	2.11	1	VAV 1-227	2160	700	700	0.5	0.4	35
33	MH-008	1-315	1-300	2280	2133	Round	14	2.04	0							
34	MH-008	1-320	1-315	530	1518	Round	8	2.04	0	VAV 1-223	530	350	350	0.5	0.4	35
35	MH-008	1-325	1-315	1750	2228	Round	12	1.77	0							
36	MH-008	1-330	1-325	1010	1852	Round	10	1.74	0	VAV 1-218	1010	670	670	0.5	0.4	35
37	MH-008	1-335	1-325	150	1719	Round	4	1.7	0	VAV 1-222	150	100	100	0.5	0.4	35
38	MH-008	1-340	1-325	590	1690	Round	8	1.79	0							
39	MH-008	1-345	1-340	110	1261	Round	4	1.67	0	VAV 1-226	110	70	70	0.5	0.4	35
40	MH-008	1-350	1-340	480	2445	Round	6	1.42	1	VAV 1-217	480	160	160	0.5	0.4	35
41	MH-008	1-400	1-005	4720	2163	Round	20	2.33	0							
42	MH-008	1-405	1-400	800	2292	Round	8	2.06	0	VAV 1-214	800	450	450	0.5	0.4	35
43	MH-008	1-410	1-400	3920	2218	Round	18	2.27	0							
44	MH-008	1-415	1-410	1300	2384	Round	10	2.25	0	VAV 1-211	1300	870	870	0.5	0.4	35
45	MH-008	1-420	1-410	2620	2451	Round	14	2.02	0							

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
46	MH-008	1-425	1-420	950	1742	Round	10	1.97	0	VAV 1-219	950	630	630	0.5	0.4	35
47	MH-008	1-430	1-420	1200	2200	Round	10	2.12	0	VAV 1-210	1200	800	800	0.5	0.4	35
48	MH-008	1-435	1-420	470	2394	Round	6	1.9	1	VAV 1-213	470	320	320	0.5	0.4	35
49	MH-008	1-500	1-010	4270	2415	Round	18	2.12	0							
50	MH-008	1-505	1-500	2920	2086	Round	16	1.92	0							
51	MH-008	1-510	1-505	500	1779	Round	8	1.88	0	VAV 1-103	600	320	320	0.5	0.4	35
52	MH-008	1-515	1-505	2310	2159	Round	14	1.78	0							
53	MH-008	1-520	1-515	858	1353	Round	6	1.64	0	VAV 1-106	360	360	360	0.5	0.4	35
54	MH-008	1-525	1-515	1950	2478	Round	12	1.5	0							
55	MH-008	1-530	1-525	452	1252	Round	6	1.36	0	VAV 1-102	450	240	240	0.5	0.4	35
56	MH-008	1-535	1-525	1500	1902	Round	12	1.9	0							
57	MH-008	1-540	1-535	160	2063	Round	4	1.15	1	VAV 1-101	180	90	90	0.5	0.4	35
58	MH-008	1-545	1-535	1320	2407	Round	16	1.25	1							
59	MH-008	1-550	1-545	400	2037	Round	6	1.17	0	VAV 1-111	400	400	400	0.5	0.4	35
60	MH-008	1-555	1-545	350	1850	Round	8	1.34	0	VAV 1-110	520	290	290	0.5	0.4	35
61	MH-008	1-560	1-545	320	1630	Round	8	1.38	0	VAV 1-113	320	210	210	0.5	0.4	35
62	MH-008	1-600	1-010	3170	2270	Round	16	2.24	2							
63	MH-008	1-605	1-600	850	2435	Round	8	2.2	0	VAV 1-107	850	490	490	0.5	0.4	35
64	MH-008	1-610	1-600	2320	2170	Round	14	2.22	0							
65	MH-008	1-615	1-610	210	2406	Round	4	1.94	0	VAV 1-119	210	210	210	0.5	0.4	35
66	MH-008	1-620	1-610	2110	1974	Round	14	2.23	0							
67	MH-008	1-625	1-620	490	2496	Round	6	1.84	0	VAV 1-109	490	360	360	0.5	0.4	35
68	MH-008	1-630	1-620	1620	2063	Round	12	2.11	0							
69	MH-008	1-635	1-630	280	2053	Round	5	1.9	0	VAV 1-120	280	140	140	0.5	0.4	35
70	MH-008	1-640	1-630	330	2420	Round	5	1.72	0	VAV 1-112	330	220	220	0.5	0.4	35
71	MH-008	1-645	1-630	1010	1852	Round	10	1.96	1							
72	MH-008	1-650	1-645	220	1613	Round	5	1.53	0	VAV 1-122	220	150	150	0.5	0.4	35
73	MH-008	1-655	1-645	790	2263	Round	8	1.78	0							
74	MH-008	1-660	1-655	330	2420	Round	5	1.57	0	VAV 1-126	330	210	210	0.5	0.4	35
75	MH-008	1-665	1-655	160	2343	Round	6	1.59	1	VAV 1-132	460	230	230	0.5	0.4	35
76	MH-008	1-700	1-010	5160	2361	Round	20	2.24	0							
77	MH-008	1-705	1-700	1500	2408	Round	12	1.97	1	VAV 1-131	1900	890	890	0.5	0.4	35
78	MH-008	1-710	1-700	2330	2310	Round	16	2.18	0							
79	MH-008	1-715	1-710	430	2190	Round	6	2.19	0	VAV 1-125	430	320	320	0.5	0.4	35
80	MH-008	1-720	1-710	2800	2000	Round	16	2	1							
81	MH-008	1-725	1-720	800	UNK	Round	8	2.1	0	VAV 1-130	600	600	600	0.5	0.4	35
82	MH-008	1-730	1-720	2190	2046	Round	14	2.05	0							
83	MH-008	1-735	1-730	840	1483	Round	5	1.85	0	VAV 1-129	340	120	120	0.5	0.4	35
84	MH-008	1-740	1-730	1850	2349	Round	12	1.7	0							
85	MH-008	1-745	1-740	710	2054	Round	8	1.66	0	VAV 1-128	710	670	670	0.5	0.4	35
86	MH-008	1-750	1-740	440	2241	Round	6	1.49	0	VAV 1-121	440	440	440	0.5	0.4	35
87	MH-008	1-755	1-740	800	2292	Round	8	1.53	0							
88	MH-008	1-760	1-755	200	2292	Round	4	0.9	1	VAV 1-127	200	70	70	0.5	0.4	35
89	MH-008	1-765	1-755	600	1719	Round	8	1.63	0	VAV 1-123	600	280	280	0.5	0.4	35
90	MH-008	1-800	1-010	2530	2367	Round	14	2.26	0							

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
91	MH-008	1-805	1-800	330	2420	Round	5	1.96	0	VAV 1-115	330	290	290	0.5	0.4	35
92	MH-008	1-810	1-800	430	2190	Round	6	2.14	0	VAV 1-118	670	670	670	0.5	0.4	35
93	MH-008	1-815	1-800	1770	2254	Round	12	2.19	0							
94	MH-008	1-820	1-815	470	2394	Round	6	1.97	0	VAV 1-117	360	250	250	0.5	0.4	35
95	MH-008	1-825	1-815	1300	2384	Round	10	2.03	0							
96	MH-008	1-830	1-825	430	2190	Round	6	1.92	0	VAV 1-116	430	430	430	0.5	0.4	35
97	MH-008	1-835	1-825	870	2492	Round	8	1.81	0							
98	MH-008	1-840	1-835	400	2037	Round	6	1.75	0	VAV 1-114	400	280	280	0.5	0.4	35
99	MH-008	1-845	1-835	470	2394	Round	6	1.72	0	VAV 1-124	360	250	250	0.5	0.4	35
100	MH-008	1-900	1-500	1340	2457	Round	10	1.54	0							
101	MH-008	1-905	1-900	600	1719	Round	8	1.96	0	VAV 1-104	600	320	320	0.5	0.4	35
102	MH-008	1-910	1-900	740	2120	Round	8	1.76	0							
103	MH-008	1-915	1-910	530	1518	Round	8	1.8	0	VAV 1-105	530	260	260	0.5	0.4	35
104	MH-008	1-920	1-910	210	2406	Round	4	1.23	1	VAV 1-108	210	140	140	0.5	0.4	35
105	MH-008	2-005	AHU-2	32760	565	Rectangle	116/72	2.33	0							
106	MH-008	2-010	2-005	18045	547	Rectangle	66/72	2.33	0							
107	MH-008	2-100	2-005	3830	2167	Round	18	1.95	0							
108	MH-008	2-105	2-100	370	1884	Round	6	1.85	0	VAV 2-206	370	260	260	0.5	0.4	35
109	MH-008	2-110	2-100	3460	2478	Round	16	1.8	0							
110	MH-008	2-115	2-110	1450	1846	Round	12	1.74	1	VAV 2-201	1450	510	510	0.5	0.4	35
111	MH-008	2-120	2-110	700	2005	Round	8	1.69	0	VAV 2-205	700	510	510	0.5	0.4	35
112	MH-008	2-125	2-110	1310	2402	Round	10	1.61	1							
113	MH-008	2-130	2-125	400	2037	Round	6	1.49	1	VAV 2-204	400	260	260	0.5	0.4	35
114	MH-008	2-135	2-125	910	1668	Round	10	1.75	0							
115	MH-008	2-140	2-135	40	2340	Round	6	1.74	0	VAV 2-202	460	330	330	0.5	0.4	35
116	MH-008	2-145	2-135	450	2292	Round	6	1.09	1	VAV 2-203	450	330	330	0.5	0.4	35
117	MH-008	2-200	2-005	1730	2203	Round	12	1.92	0							
118	MH-008	2-205	2-200	450	2292	Round	6	1.73	0	VAV 2-211	450	390	390	0.5	0.4	35
119	MH-008	2-210	2-200	1280	2347	Round	10	1.78	0							
120	MH-008	2-215	2-110	240	1760	Round	5	1.72	0	VAV 2-212	240	160	160	0.5	0.4	35
121	MH-008	2-220	2-110	1040	1907	Round	10	1.81	0							
122	MH-008	2-225	2-220	330	2420	Round	5	1.55	0	VAV 2-213	330	240	240	0.5	0.4	35
123	MH-008	2-230	2-220	710	2034	Round	8	1.72	0							
124	MH-008	2-235	2-230	390	1986	Round	6	1.59	0	VAV 2-208	390	270	270	0.5	0.4	35
125	MH-008	2-240	2-230	320	2347	Round	5	1.46	1	VAV 2-214	320	270	270	0.5	0.4	35
126	MH-008	2-300	2-005	4215	2385	Round	18	1.77	1							
127	MH-008	2-305	2-300	450	2292	Round	6	1.58	0	VAV 2-216	450	450	450	0.5	0.4	35
128	MH-008	2-310	2-300	3765	2131	Round	18	1.75	0							
129	MH-008	2-315	2-310	680	1948	Round	8	1.53	0	VAV 2-215	680	470	470	0.5	0.4	35
130	MH-008	2-320	2-310	3085	2209	Round	16	1.59	2							
131	MH-008	2-325	2-320	460	2340	Round	6	1.5	0	VAV 2-217	460	460	460	0.5	0.4	35
132	MH-008	2-330	2-320	2625	2456	Round	14	1.59	5	VAV 2-218	2625	395	395	0.5	0.4	35
133	MH-008	2-400	2-005	4375	2476	Round	18	1.84	0							
134	MH-008	2-405	2-400	2625	2456	Round	14	1.56	0	VAV 2-219	2625	395	395	0.5	0.4	35
135	MH-008	2-410	2-400	800	2300	Round	8	1.89	0	VAV 2-210	800	630	630	0.5	0.4	35

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
136	MH-008	2-415	2-400	320	2347	Round	5	1.6	0	VAV 2-207	320	200	200	0.5	0.4	35
137	MH-008	2-420	2-400	630	1805	Round	8	1.84	1	VAV 2-209	630	420	420	0.5	0.4	35
138	MH-008	2-500	2-010	3280	2349	Round	16	1.74	1							
139	MH-008	2-505	2-500	760	2177	Round	8	1.76	0	VAV 2-106	760	510	510	0.5	0.4	35
140	MH-008	2-510	2-500	2520	2357	Round	14	1.63	0							
141	MH-008	2-515	2-510	590	1690	Round	8	1.62	0	VAV 2-102	590	320	320	0.5	0.4	35
142	MH-008	2-520	2-510	1930	2457	Round	12	1.29	0							
143	MH-008	2-525	2-520	440	2241	Round	6	0.96	0	VAV 2-112	440	440	440	0.5	0.4	35
144	MH-008	2-530	2-520	420	2139	Round	6	1.23	0	VAV 2-103	420	220	220	0.5	0.4	35
145	MH-008	2-535	2-520	1070	1962	Round	10	1.25	0							
146	MH-008	2-540	2-535	460	2340	Round	6	1.27	0	VAV 2-104	460	240	240	0.5	0.4	35
147	MH-008	2-545	2-535	610	1748	Round	8	1.22	0							
148	MH-008	2-550	2-545	460	2340	Round	6	1.22	0	VAV 2-108	460	320	320	0.5	0.4	35
149	MH-008	2-555	2-545	150	1719	Round	4	1.02	1	VAV 2-105	150	70	70	0.5	0.4	35
150	MH-008	2-600	2-010	780	2235	Round	8	1.8	0							
151	MH-008	2-605	2-600	320	1630	Round	6	1.79	0	VAV 2-115	320	320	320	0.5	0.4	35
152	MH-008	2-610	2-600	400	2340	Round	6	1.53	1	VAV 2-111	400	340	340	0.5	0.4	35
153	MH-008	2-700	2-010	8120	2202	Round	26	1.97	0							
154	MH-008	2-705	2-700	570	1633	Round	8	2.03	0	VAV 2-123	570	410	410	0.5	0.4	35
155	MH-008	2-710	2-700	360	1833	Round	6	1.89	0	VAV 2-124	360	280	280	0.5	0.4	35
156	MH-008	2-715	2-700	7190	2289	Round	24	1.81	1							
157	MH-008	2-720	2-715	600	1719	Round	8	1.74	2	VAV 2-126	700	670	670	0.5	0.4	35
158	MH-008	2-725	2-715	6590	2496	Round	22	1.63	0							
159	MH-008	2-730	2-725	340	2482	Round	5	1.71	0	VAV 2-127	340	230	230	0.5	0.4	35
160	MH-008	2-735	2-725	6250	2368	Round	22	1.59	0							
161	MH-008	2-740	2-735	470	2394	Round	6	1.41	0	VAV 2-116	470	390	390	0.5	0.4	35
162	MH-008	2-745	2-735	5780	2190	Round	22	1.57	0							
163	MH-008	2-750	2-745	600	1719	Round	8	1.5	0	VAV 2-128	600	600	600	0.5	0.4	35
164	MH-008	2-755	2-745	270	1980	Round	5	1.63	0	VAV 2-117	270	130	130	0.5	0.4	35
165	MH-008	2-760	2-745	4910	2251	Round	20	1.41	0							
166	MH-008	2-765	2-760	580	1692	Round	8	1.33	0	VAV 2-118	580	380	380	0.5	0.4	35
167	MH-008	2-770	2-760	4330	2450	Round	20	1.28	0							
168	MH-008	2-775	2-770	220	1613	Round	5	1.53	0	VAV 2-129	220	150	150	0.5	0.4	35
169	MH-008	2-780	2-770	4110	2326	Round	18	1.27	0							
170	MH-008	2-785	2-780	430	2190	Round	6	1.06	0	VAV 2-119	430	430	430	0.5	0.4	35
171	MH-008	2-790	2-780	3680	2082	Round	18	1.27	0							
172	MH-008	2-791	2-790	220	1687	Round	5	1.39	0	VAV 2-120	230	150	150	0.5	0.4	35
173	MH-008	2-792	2-790	3450	2471	Round	16	1.07	0							
174	MH-008	2-793	2-792	2010	1880	Round	14	1.04	0	VAV 2-131	2355	395	395	0.5	0.4	35
175	MH-008	2-794	2-792	1440	1833	Round	12	1.22	0							
176	MH-008	2-795	2-794	260	1907	Round	5	1.11	2	VAV 2-130	260	180	180	0.5	0.4	35
177	MH-008	2-796	2-794	1180	2163	Round	10	1.07	0							
178	MH-008	2-797	2-796	550	1576	Round	8	1.08	0	VAV 2-121	550	370	370	0.5	0.4	35
179	MH-008	2-798	2-796	630	1895	Round	8	0.95	1	VAV 2-113	630	550	550	0.5	0.4	35
180	MH-008	2-800	2-010	5180	2374	Round	20	1.93	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
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181	MH-008	2-805	2-800	430	2190	Round	6	1.77	0	VAV 2-110	430	430	430	0.5	0.4	35
182	MH-008	2-810	2-800	450	2292	Round	6	1.75	0	VAV 2-114	450	450	450	0.5	0.4	35
183	MH-008	2-815	2-800	4300	2433	Round	18	1.81	0							
184	MH-008	2-820	2-815	2890	2070	Round	16	1.66	0							
185	MH-008	2-825	2-820	210	2496	Round	4	1.36	0	VAV 2-122	210	140	140	0.5	0.4	35
186	MH-008	2-830	2-820	2680	1919	Round	16	1.53	0	VAV 2-125	2355	395	395	0.5	0.4	35
187	MH-008	2-900	2-815	1410	1795	Round	12	1.79	0							
188	MH-008	2-905	2-900	460	2340	Round	6	1.77	0	VAV 2-109	460	430	430	0.5	0.4	35
189	MH-008	2-910	2-900	950	1742	Round	10	1.7	0							
190	MH-008	2-915	2-910	350	1783	Round	6	1.15	0	VAV 2-107	350	350	350	0.5	0.4	35
191	MH-008	2-920	2-910	600	1719	Round	8	1.63	0	VAV 2-101	600	320	320	0.5	0.4	35
192	MH-008	3-005	AHU-3	32890	577	Rectangle	72/114	2.56	0							
193	MH-008	3-010	3-005	16330	454	Rectangle	72/72	2.56	0							
194	MH-008	3-100	3-005	3800	2150	Round	18	2.26	0							
195	MH-008	3-105	3-100	1330	2439	Round	10	1.89	1							
196	MH-008	3-110	3-105	440	2241	Round	6	1.77	0	VAV 3-201	440	290	290	0.5	0.4	35
197	MH-008	3-115	3-105	890	1632	Round	10	2.07	0							
198	MH-008	3-120	3-115	450	2292	Round	6	1.79	0	VAV 3-203	450	340	340	0.5	0.4	35
199	MH-008	3-125	3-115	440	2241	Round	6	1.52	2	VAV 3-204	440	300	300	0.5	0.4	35
200	MH-008	3-130	3-100	2470	2311	Round	14	2.01	1							
201	MH-008	3-135	3-130	420	2139	Round	6	1.83	0	VAV 3-202	420	300	300	0.5	0.4	35
202	MH-008	3-140	3-130	2050	1918	Round	14	2.07	0							
203	MH-008	3-145	3-140	450	2292	Round	6	1.8	0	VAV 3-206	450	300	300	0.5	0.4	35
204	MH-008	3-150	3-140	1600	2037	Round	12	1.89	1	VAV 3-205	1600	410	410	0.5	0.4	35
205	MH-008	3-200	3-005	4820	2209	Round	20	2.24	0							
206	MH-008	3-205	3-200	290	2127	Round	5	2.08	0	VAV 3-210	290	140	140	0.5	0.4	35
207	MH-008	3-210	3-200	4530	2076	Round	20	2.2	0							
208	MH-008	3-215	3-210	370	1884	Round	6	2.12	0	VAV 3-208	370	290	290	0.5	0.4	35
209	MH-008	3-220	3-210	4160	2354	Round	18	1.92	1							
210	MH-008	3-225	3-220	810	2320	Round	8	1.94	0	VAV 3-212	810	550	550	0.5	0.4	35
211	MH-008	3-230	3-220	3350	2399	Round	16	1.85	0							
212	MH-008	3-235	3-230	920	1687	Round	10	1.83	4							
213	MH-008	3-240	3-235	500	1433	Round	8	1.46	0	VAV 3-218	500	330	330	0.5	0.4	35
214	MH-008	3-245	3-235	420	2139	Round	6	1.31	1	VAV 3-221	420	390	390	0.5	0.4	35
215	MH-008	3-250	3-230	2430	2273	Round	14	1.73	1							
216	MH-008	3-255	3-250	610	1748	Round	8	1.68	0	VAV 3-215	610	610	610	0.5	0.4	35
217	MH-008	3-260	3-250	1820	2317	Round	12	1.29	5							
218	MH-008	3-265	3-260	930	1705	Round	10	1.29	0	VAV 3-222	930	350	350	0.5	0.4	35
219	MH-008	3-270	3-260	890	1632	Round	10	1.38	1	VAV 3-220	890	730	730	0.5	0.4	35
220	MH-008	3-300	3-005	6580	2493	Round	22	2.13	0							
221	MH-008	3-305	3-300	690	1977	Round	8	2.06	0	VAV 3-207	690	520	520	0.5	0.4	35
222	MH-008	3-310	3-300	5890	2231	Round	22	2.09	1							
223	MH-008	3-315	3-310	4320	2445	Round	18	1.84	0							
224	MH-008	3-320	3-315	700	2005	Round	8	1.68	0	VAV 3-211	700	360	360	0.5	0.4	35
225	MH-008	3-325	3-315	3620	2049	Round	18	2	0							

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226	MH-008	3-330	3-325	1440	1833	Round	12	1.93	0	VAV 3-214	1440	970	970	0.5	0.4	35
227	MH-009	3-335	3-325	2180	2039	Round	14	1.89	0							
228	MH-009	3-340	3-335	430	2190	Round	6	1.54	0	VAV 3-216	430	280	280	0.5	0.4	35
229	MH-009	3-345	3-335	1750	2228	Round	12	1.79	0							
230	MH-009	3-350	3-345	410	2088	Round	6	1.52	0	VAV 3-217	410	270	270	0.5	0.4	35
231	MH-009	3-355	3-345	1340	2457	Round	10	1.44	4							
232	MH-009	3-360	3-355	1090	1999	Round	10	1.64	0	VAV 3-219	1090	720	720	0.5	0.4	35
233	MH-009	3-365	3-355	250	1833	Round	5	1.14	2	VAV 3-223	250	250	250	0.5	0.4	35
234	MH-009	3-370	3-310	1570	1999	Round	12	1.99	1							
235	MH-009	3-375	3-370	330	2420	Round	5	1.74	0	VAV 3-209	330	220	220	0.5	0.4	35
236	MH-009	3-380	3-370	1240	2274	Round	10	1.97	1	VAV 3-213	1240	280	280	0.5	0.4	35
237	MH-009	3-400	3-010	4700	2154	Round	20	2.22	4							
238	MH-009	3-405	3-400	450	2292	Round	6	2.03	0	VAV 3-115	450	450	450	0.5	0.4	35
239	MH-009	3-410	3-400	4250	2405	Round	18	1.99	0							
240	MH-009	3-415	3-410	490	2496	Round	6	2	0	VAV 3-110	490	430	430	0.5	0.4	35
241	MH-009	3-420	3-410	3760	2128	Round	18	2.01	0							
242	MH-009	3-425	3-420	830	2378	Round	8	1.69	2	VAV 3-109	830	440	440	0.5	0.4	35
243	MH-009	3-430	3-420	1930	2457	Round	12	1.76	0							
244	MH-009	3-435	3-430	330	2420	Round	5	1.46	0	VAV 3-106	330	330	330	0.5	0.4	35
245	MH-009	3-440	3-430	1600	2037	Round	12	1.8	0							
246	MH-009	3-445	3-440	36	1833	Round	6	1.7	0	VAV 3-104	360	340	340	0.5	0.4	35
247	MH-009	3-450	3-440	1240	2274	Round	10	1.63	0							
248	MH-009	3-455	3-450	460	2343	Round	6	1.41	0	VAV 3-103	460	310	310	0.5	0.4	35
249	MH-009	3-460	3-450	330	2420	Round	5	0.9	1	VAV 3-101	330	290	290	0.5	0.4	35
250	MH-009	3-465	3-450	450	2292	Round	6	1.52	0	VAV 3-102	450	450	450	0.5	0.4	35
251	MH-009	3-470	3-420	1000	1833	Round	10	1.92	1							
252	MH-009	3-475	3-470	130	1490	Round	4	1.82	0	VAV 3-108	130	90	90	0.5	0.4	35
253	MH-009	3-480	3-470	870	2492	Round	8	1.54	0							
254	MH-009	3-485	3-480	290	2127	Round	5	1.45	0	VAV 3-128	320	200	200	0.5	0.4	35
255	MH-009	3-490	3-480	580	1662	Round	8	1.63	1	VAV 3-107	580	410	410	0.5	0.4	35
256	MH-009	3-500	3-010	3980	2252	Round	18	2.2	0							
257	MH-009	3-505	3-500	330	2420	Round	5	1.93	0	VAV 3-119	330	290	290	0.5	0.4	35
258	MH-009	3-510	3-500	440	2241	Round	6	1.96	0	VAV 3-118	440	440	440	0.5	0.4	35
259	MH-009	3-515	3-500	3210	2299	Round	16	2.03	0							
260	MH-009	3-520	3-515	2280	2133	Round	14	1.73	4							
261	MH-009	3-525	3-520	420	2139	Round	6	1.54	0	VAV 3-116	420	270	270	0.5	0.4	35
262	MH-009	3-530	3-520	1860	2368	Round	12	1.58	0							
263	MH-009	3-535	3-530	880	1613	Round	10	1.61	0	VAV 3-114	880	590	590	0.5	0.4	35
264	MH-009	3-540	3-530	980	1797	Round	10	1.56	0							
265	MH-009	3-545	3-540	420	2139	Round	6	1.35	4	VAV 3-112	420	320	320	0.5	0.4	35
266	MH-009	3-550	3-540	560	1604	Round	8	1.33	0	VAV 3-105	560	360	360	0.5	0.4	35
267	MH-009	3-600	3-515	930	1705	Round	10	1.95	5							
268	MH-009	3-605	3-600	450	2292	Round	6	1.68	4	VAV 3-122	450	340	340	0.5	0.4	35
269	MH-009	3-610	3-600	180	2445	Round	6	1.6	0							
270	MH-009	3-615	3-610	230	1687	Round	5	1.61	0	VAV 3-127	290	140	140	0.5	0.4	35

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271	MH-009	3-620	3-610	25	1833	Round	5	1.59	1	VAV 3-124	250	170	170	0.5	0.4	35
272	MH-009	3-700	3-010	7650	2435	Round	24	2.14	0							
273	MH-009	3-705	3-700	4570	2095	Round	20	2.12	0							
274	MH-009	3-710	3-705	690	1977	Round	8	2.03	1	VAV 3-126	690	460	460	0.5	0.4	35
275	MH-009	3-715	3-705	3880	2200	Round	18	1.68	1	VAV 3-125	3880	54	54	0.5	0.4	35
276	MH-009	3-720	3-700	1510	1923	Round	12	2.04	1							
277	MH-009	3-725	3-720	700	2005	Round	8	1.91	0	VAV 3-120	700	700	700	0.5	0.4	35
278	MH-009	3-730	3-720	490	2496	Round	6	1.63	0	VAV 3-121	490	330	330	0.5	0.4	35
279	MH-009	3-735	3-720	320	2347	Round	5	1.46	1	VAV 3-123	320	210	210	0.5	0.4	35
280	MH-009	3-740	3-700	1570	1999	Round	12	2.07	1							
281	MH-009	3-745	3-740	560	1604	Round	8	2	0	VAV 3-117	560	290	290	0.5	0.4	35
282	MH-009	3-750	3-740	1010	1852	Round	10	1.97	0							
283	MH-009	3-755	3-750	51	1460	Round	8	1.96	0	VAV 3-113	510	510	510	0.5	0.4	35
284	MH-009	3-760	3-750	500	1461	Round	6	1.53	1	VAV 3-111	500	330	330	0.5	0.4	35
285	MH-009	4-005	AHU-4	35730	435	Rectangle	60/197	2.74	0							
286	MH-009	4-040	4-005	35730	626	Rectangle	60/137	2.74	0							
287	MH-009	4-015	4-010	11850	544	Rectangle	56/56	2.74	0							
288	MH-009	4-400	4-005	4960	2274	Round	20	2.44	0							
289	MH-009	4-105	4-100	19210	2445	Round	12	2.41	0	VAV 4-202	1920	1850	1850	0.5	0.4	35
290	MH-009	4-110	4-100	3040	1720	Round	18	2.52	0	VAV 4-201	3040	1820	1820	0.5	0.4	35
291	MH-009	4-200	4-005	5110	2342	Round	20	2.34	1							
292	MH-009	4-205	4-200	400	2037	Round	6	2.09	1	VAV 4-204	400	270	270	0.5	0.4	35
293	MH-009	4-210	4-200	4710	215	Round	20	2.15	2							
294	MH-009	4-215	4-210	1080	1980	Round	10	2.08	0	VAV 4-209	1080	720	720	0.5	0.4	35
295	MH-009	4-220	4-210	3900	2207	Round	18	2.08	0							
296	MH-009	4-225	4-220	810	2321	Round	8	1.78	0	VAV 4-210	810	540	540	0.5	0.4	35
297	MH-009	4-230	4-220	3490	2500	Round	16	1.87	0							
298	MH-009	4-235	4-230	640	1833	Round	8	1.79	0	VAV 4-213	640	420	420	0.5	0.4	35
299	MH-009	4-240	4-230	2850	2041	Round	16	1.94	0							
300	MH-009	4-245	4-240	300	2200	Round	5	1.6	0	VAV 4-226	300	150	150	0.5	0.4	35
301	MH-009	4-250	4-240	2550	2385	Round	14	1.77	0							
302	MH-009	4-255	4-250	810	2320	Round	8	1.8	0	VAV 4-214	810	54	54	0.5	0.4	35
303	MH-009	4-260	4-250	1740	2215	Round	12	1.72	0							
304	MH-009	4-265	4-260	410	2088	Round	6	1.42	0	VAV 4-229	410	250	250	0.5	0.4	35
305	MH-009	4-270	4-260	1330	2439	Round	10	1.39	4							
306	MH-009	4-275	4-270	790	2263	Round	8	1.5	0	VAV 4-216	790	530	530	0.5	0.4	35
307	MH-009	4-280	4-270	540	1547	Round	8	1.59	0							
308	MH-009	4-285	4-280	170	1948	Round	4	0.9	1	VAV 4-219	170	110	110	0.5	0.4	35
309	MH-009	4-290	4-280	370	1884	Round	6	1.45	0	VAV 4-218	370	250	250	0.5	0.4	35
310	MH-009	4-300	4-005	7490	1384	Round	24	2.08	4							
311	MH-009	4-305	4-300	4850	2223	Round	20	2.04	0							
312	MH-009	4-310	4-305	560	1604	Round	8	1.96	0	VAV 4-227	560	370	370	0.5	0.4	35
313	MH-009	4-315	4-305	4290	2428	Round	18	1.79	0							
314	MH-009	4-320	4-315	1120	2053	Round	10	1.72	1							
315	MH-009	4-325	4-320	250	1833	Round	5	1.65	0	VAV 4-221	250	170	170	0.5	0.4	35

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
316	MH-009	4-330	4-320	870	2492	Round	8	1.51	0							
317	MH-009	4-335	4-330	200	2292	Round	4	1.28	0	VAV 4-222	200	140	140	0.5	0.4	35
318	MH-009	4-340	4-330	670	1919	Round	8	1.61	0							
319	MH-009	4-345	4-340	410	2088	Round	6	1.22	1	VAV 4-220	410	100	100	0.5	0.4	35
320	MH-009	4-350	4-340	260	1907	Round	5	1.55	0	VAV 4-217	260	180	180	0.5	0.4	35
321	MH-009	4-355	4-300	2640	2470	Round	14	1.93	1							
322	MH-009	4-360	4-355	1020	1870	Round	10	1.92	0	VAV 4-225	1020	640	640	0.5	0.4	35
323	MH-009	4-365	4-355	1020	1870	Round	10	1.91	1	VAV 4-212	1020	990	990	0.5	0.4	35
324	MH-009	4-370	4-315	3170	2270	Round	16	1.72	1							
325	MH-009	4-375	4-370	1540	1961	Round	12	1.65	0	VAV 4-211	1540	390	390	0.5	0.4	35
326	MH-009	4-380	4-370	1020	1870	Round	10	1.67	1	VAV 4-215	1020	910	910	0.5	0.4	35
327	MH-009	4-400	4-005	2110	1974	Round	14	2.48	0							
328	MH-009	4-405	4-400	400	2037	Round	6	2.32	0	VAV 4-206	400	270	270	0.5	0.4	35
329	MH-009	4-410	4-400	1710	2177	Round	12	2.32	0							
330	MH-009	4-415	4-410	300	2200	Round	5	2.13	0	VAV 4-207	300	190	190	0.5	0.4	35
331	MH-009	4-420	4-410	1410	1795	Round	12	2.35	1	VAV 4-224	1410	1410	1410	0.5	0.4	35
332	MH-009	4-500	4-005	4650	2131	Round	20	2.47	0							
333	MH-009	4-505	4-500	2380	2226	Round	14	2.25	0							
334	MH-009	4-510	4-505	340	2494	Round	5	1.9	0	VAV 4-205	340	230	230	0.5	0.4	35
335	MH-009	4-515	4-505	2040	1908	Round	14	2.28	0							
336	MH-009	4-520	4-515	750	2149	Round	8	2.1	0	VAV 4-223	750	750	750	0.5	0.4	35
337	MH-009	4-525	4-515	1290	2365	Round	10	2.23	2	VAV 4-208	1290	860	860	0.5	0.4	35
338	MH-009	4-530	4-500	2270	2123	Round	14	2.32	0							
339	MH-009	4-535	4-530	410	2088	Round	6	2.13	0	VAV 4-203	410	250	250	0.5	0.4	35
340	MH-009	4-540	4-530	1860	2368	Round	12	2.38	0	VAV 4-228	1860	310	310	0.5	0.4	35
341	MH-009	4-600	4-010	2970	2127	Round	16	2.43	0							
342	MH-009	4-605	4-600	1680	2139	Round	12	2.36	0							
343	MH-009	4-610	4-605	580	1662	Round	8	2.31	0	VAV 4-102	580	580	580	0.5	0.4	35
344	MH-009	4-615	4-605	1360	2494	Round	10	2.28	0	VAV 4-101	1360	380	380	0.5	0.4	35
345	MH-009	4-620	4-600	1290	2365	Round	10	2.27	1							
346	MH-009	4-625	4-620	340	2494	Round	5	1.91	1	VAV 4-104	340	220	220	0.5	0.4	35
347	MH-009	4-630	4-620	950	1742	Round	10	2.34	0							
348	MH-009	4-635	4-630	420	2139	Round	6	2.12	0	VAV 4-103	420	280	280	0.5	0.4	35
349	MH-009	4-640	4-630	530	1518	Round	8	2.34	0							
350	MH-009	4-645	4-640	250	1833	Round	5	2.05	1	VAV 4-120	25	170	170	0.5	0.4	35
351	MH-009	4-650	4-640	280	2053	Round	5	2.13	0	VAV 4-105	280	140	140	0.5	0.4	35
352	MH-009	4-700	4-010	3990	2258	Round	18	2.41	0							
353	MH-009	4-705	4-700	470	2394	Round	6	2.14	0	VAV 4-122	470	470	470	0.5	0.4	35
354	MH-009	4-710	4-700	3520	1992	Round	18	2.39	0							
355	MH-009	4-715	4-710	1820	2317	Round	12	2.19	0	VAV 4-109	1820	1450	1450	0.5	0.4	35
356	MH-009	4-720	4-710	1700	2165	Round	12	2.22	0							
357	MH-009	4-725	4-720	270	1980	Round	5	2.13	0	VAV 4-106	270	200	200	0.5	0.4	35
358	MH-009	4-730	4-720	1430	1821	Round	12	2.22	1							
359	MH-009	4-735	4-730	110	1261	Round	4	2.23	0	VAV 4-110	110	100	100	0.5	0.4	35
360	MH-009	4-740	4-730	1320	2420	Round	10	1.91	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
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361	MH-009	4-745	4-740	360	1833	Round	6	1.79	1	VAV 4-113	360	240	240	0.5	0.4	35
362	MH-009	4-750	4-740	960	1760	Round	10	1.99	0							
363	MH-009	4-755	4-750	250	1833	Round	5	1.87	0	VAV 4-116	250	170	170	0.5	0.4	35
364	MH-009	4-760	4-750	710	2034	Round	8	1.8	0							
365	MH-009	4-765	4-760	270	1980	Round	5	1.66	0	VAV 4-117	270	180	180	0.5	0.4	35
366	MH-009	4-770	4-760	440	2241	Round	6	1.61	0							
367	MH-009	4-775	4-770	110	1261	Round	4	1.56	1	VAV 4-118	110	80	80	0.5	0.4	35
368	MH-009	4-780	4-770	330	2420	Round	5	1.49	0	VAV 4-112	330	220	220	0.5	0.4	35
369	MH-009	4-800	4-010	4550	2086	Round	20	2.46	0							
370	MH-009	4-805	4-800	1150	2108	Round	10	2.23	1	VAV 4-107	1150	880	880	0.5	0.4	35
371	MH-009	4-810	4-800	3400	2435	Round	16	2.26	0							
372	MH-009	4-815	4-810	360	1833	Round	6	2.22	0	VAV 4-108	360	360	360	0.5	0.4	35
373	MH-009	4-820	4-810	3040	2177	Round	16	2.26	0							
374	MH-009	4-825	4-820	290	2127	Round	5	2.04	1	VAV 4-111	290	220	220	0.5	0.4	35
375	MH-009	4-830	4-820	2750	1970	Round	16	2.28	0							
376	MH-009	4-835	4-830	590	1690	Round	8	2.2	0	VAV 4-121	590	80	80	0.5	0.4	35
377	MH-009	4-840	4-830	2160	2021	Round	14	2.21	0							
378	MH-009	4-845	4-840	1230	2255	Round	10	2.17	0	VAV 4-114	1230	870	870	0.5	0.4	35
379	MH-009	4-850	4-840	930	1705	Round	10	2.17	0							
380	MH-009	4-855	4-850	650	1862	Round	8	1.97	0	VAV 4-115	650	630	630	0.5	0.4	35
381	MH-009	4-860	4-850	280	2053	Round	5	1.99	0	VAV 4-119	280	190	190	0.5	0.4	35
382	MH-009	5-005	AHU-5	29150	530	Rectangle	104/76	2.85	0							
383	MH-009	5-010	5-005	11935	473	Rectangle	60/60	2.85	0							
384	MH-009	5-100	5-005	7210	2295	Round	24	2.42	1							
385	MH-009	5-105	5-100	360	1833	Round	6	2.36	4	VAV 5-201	360	180	180	0.5	0.4	35
386	MH-009	5-110	5--100	6850	2180	Round	24	2.4	0							
387	MH-009	5-115	5-110	1160	2127	Round	10	2.18	0	VAV 5-205	131	890	890	0.5	0.4	35
388	MH-009	5-120	5-110	5698	2155	Round	22	2.35	0							
389	MH-009	5-125	5-120	720	2063	Round	8	2.05	4	VAV 5-202	720	280	280	0.5	0.4	35
390	MH-009	5-130	5-120	4970	2278	Round	20	2.19	0							
391	MH-009	5-135	5-130	180	2063	Round	4	2.11	0	VAV 5-206	180	120	120	0.5	0.4	35
392	MH-009	5-140	5-130	4790	2196	Round	20	2.13	0							
393	MH-009	5-145	5-140	1280	2347	Round	10	1.9	0	VAV 5-211	1280	690	690	0.5	0.4	35
394	MH-009	5-150	5-140	3410	1986	Round	18	2.15	0							
395	MH-009	5-155	5-150	940	1724	Round	10	2.09	0	VAV 5-207	940	840	840	0.5	0.4	35
396	MH-009	5-160	5-150	2570	2404	Round	14	1.91	0							
397	MH-009	5-165	5-160	290	2127	Round	5	1.68	0	VAV 5-212	290	200	200	0.5	0.4	35
398	MH-009	5-170	5-160	2280	2133	Round	14	1.88	0							
399	MH-009	5-175	5-170	200	2292	Round	4	1.38	0	VAV 5-203	200	100	100	0.5	0.4	35
400	MH-009	5-180	5-170	2080	1946	Round	14	1.86	0							
401	MH-009	5-185	5-180	1040	1907	Round	10	1.77	0	VAV 5-208	1040	680	680	0.5	0.4	35
402	MH-009	5-190	5-180	440	2241	Round	6	1.47	0	VAV 5-204	440	250	250	0.5	0.4	35
403	MH-009	5-195	5-180	600	1719	Round	8	1.75	2	VAV 5-209	600	200	200	0.5	0.4	35
404	MH-009	5-200	5-005	1070	1962	Round	10	2.51	1	VAV 5-210	1070	720	720	0.5	0.4	35
405	MH-009	5-300	5-005	8920	2419	Round	26	2.45	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
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406	MH-009	5-305	5-300	1430	1821	Round	12	2.35	0	VAV 5-213	1430	950	950	0.5	0.4	35
407	MH-009	5-310	5-300	7490	2384	Round	24	2.34	1							
408	MH-009	5-315	5-310	2150	2011	Round	14	2.27	0	VAV 5-220	2150	1500	1500	0.5	0.4	35
409	MH-009	5-320	5-310	5340	2448	Round	20	2.25	0							
410	MH-009	5-325	5-320	350	1783	Round	6	2.34	0	VAV 5-214	350	230	230	0.5	0.4	35
411	MH-009	5-330	5-320	4990	2287	Round	20	2.22	0							
412	MH-009	5-335	5-330	1020	1870	Round	10	2.14	0	VAV 5-221	1020	420	420	0.5	0.4	35
413	MH-009	5-340	5-330	3970	2247	Round	18	2.14	0							
414	MH-009	5-345	5-340	250	1833	Round	5	2.15	0	VAV 5-215	250	160	160	0.5	0.4	35
415	MH-009	5-350	5-340	3720	2105	Round	18	1.96	4							
416	MH-009	5-355	5-350	26	1907	Round	5	1.91	0	VAV 5-216	260	170	170	0.5	0.4	35
417	MH-009	5-360	5-350	3460	2478	Round	16	1.76	0							
418	MH-009	5-365	5-360	1800	2292	Round	12	1.63	0	VAV 5-222	1800	1200	1200	0.5	0.4	35
419	MH-009	5-370	5-360	1660	2114	Round	12	1.75	0							
420	MH-009	5-375	5-370	260	1907	Round	5	1.58	0	VAV 5-217	260	130	130	0.5	0.4	35
421	MH-009	5-380	5-370	1400	1783	Round	12	1.8	0							
422	MH-009	5-385	5-380	850	2435	Round	8	1.4	4	VAV 5-223	850	280	280	0.5	0.4	35
423	MH-009	5-390	5-380	550	1576	Round	8	1.75	0							
424	MH-009	5-395	5-390	220	1613	Round	5	1.36	0	VAV 5-218	220	16	16	0.5	0.4	35
425	MH-009	5-396	5-390	330	2420	Round	5	1.32	0							
426	MH-009	5-397	5-396	200	2292	Round	4	0.9	0	VAV 5-224	200	90	90	0.5	0.4	35
427	MH-009	5-398	5-396	130	1490	Round	4	1.41	2	VAV 5-219	130	90	90	0.5	0.4	35
428	MH-009	5-400	5-010	8420	2284	Round	26	2.5	0							
429	MH-009	5-405	5-400	420	2139	Round	6	2.36	1	VAV 5-114	420	380	380	0.5	0.4	35
430	MH-009	5-410	5-400	8000	2170	Round	26	2.46	0							
431	MH-009	5-415	5-410	480	2445	Round	6	2.16	1	VAV 5-106	480	220	220	0.5	0.4	35
432	MH-009	5-420	5-410	7520	2394	Round	24	2.2	1							
433	MH-009	5-425	5-420	210	2406	Round	4	1.94	1	VAV 5-102	210	210	210	0.5	0.4	35
434	MH-009	5-430	5-420	7310	2327	Round	24	2.17	0							
435	MH-009	5-435	5-430	1820	2318	Round	12	2.12	0	VAV 5-101	1820	970	970	0.5	0.4	35
436	MH-009	5-440	5-430	5490	2080	Round	22	2.17	0							
437	MH-009	5-445	5-540	640	1833	Round	8	2.04	0	VAV 5-107	640	640	640	0.5	0.4	35
438	MH-009	5-450	5-540	4850	2233	Round	20	1.83	4							
439	MH-009	5-455	5-550	650	1862	Round	8	1.69	0	VAV 5-108	650	450	450	0.5	0.4	35
440	MH-009	5-460	5-550	4200	2377	Round	18	1.87	0							
441	MH-009	5-465	5-560	700	2005	Round	8	1.54	4	VAV 5-119	700	310	310	0.5	0.4	35
442	MH-009	5-470	5-560	3500	1981	Round	18	1.78	0							
443	MH-009	5-475	5-570	350	1783	Round	6	1.29	1	VAV 5-103	350	230	230	0.5	0.4	35
444	MH-009	5-480	5-570	170	1980	Round	5	1.17	0	VAV 5-111	270	130	130	0.5	0.4	35
445	MH-009	5-485	5-570	2880	2063	Round	16	1.67	0							
446	MH-009	5-490	5-585	1240	2274	Round	10	1.47	0	VAV 5-104	1240	1240	1240	0.5	0.4	35
447	MH-009	5-491	5-585	1640	2088	Round	12	1.61	0							
448	MH-009	5-492	5-591	850	2435	Round	8	1.42	0	VAV 5-105	850	490	490	0.5	0.4	35
449	MH-009	5-493	5-591	790	2263	Round	8	1.34	1							
450	MH-009	5-494	5-493	410	2088	Round	6	1.22	0	VAV 5-109	410	270	270	0.5	0.4	35

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451	MH-009	5-495	5-493	380	1935	Round	6	1.13	1	VAV 5-118	380	70	70	0.5	0.4	35
452	MH-009	5-500	5-010	3600	2037	Round	18	2.5	5							
453	MH-010	5-505	5-500	690	1977	Round	8	2.37	0	VAV 5-112	690	320	320	0.5	0.4	35
454	MH-010	5-510	5-500	2910	2084	Round	16	2.38	1							
455	MH-010	5-515	5-520	440	2241	Round	6	2.02	0	VAV 5-117	440	260	260	0.5	0.4	35
456	MH-010	5-520	5-520	2470	2311	Round	14	2.23	0							
457	MH-010	5-525	5-520	1080	1980	Round	10	2.16	0	VAV 5-113	1080	320	320	0.5	0.4	35
458	MH-010	5-530	5-520	1390	1770	Round	12	2.32	0							
459	MH-010	5-535	5-530	390	1986	Round	6	2.08	1	VAV 5-115	390	270	270	0.5	0.4	35
460	MH-010	5-540	5-530	340	2494	Round	5	1.82	0	VAV 5-116	340	160	160	0.5	0.4	35
461	MH-010	5-545	5-530	660	1891	Round	8	2.17	1	VAV 5-11-	660	410	410	0.5	0.4	35
462	MH-010	7-005	AHU-7	7230	2301	Round	24	0.97	0							
463	MH-010	7-010	7-005	2850	2041	Round	16	0.89	0							
464	MH-010	7-100	7-005	2310	2161	Round	14	0.75	5							
465	MH-010	7-105	7-100	490	2495	Round	6	0.49	0	VAV 7-206	490	330	330	0.5	0.4	35
466	MH-010	7-110	7-100	1820	2317	Round	12	0.64	0							
467	MH-010	7-115	7-110	240	1760	Round	5	0.6	0	VAV 7-204	240	120	120	0.5	0.4	35
468	MH-010	7-120	7-110	1580	2012	Round	12	0.66	0							
469	MH-010	7-125	7-120	1190	2182	Round	10	0.49	0	VAV 7-202	1190	770	770	0.5	0.4	35
470	MH-010	7-130	7-120	390	1986	Round	6	0.5	2	VAV 7-201	390	200	200	0.5	0.4	35
471	MH-010	7-200	7-005	1790	2279	Round	12	0.86	0							
472	MH-010	7-205	7-200	260	1907	Round	5	0.78	0	VAV 7-207	260	120	120	0.5	0.4	35
473	MH-010	7-210	7-200	1530	1948	Round	12	0.75	4							
474	MH-010	7-215	7-210	640	1833	Round	8	0.66	0	VAV 7-208	640	640	640	0.5	0.4	35
475	MH-010	7-220	7-210	890	1632	Round	10	0.59	1	VAV 7-209	890	590	590	0.5	0.4	35
476	MH-010	7-300	7-010	1820	2317	Round	12	0.45	0							
477	MH-010	7-305	7-300	150	1910	Round	12	0.45	0	VAV 7-205	1500	1500	1500	0.5	0.4	35
478	MH-010	7-310	7-300	320	2347	Round	5	0.45	5	VAV 7-203	320	320	320	0.5	0.4	35
479	MH-010	7-400	7-010	1030	1889	Round	10	0.7	1	VAV 7-210	1030	1030	1030	0.5	0.4	35
480	MH-010	9-005	AHU-9	3050	2098	Round	16	1.33	2							
481	MH-010	9-010	9-005	460	2184	Round	6	0.93	0	VAV 9-101	460	460	460	0.5	0.4	35
482	MH-010	9-015	9-005	2470	2311	Round	14	1.11	1							
483	MH-010	9-020	9-015	2030	1899	Round	14	1.05	0	VAV 9-102	2030	2030	2030	0.5	0.4	35
484	MH-010	9-025	9-015	440	2241	Round	6	0.9	1	VAV 9-103	440	440	440	0.5	0.4	35

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
1	MH-004	RHC 1-101	VAV 1-101	1778	0.5	90	55	72	188	158	10x8	144	0.2	5
2	MH-004	RHC 1-102	VAV 1-102	4743	0.5	240	55	72	188	158	10x8	144	0.2	5
3	MH-004	RHC 1-103	VAV 1-103	6324	0.5	320	55	72	188	158	11x10	144	0.2	5
4	MH-004	RHC 1-104	VAV 1-104	6324	0.5	320	55	72	188	158	11x10	144	0.2	5
5	MH-004	RHC 1-105	VAV 1-105	5,138	0.5	260	55	72	188	158	11x10	144	0.2	5
6	MH-004	RHC 1-106	VAV 1-106	9,625	0.6	360	55	78	188	158	10x8	144	0.2	5
7	MH-004	RHC 1-107	VAV 1-107	9,683	0.6	490	55	72	188	158	14x12	144	0.2	5
8	MH-004	RHC 1-108	VAV 1-108	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
9	MH-004	RHC 1-109	VAV 1-109	9,625	0.6	360	55	78	188	158	11x10	144	0.2	5
10	MH-004	RHC 1-110	VAV 1-110	7,754	0.5	290	55	78	188	158	11x10	144	0.2	5
11	MH-004	RHC 1-111	VAV 1-111	10,695	0.7	400	55	78	188	158	10x8	144	0.2	5
12	MH-004	RHC 1-112	VAV 1-112	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
13	MH-004	RHC 1-113	VAV 1-113	4,150	0.5	210	55	72	188	158	11x10	144	0.2	5
14	MH-004	RHC 1-114	VAV 1-114	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
15	MH-004	RHC 1-115	VAV 1-115	7,754	0.5	290	55	78	188	158	10x8	144	0.2	5
16	MH-004	RHC 1-116	VAV 1-116	11,497	0.8	430	55	78	188	158	11x10	144	0.2	5
17	MH-004	RHC 1-117	VAV 1-117	4,590	0.5	250	55	72	188	158	10x8	144	0.2	5
18	MH-004	RHC 1-118	VAV 1-118	17,915	1.2	670	55	78	188	158	11x10	144	0.2	5
19	MH-004	RHC 1-119	VAV 1-119	5,615	0.5	210	55	78	188	158	10x8	144	0.2	5
20	MH-004	RHC 1-121	VAV 1-121	11,765	0.8	440	55	78	188	158	10x8	144	0.2	5
21	MH-004	RHC 1-122	VAV 1-122	2,964	0.5	150	55	72	188	158	10x8	144	0.2	5
22	MH-004	RHC 1-123	VAV 1-123	7,486	0.5	280	55	78	188	158	11x10	144	0.2	5
23	MH-004	RHC 1-124	VAV 1-124	4,941	0.5	250	55	72	188	158	10x8	144	0.2	5
24	MH-004	RHC 1-125	VAV 1-125	6,324	0.5	320	55	72	188	158	11x10	144	0.2	5
25	MH-004	RHC 1-126	VAV 1-126	4,150	0.5	210	55	72	188	158	10x8	144	0.2	5
26	MH-004	RHC 1-127	VAV 1-127	1,383	0.5	70	55	72	188	158	10x8	144	0.2	5
27	MH-004	RHC 1-128	VAV 1-128	13,241	0.9	670	55	72	188	158	11x10	144	0.2	5
28	MH-004	RHC 1-129	VAV 1-129	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
29	MH-004	RHC 1-130	VAV 1-130	11,857	0.8	600	55	72	188	158	11x10	144	0.2	5
30	MH-004	RHC 1-131	VAV 1-131	17,589	1.2	890	55	72	188	158	19x18	144	0.2	5
31	MH-004	RHC 1-132	VAV 1-132	4,545	0.5	230	55	72	188	158	11x10	144	0.2	5
32	MH-004	RHC 1-201	VAV 1-201	1,976	0.5	100	55	72	188	158	10x8	144	0.2	5
33	MH-004	RHC 1-202	VAV 1-202	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
34	MH-004	RHC 1-203	VAV 1-203	4,545	0.5	230	55	72	188	158	11x10	144	0.2	5
35	MH-004	RHC 1-204	VAV 1-204	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
36	MH-004	RHC 1-205	VAV 1-205	7,114	0.5	360	55	72	188	158	11x10	144	0.2	5
37	MH-004	RHC 1-206	VAV 1-206	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
38	MH-004	RHC 1-207	VAV 1-207	3,359	0.5	170	55	72	188	158	11x10	144	0.2	5
39	MH-004	RHC 1-208	VAV 1-208	9,881	0.5	500	55	72	188	158	14x12	144	0.2	5
40	MH-004	RHC 1-209	VAV 1-209	8,102	0.7	410	55	72	188	158	11x10	144	0.2	5
41	MH-004	RHC 1-210	VAV 1-210	15,810	0.5	800	55	72	188	158	17x14	144	0.2	5
42	MH-004	RHC 1-211	VAV 1-211	17,193	1	870	55	72	188	158	17x14	144	0.2	5
43	MH-004	RHC 1-212	VAV 1-212	2,766	1.1	140	55	72	188	158	10x8	144	0.2	5
44	MH-004	RHC 1-213	VAV 1-213	6,324	0.5	320	55	72	188	158	10x8	144	0.2	5
45	MH-004	RHC 1-214	VAV 1-214	8,893	0.5	450	55	72	188	158	11x10	144	0.2	5
46	MH-004	RHC 1-216	VAV 1-216	3,162	0.5	390	55	72	188	158	11x10	144	0.2	5
47	MH-004	RHC 1-217	VAV 1-217	13,241	0.5	160	55	72	188	158	10x8	144	0.2	5
48	MH-004	RHC 1-218	VAV 1-218	12,450	0.9	670	55	72	188	158	14x12	144	0.2	5
49	MH-004	RHC 1-219	VAV 1-219	5,336	0.8	630	55	72	188	158	14x12	144	0.2	5
50	MH-004	RHC 1-220	VAV 1-220	7,114	0.5	270	55	72	188	158	10x8	144	0.2	5
51	MH-004	RHC 1-221	VAV 1-221	1,976	0.5	360	55	72	188	158	11x10	144	0.2	5
52	MH-004	RHC 1-222	VAV 1-222	6,917	0.5	100	55	72	188	158	10x8	144	0.2	5
53	MH-004	RHC 1-223	VAV 1-223	7,707	0.5	350	55	72	188	158	11x10	144	0.2	5
54	MH-004	RHC 1-224	VAV 1-224	2,569	0.5	380	55	72	188	158	11x10	144	0.2	5
55	MH-004	RHC 1-225	VAV 1-225	1,383	0.5	130	55	72	188	158	10x8	144	0.2	5
56	MH-004	RHC 1-226	VAV 1-226	13,834	0.5	70	55	72	188	158	10x8	144	0.2	5
57	MH-004	RHC 1-227	VAV 1-227	6,324	0.9	700	55	72	188	158	19x18	144	0.2	5
58	MH-004	RHC 2-101	VAV 2-101	6,324	0.5	320	55	72	188	158	11x10	144	0.2	5
59	MH-004	RHC 2-102	VAV 2-102	6,324	0.5	320	55	72	188	158	11x10	144	0.2	5
60	MH-004	RHC 2-103	VAV 2-103	4,347	0.5	220	55	72	188	158	11x10	144	0.2	5
61	MH-004	RHC 2-104	VAV 2-104	4,743	0.5	240	55	72	188	158	10x8	144	0.2	5
62	MH-004	RHC 2-105	VAV 2-105	1,383	0.7	70	55	72	188	158	10x8	144	0.2	5
63	MH-004	RHC 2-106	VAV 2-106	10,079	0.6	510	55	72	188	158	14x12	144	0.2	5
64	MH-004	RHC 2-107	VAV 2-107	9,358	0.5	350	55	78	188	158	10x8	144	0.2	5
65	MH-004	RHC 2-108	VAV 2-108	6,324	0.8	320	55	72	188	158	10x8	144	0.2	5
66	MH-004	RHC 2-109	VAV 2-109	11,497	0.8	430	55	78	188	158	11x10	144	0.2	5
67	MH-004	RHC 2-110	VAV 2-110	11,498	0.5	430	55	78	188	158	10x8	144	0.2	5
68	MH-004	RHC 2-111	VAV 2-111	6,719	0.8	340	55	72	188	158	10x8	144	0.2	5
69	MH-004	RHC 2-112	VAV 2-112	11,764	0.7	440	55	78	188	158	11x10	144	0.2	5

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
70	MH-004	RHC 2-113	VAV 2-113	10,869	0.8	550	55	72	188	158	11x10	144	0.2	5
71	MH-004	RHC 2-114	VAV 2-114	12,032	0.6	450	55	78	188	158	11x10	144	0.2	5
72	MH-004	RHC 2-115	VAV 2-115	8,556	0.5	320	55	78	188	158	11x10	144	0.2	5
73	MH-004	RHC 2-116	VAV 2-116	7,708	0.5	390	55	72	188	158	11x10	144	0.2	5
74	MH-004	RHC 2-118	VAV 2-118	7,510	0.5	380	55	72	188	158	11x10	144	0.2	5
75	MH-004	RHC 2-119	VAV 2-119	11,498	0.8	430	55	78	188	158	10x8	144	0.2	5
76	MH-004	RHC 2-120	VAV 2-120	2,964	0.5	150	55	72	188	158	10x8	144	0.2	5
77	MH-004	RHC 2-121	VAV 2-121	7,312	0.5	370	55	72	188	158	11x10	144	0.2	5
78	MH-004	RHC 2-122	VAV 2-122	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
79	MH-004	RHC 2-123	VAV 2-123	8,102	0.5	410	55	72	188	158	11x10	144	0.2	5
80	MH-004	RHC 2-124	VAV 2-124	5,534	0.5	280	55	72	188	158	11x10	144	0.2	5
81	MH-004	RHC 2-125	VAV 2-125	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
82	MH-004	RHC 2-126	VAV 2-126	13,241	0.9	670	55	72	188	158	11x10	144	0.2	5
83	MH-004	RHC 2-127	VAV 2-127	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
84	MH-004	RHC 2-128	VAV 2-128	11,857	0.8	600	55	72	188	158	14x12	144	0.2	5
85	MH-004	RHC 2-129	VAV 2-129	2,964	0.5	150	55	72	188	158	10x8	144	0.2	5
86	MH-004	RHC 2-130	VAV 2-130	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
87	MH-004	RHC 2-131	VAV 2-131	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
88	MH-004	RHC 2-201	VAV 2-201	10,079	0.7	510	55	72	188	158	17x14	144	0.2	5
89	MH-004	RHC 2-202	VAV 2-202	8,823	0.6	330	55	78	188	158	11x10	144	0.2	5
90	MH-004	RHC 2-203	VAV 2-203	8,823	0.6	330	55	78	188	158	11x10	144	0.2	5
91	MH-004	RHC 2-204	VAV 2-204	5,138	0.5	260	55	72	188	158	11x10	144	0.2	5
92	MH-004	RHC 2-205	VAV 2-205	10,079	0.7	510	55	72	188	158	11x10	144	0.2	5
93	MH-004	RHC 2-206	VAV 2-206	5,138	0.5	260	55	72	188	158	10x8	144	0.2	5
94	MH-004	RHC 2-207	VAV 2-207	3,952	0.5	200	55	72	188	158	10x8	144	0.2	5
95	MH-004	RHC 2-208	VAV 2-208	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
96	MH-004	RHC 2-209	VAV 2-209	8,300	0.5	420	55	72	188	158	11x10	144	0.2	5
97	MH-004	RHC 2-210	VAV 2-210	12,450	0.8	630	55	72	188	158	14x12	144	0.2	5
98	MH-004	RHC 2-211	VAV 2-211	10,427	0.7	390	55	78	188	158	11x10	144	0.2	5
99	MH-004	RHC 2-212	VAV 2-212	3,162	0.5	160	55	72	188	158	10x8	144	0.2	5
100	MH-004	RHC 2-213	VAV 2-213	4,743	0.5	240	55	72	188	158	10x8	144	0.2	5
101	MH-004	RHC 2-214	VAV 2-214	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
102	MH-004	RHC 2-215	VAV 2-215	12,567	0.8	470	55	78	188	158	11x10	144	0.2	5
103	MH-004	RHC 2-216	VAV 2-216	8,893	0.6	450	55	72	188	158	10x8	144	0.2	5
104	MH-004	RHC 2-217	VAV 2-217	9,091	0.6	460	55	72	188	158	10x8	144	0.2	5
105	MH-004	RHC 2-218	VAV 2-218	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
106	MH-004	RHC 2-219	VAV 2-219	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
107	MH-004	RHC 3-101	VAV 3-101	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
108	MH-004	RHC 3-102	VAV 3-102	12,032	0.8	450	55	78	188	158	11x10	144	0.2	5
109	MH-004	RHC 3-103	VAV 3-103	6,126	0.5	310	55	72	188	158	11x10	144	0.2	5
110	MH-004	RHC 3-104	VAV 3-104	6,719	0.5	340	55	72	188	158	11x10	144	0.2	5
111	MH-004	RHC 3-105	VAV 3-105	7,114	0.5	360	55	72	188	158	11x10	144	0.2	5
112	MH-004	RHC 3-106	VAV 3-106	8,823	0.6	330	55	78	188	158	11x10	144	0.2	5
113	MH-004	RHC 3-107	VAV 3-107	8,102	0.5	410	55	72	188	158	11x10	144	0.2	5
114	MH-004	RHC 3-109	VAV 3-109	8,695	0.6	440	55	72	188	158	11x10	144	0.2	5
115	MH-004	RHC 3-110	VAV 3-110	11,497	0.8	430	55	78	188	158	11x10	144	0.2	5
116	MH-004	RHC 3-111	VAV 3-111	6,521	0.5	330	55	72	188	158	11x10	144	0.2	5
117	MH-004	RHC 3-112	VAV 3-112	6,324	0.5	320	55	72	188	158	10x8	144	0.2	5
118	MH-004	RHC 3-113	VAV 3-113	10,079	0.7	510	55	72	188	158	11x10	144	0.2	5
119	MH-004	RHC 3-114	VAV 3-114	11,660	0.8	590	55	72	188	158	14x12	144	0.2	5
120	MH-004	RHC 3-115	VAV 3-115	12,032	0.8	450	55	78	188	158	11x10	144	0.2	5
121	MH-004	RHC 3-116	VAV 3-116	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
122	MH-004	RHC 3-117	VAV 3-117	5,731	0.5	290	55	72	188	158	11x10	144	0.2	5
123	MH-004	RHC 3-118	VAV 3-118	11,764	0.8	440	55	78	188	158	11x10	144	0.2	5
124	MH-004	RHC 3-119	VAV 3-119	7,754	0.5	290	55	78	188	158	10x8	144	0.2	5
125	MH-004	RHC 3-120	VAV 3-120	13,834	0.9	700	55	72	188	158	11x10	144	0.2	5
126	MH-004	RHC 3-121	VAV 3-121	6,521	0.5	330	55	72	188	158	10x8	144	0.2	5
127	MH-004	RHC 3-122	VAV 3-122	6,719	0.5	340	55	72	188	158	10x8	144	0.2	5
128	MH-004	RHC 3-123	VAV 3-123	4,150	0.5	210	55	72	188	158	10x8	144	0.2	5
129	MH-004	RHC 3-124	VAV 3-124	3,359	0.5	170	55	72	188	158	10x8	144	0.2	5
130	MH-004	RHC 3-125	VAV 3-125	10,672	0.7	540	55	72	188	158	10x8	144	0.2	5
131	MH-004	RHC 3-126	VAV 3-126	9,091	0.6	460	55	72	188	158	17x14	144	0.2	5
132	MH-004	RHC 3-128	VAV 3-128	5,347	0.5	200	55	78	188	158	19x18	144	0.2	5
133	MH-004	RHC 3-201	VAV 3-201	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
134	MH-004	RHC 3-202	VAV 3-202	5,928	0.5	300	55	72	188	158	11x10	144	0.2	5
135	MH-004	RHC 3-203	VAV 3-203	6,719	0.5	340	55	72	188	158	10x8	144	0.2	5
136	MH-004	RHC 3-204	VAV 3-204	5,928	0.5	300	55	72	188	158	11x10	144	0.2	5
137	MH-004	RHC 3-205	VAV 3-205	8,102	0.5	410	55	72	188	158	19x18	144	0.2	5
138	MH-004	RHC 3-206	VAV 3-206	5,928	0.5	300	55	72	188	158	11x10	144	0.2	5

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
139	MH-004	RHC 3-207	VAV 3-207	10,276	0.7	520	55	72	188	158	11x10	144	0.2	5
140	MH-004	RHC 3-208	VAV 3-208	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
141	MH-004	RHC 3-209	VAV 3-209	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
142	MH-004	RHC 3-211	VAV 3-211	7,114	0.5	360	55	72	188	158	11x10	144	0.2	5
143	MH-004	RHC 3-212	VAV 3-212	10,869	0.7	550	55	72	188	158	14x12	144	0.2	5
144	MH-004	RHC 3-213	VAV 3-213	5,533	0.5	280	55	72	188	158	17x14	144	0.2	5
145	MH-004	RHC 3-214	VAV 3-214	19,170	1.3	970	55	72	188	158	19x18	144	0.2	5
146	MH-004	RHC 3-215	VAV 3-215	12,055	0.8	610	55	72	188	158	14x12	144	0.2	5
147	MH-004	RHC 3-216	VAV 3-216	5,533	0.5	280	55	72	188	158	11x10	144	0.2	5
148	MH-004	RHC 3-217	VAV 3-217	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
149	MH-004	RHC 3-218	VAV 3-218	6,521	0.5	330	55	72	188	158	11x10	144	0.2	5
150	MH-004	RHC 3-219	VAV 3-219	14,229	0.9	720	55	72	188	158	17x14	144	0.2	5
151	MH-004	RHC 3-220	VAV 3-220	14,427	1	730	55	72	188	158	14x12	144	0.2	5
152	MH-004	RHC 3-221	VAV 3-221	7,707	0.5	390	55	72	188	158	11x10	144	0.2	5
153	MH-004	RHC 3-222	VAV 3-222	6,917	0.5	350	55	72	188	158	14x12	144	0.2	5
154	MH-004	RHC 3-223	VAV 3-223	4,940	0.5	250	55	72	188	158	10x8	144	0.2	5
155	MH-004	RHC 4-101	VAV 4-101	7,510	0.5	380	55	72	188	158	14x12	144	0.2	5
156	MH-004	RHC 4-102	VAV 4-102	11,462	0.8	580	55	72	188	158	14x12	144	0.2	5
157	MH-004	RHC 4-103	VAV 4-103	5,533	0.5	280	55	72	188	158	11x10	144	0.2	5
158	MH-004	RHC 4-104	VAV 4-104	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
159	MH-004	RHC 4-106	VAV 4-106	3,953	0.5	200	55	72	188	158	11x10	144	0.2	5
160	MH-004	RHC 4-107	VAV 4-107	17,391	1.1	880	55	72	188	158	17x14	144	0.2	5
161	MH-004	RHC 4-108	VAV 4-108	7,114	0.5	360	55	72	188	158	10x8	144	0.2	5
162	MH-004	RHC 4-109	VAV 4-109	28,656	1.9	1450	55	72	188	158	19x18	144	0.2	5
163	MH-004	RHC 4-110	VAV 4-110	1,976	0.5	100	55	72	188	158	10x8	144	0.2	5
164	MH-004	RHC 4-111	VAV 4-111	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
165	MH-004	RHC 4-112	VAV 4-112	4,328	0.5	220	55	72	188	158	10x8	144	0.2	5
166	MH-004	RHC 4-113	VAV 4-113	4,743	0.5	240	55	72	188	158	10x8	144	0.2	5
167	MH-004	RHC 4-114	VAV 4-114	17,193	1.1	870	55	72	188	158	17x14	144	0.2	5
168	MH-004	RHC 4-115	VAV 4-115	12,451	0.8	630	55	72	188	158	11x10	144	0.2	5
169	MH-004	RHC 4-116	VAV 4-116	3,359	0.5	170	55	72	188	158	10x8	144	0.2	5
170	MH-004	RHC 4-117	VAV 4-117	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
171	MH-004	RHC 4-118	VAV 4-118	1,581	0.5	80	55	72	188	158	10x8	144	0.2	5
172	MH-004	RHC 4-119	VAV 4-119	3,755	0.5	190	55	72	188	158	10x8	144	0.2	5
173	MH-004	RHC 4-120	VAV 4-120	3,359	0.5	170	55	72	188	158	10x8	144	0.2	5
174	MH-004	RHC 4-121	VAV 4-121	830	0.5	80	55	65	188	158	11x10	144	0.2	5
175	MH-004	RHC 4-122	VAV 4-122	8,289	0.6	470	55	72	188	158	14x12	144	0.2	5
176	MH-004	RHC 4-201	VAV 4-201	35,968	2.4	1820	55	72	188	158	23x18	144	0.2	5
177	MH-004	RHC 4-202	VAV 4-202	32,260	2.1	1850	55	70	188	158	17x14	144	0.2	5
178	MH-004	RHC 4-203	VAV 4-203	4,940	0.5	250	55	72	188	158	11x10	144	0.2	5
179	MH-004	RHC 4-205	VAV 4-205	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
180	MH-004	RHC 4-206	VAV 4-206	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
181	MH-004	RHC 4-207	VAV 4-207	3,755	0.5	190	55	72	188	158	10x8	144	0.2	5
182	MH-004	RHC 4-208	VAV 4-208	71,984	4.7	860	55	72	188	158	27x18	144	0.2	5
183	MH-004	RHC 4-209	VAV 4-209	14,229	0.9	720	55	72	188	158	17x14	144	0.2	5
184	MH-004	RHC 4-210	VAV 4-210	10,672	0.7	540	55	72	188	158	14x12	144	0.2	5
185	MH-004	RHC 4-211	VAV 4-211	7,707	0.5	390	55	72	188	158	19x18	144	0.2	5
186	MH-004	RHC 4-212	VAV 4-212	19,565	1.3	990	55	72	188	158	19x18	144	0.2	5
187	MH-004	RHC 4-213	VAV 4-213	8,300	0.5	420	55	72	188	158	11x10	144	0.2	5
188	MH-004	RHC 4-214	VAV 4-214	10,672	0.7	540	55	72	188	158	14x12	144	0.2	5
189	MH-004	RHC 4-215	VAV 4-215	20,158	0.9	720	55	72	188	158	17x14	144	0.2	5
190	MH-004	RHC 4-216	VAV 4-216	10,474	0.7	530	55	72	188	158	11x10	144	0.2	5
191	MH-004	RHC 4-217	VAV 4-217	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
192	MH-004	RHC 4-218	VAV 4-218	4,940	0.5	250	55	72	188	158	10x8	144	0.2	5
193	MH-004	RHC 4-219	VAV 4-219	2,173	0.5	110	55	72	188	158	10x8	144	0.2	5
194	MH-004	RHC 4-220	VAV 4-220	1,976	0.5	100	55	72	188	158	10x8	144	0.2	5
195	MH-004	RHC 4-221	VAV 4-221	1,976	0.5	170	55	72	188	158	10x8	144	0.2	5
196	MH-004	RHC 4-222	VAV 4-222	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
197	MH-004	RHC 4-223	VAV 4-223	14,822	1	750	55	72	188	158	11x10	144	0.2	5
198	MH-004	RHC 4-224	VAV 4-224	27,866	1.8	1410	55	72	188	158	17x14	144	0.2	5
199	MH-004	RHC 4-225	VAV 4-225	12,648	0.8	640	55	72	188	158	14x12	144	0.2	5
200	MH-004	RHC 4-227	VAV 4-227	7,312	0.5	370	55	72	188	158	11x10	144	0.2	5
201	MH-004	RHC 4-228	VAV 4-228	6,126	0.5	310	55	72	188	158	19x18	144	0.2	5
202	MH-004	RHC 4-229	VAV 4-229	4,940	0.5	250	55	72	188	158	11x10	144	0.2	5
203	MH-004	RHC 5-101	VAV 5-101	19,170	1.3	970	55	72	188	158	17x14	144	0.2	5
204	MH-004	RHC 5-102	VAV 5-102	4,150	1.3	210	55	72	188	158	10x8	144	0.2	5
205	MH-004	RHC 5-103	VAV 5-103	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
206	MH-004	RHC 5-104	VAV 5-104	23,188	0.5	1240	55	72	188	158	14x12	144	0.2	5
207	MH-004	RHC 5-105	VAV 5-105	9,683	1.7	710	55	72	188	158	14x12	144	0.2	5

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
208	MH-004	RHC 5-106	VAV 5-106	5,882	0.9	220	55	78	188	158	10x8	144	0.2	5
209	MH-004	RHC 5-107	VAV 5-107	12,648	0.5	640	55	72	188	158	11x10	144	0.2	5
210	MH-004	RHC 5-108	VAV 5-108	8,893	0.8	450	55	72	188	158	11x10	144	0.2	5
211	MH-004	RHC 5-109	VAV 5-109	5,336	0.6	270	55	72	188	158	10x8	144	0.2	5
212	MH-004	RHC 5-110	VAV 5-110	8,102	0.5	410	55	72	188	158	11x10	144	0.2	5
213	MH-004	RHC 5-111	VAV 5-111	2,569	0.5	130	55	72	188	158	10x8	144	0.2	5
214	MH-004	RHC 5-112	VAV 5-112	8,556	0.5	320	55	78	188	158	11x10	144	0.2	5
215	MH-004	RHC 5-113	VAV 5-113	8,556	0.6	320	55	78	188	158	14x12	144	0.2	5
216	MH-004	RHC 5-114	VAV 5-114	7,510	0.6	380	55	72	188	158	17x14	144	0.2	5
217	MH-004	RHC 5-115	VAV 5-115	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
218	MH-004	RHC 5-116	VAV 5-116	3,162	0.5	160	55	72	188	158	10x8	144	0.2	5
219	MH-004	RHC 5-117	VAV 5-117	5,138	0.5	260	55	72	188	158	10x8	144	0.2	5
220	MH-004	RHC 5-118	VAV 5-118	813	0.5	70	55	65	188	158	11x10	144	0.2	5
221	MH-005	RHC 5-201	VAV 5-201	3,557	0.5	180	55	72	188	158		144	0.2	5
222	MH-005	RHC 5-202	VAV 5-202	5,533	0.5	280	55	72	188	158		144	0.2	5
223	MH-005	RHC 5-203	VAV 5-203	1,976	0.5	100	55	72	188	158		144	0.2	5
224	MH-005	RHC 5-204	VAV 5-204	4,940	0.5	250	55	72	188	158		144	0.2	5
225	MH-005	RHC 5-205	VAV 5-205	17,589	1.2	890	55	72	188	158		144	0.2	5
226	MH-005	RHC 5-206	VAV 5-206	2,371	0.5	120	55	72	188	158		144	0.2	5
227	MH-005	RHC 5-207	VAV 5-207	16,601	1.1	840	55	72	188	158		144	0.2	5
228	MH-005	RHC 5-208	VAV 5-208	13,438	0.9	680	55	72	188	158		144	0.2	5
229	MH-005	RHC 5-209	VAV 5-209	3,952	0.5	200	55	72	188	158		144	0.2	5
230	MH-005	RHC 5-210	VAV 5-210	14,229	0.9	720	55	72	188	158		144	0.2	5
231	MH-005	RHC 5-211	VAV 5-211	11,462	0.8	690	55	72	188	158		144	0.2	5
232	MH-005	RHC 5-212	VAV 5-212	3,952	0.5	200	55	72	188	158		144	0.2	5
233	MH-005	RHC 5-213	VAV 5-213	18,775	1.2	950	55	72	188	158		144	0.2	5
234	MH-005	RHC 5-214	VAV 5-214	4,545	0.5	230	55	72	188	158		144	0.2	5
235	MH-005	RHC 5-215	VAV 5-215	3,162	0.5	160	55	72	188	158		144	0.2	5
236	MH-005	RHC 5-216	VAV 5-216	3,359	0.5	170	55	72	188	158		144	0.2	5
237	MH-005	RHC 5-218	VAV 5-218	3,162	0.5	160	55	72	188	158		144	0.2	5
238	MH-005	RHC 5-219	VAV 5-219	1,778	0.5	90	55	72	188	158		144	0.2	5
239	MH-005	RHC 5-220	VAV 5-220	29,644	2.1	1500	55	72	188	158		144	0.2	5
240	MH-005	RHC 5-221	VAV 5-221	8,300	0.5	420	55	72	188	158		144	0.2	5
241	MH-005	RHC 5-222	VAV 5-222	23,715	1.6	1200	55	72	188	158		144	0.2	5
242	MH-005	RHC 5-223	VAV 5-223	5,533	0.5	280	55	72	188	158		144	0.2	5
243	MH-005	RHC 5-224	VAV 5-224	1,778	0.5	90	55	72	188	158		144	0.2	5
244	MH-005	RHC 7-201	VAV 7-201	3,952	0.5	200	55	72	188	158		144	0.2	5
245	MH-005	RHC 7-202	VAV 7-202	15,217	1.4	770	55	72	188	158		144	0.2	5
246	MH-005	RHC 7-203	VAV 7-203	6,324	0.5	320	55	72	188	158		144	0.2	5
247	MH-005	RHC 7-204	VAV 7-204	2,171	0.5	120	55	72	188	158		144	0.2	5
248	MH-005	RHC 7-205	VAV 7-205	28,050	2	1500	55	72	188	158		144	0.2	5
249	MH-005	RHC 7-206	VAV 7-206	6,170	0.5	230	55	72	188	158		144	0.2	5
250	MH-005	RHC 7-208	VAV 7-208	12,648	0.8	640	55	72	188	158		144	0.2	5
251	MH-005	RHC 7-209	VAV 7-209	11,660	0.8	580	55	72	188	158		144	0.2	5
252	MH-005	RHC 7-210	VAV 7-210	19,368	1.4	1030	55	72	188	158		144	0.2	5
253	MH-005	RHC 8-101	VAV 8-101	47,347	3.1	1630	55	80	188	158		144	0.2	5
254	MH-005	RHC 8-102	VAV 8-102	25,576	1.8	880	55	80	188	158		144	0.2	5
255	MH-005	RHC 8-103	VAV 8-103	9,782	0.6	490	55	72	188	158		144	0.2	5
256	MH-005	RHC 8-104	VAV 8-104	10,927	0.7	470	55	72	188	158		144	0.2	5
257	MH-005	RHC 8-105	VAV 8-105	1,779	0.5	90	55	72	188	158		144	0.2	5
258	MH-005	RHC 8-106	VAV 8-106	2,964	0.5	150	55	72	188	158		144	0.2	5
259	MH-005	RHC 8-107	VAV 8-107	3,952	0.5	200	55	72	188	158		144	0.2	5
260	MH-005	RHC 8-108	VAV 8-108	3,360	0.6	400	55	75	188	158		144	0.2	5
261	MH-005	RHC 8-109	VAV 8-109	13,718	0.9	590	55	75	188	158		144	0.2	5
262	MH-005	RHC 8-110	VAV 8-110	7,207	0.5	310	55	75	188	158		144	0.2	5
263	MH-005	RHC 8-111	VAV 8-111	9,765	0.6	420	55	75	188	158		144	0.2	5
264	MH-005	RHC 8-112	VAV 8-112	3,162	0.5	160	55	72	188	158		144	0.2	5
265	MH-005	RHC 8-113	VAV 8-113	6,685	0.5	250	55	78	188	158		144	0.2	5
266	MH-005	RHC 8-114	VAV 8-114	6,952	0.5	260	55	78	188	158		144	0.2	5
267	MH-005	RHC 8-115	VAV 8-115	9,998	0.7	430	55	75	188	158		144	0.2	5
268	MH-005	RHC 9-101	VAV 9-101	9,091	0.6	460	55	72	188	158		144	0.2	5
269	MH-005	RHC 9-102	VAV 9-102	40,119	2.6	2030	55	72	188	158		144	0.2	5
270	MH-005	RHC 9-103	VAV 9-103	8,695	0.6	440	55	72	188	158		144	0.2	5

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AHU-8 DUCT & AIR VALVE SCHEDULE																	
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out (in w.c.)	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)	Note
1	MH-010	8-005	AHU-8	7940	4878	Round	26	2.94	0								
2	MH-010	8-100	8-005	3700	2094	Round	18	2.58	2								Variable Vol. Air Valve
3	MH-010	8-105	8-100	650	1802	Round	8	2.44	1	SAV 8-115	650	430	430	0.6	0.5	35	
4	MH-010	8-110	8-100	3050	2184	Round	16	2.35	4								Constant Vol. Air Valve
5	MH-010	8-115	8-110	420	2189	Round	6	2.3	0	SAV 8-111	420	420	420	0.6	0.5	35	
6	MH-010	8-120	8-110	2630	2460	Round	14	2.08	0								Variable Vol. Air Valve
7	MH-010	8-125	8-120	440	2241	Round	6	1.88	0	SAV 8-113	440	250	250	0.6	0.5	35	
8	MH-010	8-130	8-120	2190	2049	Round	14	2.12	0								Variable Vol. Air Valve
9	MH-010	8-135	8-130	440	2241	Round	6	1.95	0	SAV 8-114	440	260	260	0.6	0.5	35	Variable Vol. Air Valve
10	MH-010	8-140	8-130	290	2127	Round	5	1.3	0	SAV 8-112	290	160	160	0.6	0.5	35	
11	MH-010	8-145	8-130	1460	1859	Round	12	1.87	5								Constant Vol. Air Valve
12	MH-010	8-150	8-145	490	2496	Round	6	1.58	0	SAV 8-103	490	490	490	0.6	0.5	35	Two-Position Air Valve
13	MH-010	8-155	8-145	880	1778	Round	10	1.83	1	SAV 8-102	660	350	350	0.6	0.5	35	
14	MH-010	8-200	8-005	4330	2450	Round	10	2.5	0								
15	MH-010	8-205	8-200	2750	1970	Round	16	2.53	1								Constant Vol. Air Valve
16	MH-010	8-210	8-205	200	2252	Round	4	2.3	0	SAV 8-107	200	200	200	0.6	0.5	35	
17	MH-010	8-215	8-205	2550	2385	Round	14	2.27	0								Constant Vol. Air Valve
18	MH-010	8-220	8-215	150	1719	Round	4	2.36	0	SAV 8-106	150	150	150	0.6	0.5	35	Constant Vol. Air Valve
19	MH-010	8-225	8-215	470	2394	Round	6	1.94	1	SAV 8-104	470	470	470	0.6	0.5	35	
20	MH-010	8-230	8-215	1930	2457	Round	12	2.11	0								Variable Vol. Air Valve
21	MH-010	8-235	8-230	300	2200	Round	5	2.04	0	SAV 8-105	300	90	90	0.6	0.5	35	Two-Position Air Valve
22	MH-010	8-240	8-230	1630	2075	Round	12	2.18	0	SAV 8-101	1220	650	650	0.6	0.5	35	
23	MH-010	8-245	8-200	1580	2012	Round	12	2.46	0								Variable Vol. Air Valve
24	MH-010	8-250	8-245	870	2492	Round	8	2.19	0	SAV 8-109	870	590	590	0.6	0.5	35	
25	MH-010	8-255	8-245	710	2034	Round	8	2.4	0								Constant Vol. Air Valve
26	MH-010	8-260	8-255	400	2037	Round	6	2.18	0	SAV 8-108	400	400	400	0.6	0.5	35	Constant Vol. Air Valve
27	MH-010	8-265	8-255	310	2274	Round	5	2.48	0	SAV 8-110	310	310	310	0.6	0.5	35	Two-Position Air Valve

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EF-9 DUCT & AIR VALVE SCHEDULE (replaces EF-11 schedule)																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out (in w.c.)	Elbow Quanitity	Unit #	CFM MAX	CFM MIN	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)	Note
1	MH-010	11-005	EF-11	7105	2349	Round	24	1.33	2							
2	MH-010	11-100	11-005	2760	1977	Round	16	1.1	0							
3	MH-010	11-105	11-100	950	1742	Round	10	1.13	0							
4	MH-010	11-110	11-105	490	2496	Round	6	0.78	0	EAV 8-111	490	490	0.6	0.5	35	Constant Vol. Air Valve
5	MH-010	11-115	11-105	460	2343	Round	6	0.66	0							
6	MH-010	11-116	11-115	200	2292	Round	4	0.52	0	EAV 8-116	200	200	0.6	0.5	35	Constant Vol. Air Valve
7	MH-010	11-117	11-115	260	1907	Round	5	0.53	3	EAV 8-112	260	140	0.6	0.5	35	Variable Vol. Air Valve
8	MH-010	11-120	11-100	1810	2305	Round	12	0.87	0							
9	MH-010	11-125	11-120	430	2190	Round	6	0.74	0	EAV 8-115	430	390	0.6	0.5	35	Variable Vol. Air Valve
10	MH-010	11-130	11-120	1380	1757	Round	12	0.94	1							
11	MH-010	11-135	11-130	280	2053	Round	5	0.72	1	EAV 8-110	280	280	0.6	0.5	35	Constant Vol. Air Valve
12	MH-010	11-140	11-130	1100	2017	Round	10	0.63	4							
13	MH-010	11-145	11-140	740	2120	Round	8	0.47	0	EAV 8-109	740	530	0.6	0.5	35	Variable Vol. Air Valve
14	MH-010	11-150	11-140	360	1833	Round	6	0.61	0	EAV 8-108	360	360	0.6	0.5	35	Constant Vol. Air Valve
15	MH-010	11-200	11-005	4625	2120	Round	20	0.98	2							
16	MH-010	11-205	11-200	2180	2039	Round	14	0.85	1							
17	MH-010	11-210	11-205	300	2200	Round	5	0.61	0	EAV 8-107	300	300	0.6	0.5	35	Constant Vol. Air Valve
18	MH-010	11-215	11-205	1880	2394	Round	12	0.59	0							
19	MH-010	11-220	11-215	140	1604	Round	4	0.7	0	EAV 8-106	140	140	0.6	0.5	35	Constant Vol. Air Valve
20	MH-010	11-225	11-215	1740	2215	Round	12	0.57	0							
21	MH-010	11-230	11-225	270	1980	Round	5	0.41	0	EAV 8-105	270	80	0.6	0.5	35	Variable Vol. Air Valve
22	MH-010	11-235	11-225	1320	1872	Round	12	0.63	0	EAV 8-101	1320	520	0.6	0.5	35	Two-Position Air Valve
23	MH-010	11-240	11-200	2445	2287	Round	14	0.79	0							
24	MH-010	11-245	11-240	330	2420	Round	5	0.43	1	EAV 8-113	330	230	0.6	0.5	35	Variable Vol. Air Valve
25	MH-010	11-250	11-240	2115	1978	Round	14	0.81	0							
26	MH-010	11-255	11-250	330	2420	Round	5	0.4	1	EAV 8-114	330	230	0.6	0.5	35	Variable Vol. Air Valve
27	MH-010	11-260	11-250	1785	2273	Round	12	0.64	0							
28	MH-010	11-265	11-260	495	1418	Round	8	0.59	1	EAV 8-103	495	495	0.6	0.5	35	Constant Vol. Air Valve
29	MH-010	11-270	11-260	1290	2365	Round	10	0.53	0							
30	MH-010	11-275	11-270	420	2139	Round	6	0.45	0	EAV 8-104	420	420	0.6	0.5	35	Constant Vol. Air Valve
31	MH-010	11-280	11-270	710	2492	Round	8	0.43	0	EAV 8-102	710	280	0.6	0.5	35	Two-Position Air Valve

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DUCT PRESSURE CLASS SCHEDULE				
#	Unit #	Service	Positive (P) or Negative (N) Pressure	Minimum Pressure Class (W.G. IN)
1	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	OSA PLENUM	N	1
2	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	SUPPLY TO VAV BOX	P	3
3	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	VAV BOX TO DIFFUSER	P	1
4	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	RETURN DUCT	N	2
5	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	RELIEF PLENUM	P	1
6	AHU-6, AHU-11	OSA INTAKE	N	1
7	AHU-6, AHU-11	SUPPLY DUCT	P	2
8	AHU-6, AHU-11	RETURN DUCT	N	2
9	AHU-6, AHU-11	RELIEF DUCT	P	1
10	AHU-7, AHU-9	OSA INTAKE	N	1
11	AHU-7, AHU-9	SUPPLY TO VAV BOX	P	3
12	AHU-7, AHU-9	VAV BOX TO DIFFUSER	P	1
13	AHU-8	OSA PLENUM	P&N	1
14	AHU-8	SUPPLY TO AIR VALVE	P	4
15	AHU-8	AIR VALVE TO DIFFUSER	P	1
16	AHU-10	OSA INTAKE	N	1
17	AHU-10	SUPPLY DUCT	P	2
18	EF-1, EF-2, EF-3, EF-4, EF-5, EF-12	EXHAUST DUCT	N	2
19	EF-1, EF-2, EF-3, EF-4, EF-5, EF-12	EXHAUST DISCHARGE	P	2
20	EF-6	EXHAUST DUCT	N	3
21	EF-7, EF-8, EF-9, EF-10, EF-11	EXHAUST DUCT	N	3
22	EF-7, EF-8, EF-9, EF-10, EF-11	EXHAUST DISCHARGE	P	2
23	EF-13, EF-14	EXHAUST DUCT	N	2
24	EF-13, EF-14	EXHAUST DISCHARGE	P	2

VISN 20 Alaska: Equipment List

DIFFUESER / REGISTER / GRILLE SCHEDULE									
#	Designation	Type	Face Size or Length	Inlet/ Neck Size	Throw Direction	Max APD (In W.C.)	Max NC Rating	Material	Note
1	SA	Supply Slot Diffuser	48"	6"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
2	SB	Supply Slot Diffuser	48"	8"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
3	SC	Supply Slot Diffuser	48"	10"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
4	SD	Supply Slot Diffuser	48"	12"	See Plans	0.1	30	Steel	Provide 4 Slots, 1" Width. Inlect Connection is Oval.
5	SE	Supply Slot Diffuser	24"	8"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
6	SF	Supply Slot Diffuser	24"	10"	See Plans	0.1	30	Steel	Provide 4 Slots, 1" Width. Inlect Connection is Oval.
7	SG	Supply Grill	24" X 24"	6"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
8	SH	Supply Grill	24" X 24"	8"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
9	SI	Supply Grill	24" X 24"	10"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
10	SJ	Supply Grill	24" X 24"	12"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
11	SK	Supply Grill	24" X 24"	14"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
12	SL	Supply Grill	24" X 24"	16"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
13	SN	Spot Diffuser	10"%%c	27" X 14"	See Plans	0.1	30	Aluminum	Dual Round Spot Diffusers With Rotatable Body Capable Of 30%/d-Rotation From CL.
14	SO	Supply Grill	48"	48" X 6"	See Plans	0.15	30	Aluminum	Linear Bar Grille, 1/2" Spacing, 1/4" Bars, 0%/d Deflection, 200 CFM/FT At 0.06 IN W.C.
15	SP	Supply Grill	42" X 14"	40" X 12"	See Plans	0.1	30	Aluminum	Drum Louver.
16	SQ	Supply Grill	20" X 8"	18" X 6"	See Plans	0.1	30	Aluminum	Drum Louver.
17	SR	Supply Grill	36"	36" X 4"	See Plans	0.1	30	Aluminum	Linear Bar Grille, 1/2" Spacing, 1/4" Bars, 0%/d Deflection, 120 CFM/FT At 0.06 IN W.C.
18	SS	Supply Grill	36" X 42"	36" X 42"	See Plans	0.12	45	Steel	Surface Mount. 3/4" Blade Spacing.
19	ST	Supply Grill	48" X 42"	48" X 42"	See Plans	0.12	45	Steel	Surface Mount. 3/4" Blade Spacing.
20	SU	Supply Grill	12" X 12"	6"	See Plans	0.1	30	Steel	Perforated Grille. Surface Mount.
21	SV	Supply Grill	24" X 48"	8"	Laminar	0.1	30	Stainless Steel	Surface Mount.
22	SW	Supply Grill	12" X 48"	6"	[16]	0.1	30	Stainless Steel	Surface Mount.
23	SX	Supply Grill	12" X 72"	6"	[16]	0.1	30	Stainless Steel	Surface Mount.
24	SY	Supply Grill	12" X 66"	8"	[16]	0.1	30	Stainless Steel	Surface Mount.
25	SZ	Supply Grill	12" X 72"	8"	[16]	0.1	30	Stainless Steel	Surface Mount.
26	SAA	Supply Grill	24" X 24"	10"	See Plans	0.1	30	Stainless Steel	Perforated Grille. Lay-in.
27	EA	Exhaust Grille	24" X 24"	6"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
28	EB	Exhaust Grille	24" X 24"	8"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
29	EC	Exhaust Grille	24" X 24"	10"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
30	ED	Exhaust Grille	24" X 24"	12"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
31	EE	Exhaust Grille	24" X 24"	14"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
32	EF	Exhaust Grille	24" X 24"	16"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
33	EG	Exhaust Grille	24" X 24"	18" X 18"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.

#	Designation	Type	Face Size or Length	Inlet/ Neck Size	Throw Direction	Max APD (In W.C.)	Max NC Rating	Material	Note
34	EH	Exhaust Grille	8" X 8"	6" X 6"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
35	EI	Exhaust Grille	10" X 10"	8" X 8"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
36	EJ	Exhaust Grille	12" X 12"	10" X 10"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
37	EK	Exhaust Grille	14" X 14"	12" X 12"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
38	EL	Exhaust Grille	18" X 18"	16" X 16"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
39	EM	Exhaust Grille	20" X 20"	18" X 18"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
40	EN	Exhaust Grille	16" X 16"	14" X 14"	N/A	0.1	30	Stainless Steel	Perforated Grille. 3/4" Blade Spacing.
41	EO	Exhaust Grille	14" X 14"	12" X 12"	N/A	0.1	30	Stainless Steel	Perforated Grille. 3/4" Blade Spacing.
42	RA	Return Grille	24" X 24"	6"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
43	RB	Return Grille	24" X 24"	8"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
44	RC	Return Grille	24" X 24"	10"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
45	RD	Return Grille	24" X 24"	12"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
46	RE	Return Grille	24" X 24"	14"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
47	RF	Return Grille	24" X 24"	16"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
48	RG	Return Grille	24" X 24"	18" X 18"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
49	RH	Return Grille	8" X 8"	6" X 6"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
50	RI	Return Grille	10" X 10"	8" X 8"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
51	RJ	Return Grille	12" X 12"	10" X 10"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
52	RK	Return Grille	14" X 14"	12" X 12"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
53	RL	Return Grille	18" X 18"	16" X 16"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
54	RM	Return Grille	20" X 20"	18" X 18"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
55	RN	Return Grille	60"	60" X 6"	See Plans	0.1	30	Aluminum	Linear Bar Grille, 1/2" Spacing, 1/4" Bars, 0%%d Deflection, 200 CFM/FT At 0.06 IN W.C.
56	RO	Return Grille	26" X 26"	24" X 24"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
57	RP	Return Grille	50" X 26"	48" X 24"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
58	RQ	Return Grille	14" X 10"	12" X 8"	N/A	0.1	30	Steel	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
59	RR	Return Slot	48"	6" X 46"	N/A	0.1	30	Steel	Provide 4 Slots, 1" Width. Surface Mounts.
60	TA	Transfer Grille	24" X 24"	6" X 6"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
61	TB	Transfer Grille	24" X 24"	8" X 8"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
62	TC	Transfer Grille	24" X 24"	10" X 10"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
63	TD	Transfer Grille	24" X 24"	12" X 12"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
64	TE	Transfer Grille	24" X 24"	14" X 14"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
65	TF	Transfer Grille	24" X 24"	16" X 16"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
66	TG	Transfer Grille	24" X 24"	18" X 18"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
67	TH	Transfer Grille	8" X 8"	6" X 6"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
68	TI	Transfer Grille	10" X 10"	8" X 8"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.

#	Designation	Type	Face Size or Length	Inlet/ Neck Size	Throw Direction	Max APD (In W.C.)	Max NC Rating	Material	Note
69	TJ	Transfer Grille	12" X 12"	10" X 10"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
70	TK	Transfer Grille	14" X 14"	12" X 12"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
71	TL	Transfer Grille	18" X 18"	16" X 16"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
72	TM	Transfer Grille	20" X 20"	18" X 18"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.

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FINNED TUBE SCHEDULE							
#	Draw #	Tag ID	Btu/LF	EGT	LGT	Fins/Ft	Notes
1	MH003	FTR-1	1340	188	158	60	
2	MH003	FTR-2	1040	188	158	60	8
3	MH003	FTR-3	1340	188	158	60	5
4	MH003	FTR-4	1340	188	158	48	
5	MH003	FTR-5	1340	188	158	48	7
6	MH003	FTR-6	1040	188	158	60	8

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TERMINAL HEATING UNIT SCHEDULE											
#	Draw #	Tag ID	MBH	Hp	CFM Rated	EGT	LGT	Volt	Ph	RPM	Notes
1	MH003	UH-1	3.9	0.04	280	188	158	120	1		
2	MH003	UH-2	18.3	0.05	815	188	158	120	1		
3	MH003	UH-3	55.46	0.17	1760	188	158	120	1		
4	MH003	CUH-1	58.1	0.07	623	188	158	120	1	925	
5	MH003	CUH-2	73.4	0.07	786	188	158	120	1	935	7
6	MH003	CUH-3	21.2	0.07	245	188	158	120	1	750	
7	MH003	CUH-4	48.9	0.07	574	188	158	120	1	925	
8	MH003	CUH-5	131	1.00	3624	188	158	120	1		
9	MH003	RCP-1	1.68			188	158				5
10	MH003	EUH-1	3 kW	0.04	400			240	1	1550	6

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EXHAUST HOOD SCHEDULE								
#	Draw #	Tag ID	Location	Serves	Size W X L (IN)	Exhaust Air CFM	Exhaust Air Fan No.	Note
1	MH-010	EH-1	Sub Sterile 1D223	Autoclave	36 X 18	490	EF-10	Capture hood and associated ductwork to be stainless steel.
2	MH-010	EH-2	Lab 2B147	Dental Lab	36 X 30	770	EF-8	Capture hood and associated ductwork to be stainless steel.
3	MH-010	EH-3	Lab 2B147	Dental Lab	36 X 48	580	EF-8	Capture hood and associated ductwork to be stainless steel.
4	MH-010	EH-4	Canteen 2B10	Kitchen	42 X 84	2100	EF-6	Capture hood and associated ductwork to be stainless steel. Provide commercial kitchen hood: type 1, medium duty wall mounted canopywith water wahs and wet chemical fire suppresion system.

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FILTER SCHEDULE								
#	Draw #	Tag ID	Serves	%Eff	CFM Rated	VA Grade	MAX APD-Final	PD (in w.c.)
1	MH-007	F-1	AHU-1	30%	32540	D	1	0.33
2	MH-007	F-2	AHU-1	85%	32540	B	1.2	0.6
3	MH-007	F-3	AHU-2	30%	33040	D	1	0.33
4	MH-007	F-4	AHU-2	85%	33040	B	1.2	0.6
5	MH-007	F-5	AHU-3	30%	32040	D	1	0.33
6	MH-007	F-6	AHU-3	85%	32040	B	1.2	0.6
7	MH-007	F-7	AHU-4	30%	35870	D	1	0.33
8	MH-007	F-8	AHU-4	85%	35870	B	1.2	0.6
9	MH-007	F-9	AHU-5	30%	28540	D	1	0.33
10	MH-007	F-10	AHU-5	85%	28540	B	1.2	0.6
11	MH-007	F-11	AHU-6	30%	12480	D	1	0.33
12	MH-007	F-12	AHU-6	60%	12480	C	1.2	0.4
13	MH-007	F-13	AHU-7	30%	7230	D	1	0.33
14	MH-007	F-14	AHU-7	30%	7230	C	1.2	0.4
15	MH-007	F-15	AHU-7	85%	7230	B	1.2	0.6
16	MH-007	F-16	AHU-8	30%	7890	D	1	0.33
17	MH-007	F-17	AHU-8	30%	7890	D	1	0.33
18	MH-007	F-18	AHU-8	95%	7890	A	1.2	0.75
19	MH-007	F-19	AHU-9	30%	3050	D	1	0.33
20	MH-007	F-20	AHU-9	30%	3050	D	1	0.33
21	MH-007	F-21	AHU-9	85%	3050	B	1.2	0.6
22	MH-007	F-22	AHU-10	30%	18223	D	1	0.33
23	MH-007	F-23	AHU-11	30%	4970	D	1	0.33
24	MH-007	F-24	EF-13	30%	500	D	1	0.33
25	MH-007	F-25	EF-13	100%	500	HEPA	2	1
26	MH-007	F-26	EF-14	30%	500	D	1	0.33
27	MH-007	F-27	EF-14	100%	500	HEPA	2	1
28	MH-007	F-28	SAV 8-101	95%	1220	A	1	0.33
29	MH-007	F-29	SAV 8-102	95%	660	A	1	0.33
30	MH-007	F-30	PR-32	100%	470	HEPA	1	0.5

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EXPANSION TANK SCHEDULE								
#	Draw #	Tag ID	Location	Serves	Tank Vol. (GAL)	Acc. Vol. (GAL)	PSIG	ΔT
1	MH003	ET-1	VA Mech Room	Heating System	211	84	50	32
2	MH003	ET-2	VA Mech Room	Cooling System	68	34	50	22
3	MH003	ET-3	VA Mech Room	Snow Melt	68	34	12	130
4	MH003	ET-4	Engine Generator Rm	EG Jacket Water	22	11	12	190
5	MH003	ET-5	Engine Generator Rm	EG After Cooler	13	11	12	135

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OTHER EQUIPMENT LIST																
#	Draw #	Tag ID	Description	BtuH	Tons	# Mtr	Hp	CFM Rated	Gal.	Stack Exh Temp.	LAT	Pri EGT	Pri LGT	Water Press. Drop (psig)	Volt	Ph
1	MH002	CC-1	Charge Air Cooler	592620				1558		488	136	127	145	2.75		
2	MH002	CU-1	DX Condensing Unit		30	2	1								460	3
3	MH002	AC-1 & AC-3	Air Atomizing Air Compressor FS Recip M#OL101HTID20-A4			2	10	71.2	200						480	3
5	Pict IMG_0292	AC-3	Air Atomizing Air Compressor FS Curtis Rotary Screw M #VS 60D S #AF-280			1	60	80 to 280							460	3
6	Pict IMG_0496	AT-1	Compressed Air Storage Tank (est 200 Gallon)						200							
7	Pict IMG_0652	AD-1	Compressed Air Dryer ZEKS M #250HSGA4GFZ													

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

Set Points and As Found Conditions			VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points					
		Supply Air Temperature Set-Pt				
		Min SAT Set-Pt (and corresponding zone requests)				
		Max SAT Set-Pt (and corresponding zone requests)				
		Supply DSP Set-Pt				
		Min DSP Set-Pt (and corresponding zone requests)				
		Max DSP Set-Pt (and corresponding zone requests)				
		EF-9 Duct Static Pressure				
		Space Humidity Set-Pt				
		Filter Dirty Set-Pt				
		Low Temperature Set-Pt.				
		High Duct Static Pressure Set-Pt				
		OR Max Humidity				
	As-Found Conditions					
		SF VFD Speed				
		EF-7 Fan Speed				
		OA Damper				
		EA Damper				
		Humidity				
		Pre-Heat Valve				
		Heating Vavle				
		Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	EF-9 On		PASS	JTWB	1/9/2014	
	Humidifier Valve Auto		PASS	JTWB	1/9/2014	
	Pre-Heat Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Once Pre-Heat is 100% Open, Heating Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	EF-9 On		PASS	JTWB	1/9/2014	
	Humidifier Valve Auto		PASS	JTWB	1/9/2014	
	Pre-Heat Valve is Closed		FAIL	JTWB	1/9/2014	1
	Heating Valve is Closed		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released		PASS	JTWB	1/9/2014	
	All Commands reture to Auto		PASS	JTWB	1/9/2014	

NOTES
1 When I attempted to take away the call for heating the unit stays in heat mode, DAT set-pt goes to a value between the upper and lower DAT limits. Pre-heat valve modulates to maintain the new DAT set-pt.
As found conditions were the DAT upper and lower limit equal 55.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling					1
	Supply fan is on					
	EF-9 is on					
	Pre-Heat water valve is closed					
	Hot water valve is closed					
	Chilled water valve modulates to maintain SAT setpoint					
	Simulate the conditions where there is no call for cooling					2
	Supply fan is on					
	EF-9 is on					
	Pre-Heat water valve is closed					
	Hot water valve is closed					
	Chilled water valve is closed					
	Release all system overrides					
	All overrides are released	yes				

NOTES
1 could not get any zones to call for cooling on AHU set-pt screen, however 7 VAVs were in cooling mode. Therfore could not test 1/9/14 evening (18:28)
2 even with no call for heating or cooling (deadband) the unit remains in heat mode, operates normally to maintain upper limit DAT set-pt

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint	MIN 1.13" WC	FAIL	JTWB	1/9/2014	creates alarm
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		pass	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		PASS	JTWB	1/9/2014	

OCCUPIED DEHUMMIDIFICATION CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for de hummidification					
DX Stage #1 to meet Space Humidity Set-Pt					1
DX Stage #2 to meet Space Humidity Set-Pt					1
Simulate the conditions where there is no call for hummidity					
DX Off					
Release all system overrides					
All overrides are released	yes				

NOTES
1 Condensing unit is secured for the winter, not possible to test de-humidification.

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-8 and EF-9

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON ZONE HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)					
Release all system overrides					
All overrides are released					

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON ZONE REQUESTS	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint					
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint					
Release all system overrides					
All overrides are released					

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan S/S								
EF-11 S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Supply Fan Status								
EF-11 Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			35/36.8	75/78	100/100	PASS			
EF-11 Fan Speed			35/36.3	75/77	100/100	PASS			
Humidity			0	50	100	PASS			
Pre-Heat Vavle			0	50	100	PASS			
Heating Vavle			0	50	100	PASS			
Cooling Valve			0	50	100	PASS			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Pre Heat Air Temperature		49.8	54.6	°F		-4.8				11/22/2013	
Supply Air Temperature		55	65.7	°F		-10.7				11/22/2013	
Outside Air Temperature											
Supply Duct Static Pressure											
EF-11 Duct Static Pressure											
Supply Air Humidity											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt				
	Min SAT Set-Pt (and corresponding zone requests)				
	Max SAT Set-Pt (and corresponding zone requests)				
	Supply DSP Set-Pt				
	Min DSP Set-Pt (and corresponding zone requests)				
	Max DSP Set-Pt (and corresponding zone requests)				
	EF-11 Duct Static Pressure				
	Space Humidity Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	EF-7 Fan Speed				
	OA Damper				
	EA Damper				
	Humidity				
	Pre-Heat Valve				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating					
	Supply Fan On	YES	PASS	AK	1/9/2014	
	EF-11 On	YES	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Pre-Heat Valve Modulates to Maintain Supply Air Temp	5800 CFM	PASS	AK	1/9/2014	
	Once Pre-Heat is 100% Open, Heating Valve Modulates to Maintain Supply Air Temp	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
	Simulate NO Call for Heating					
	Supply Fan On	YES	PASS	AK	1/9/2014	
	EF-11 On	YES	PASS	AK	1/9/2014	
	Humidifier Valve Auto	YES	PASS	AK	1/9/2014	
	Pre-Heat Valve is Closed	YES	PASS	AK	1/9/2014	
	Heating Valve is Closed	YES	PASS	AK	1/9/2014	
	Cooling Valve is Closed	YES	PASS	AK	1/9/2014	
	Release Override Commands					
	All Overrides are Released	YES				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
	Supply fan is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve modulates to maintain SAT setpoint		PASS	AK	1/9/2014	
	Simulate the conditions where there is no call for cooling					
	Supply fan is on		PASS	AK	1/9/2014	
	Pre-Heat water valve is closed		PASS	AK	1/9/2014	
	Hot water valve is closed		PASS	AK	1/9/2014	
	Chilled water valve is closed		PASS	AK	1/9/2014	
	Release all system overrides					
	All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

SUPPLY FAN CONTROL - DUCT STATIC PRESSURE	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the duct static pressure setpoint to 1.0 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.9 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Override the duct static pressure setpoint to 1.5 in. W.C.					
Supply fan VFD modulates to maintain the duct static pressure at setpoint		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released					

OCCUPIED HUMMIDITY CONTROL	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for hummidity					
Hummidity Valve modulates to maintain hummidity Set-Pt		PASS	AK	1/9/2014	
Simulate the conditions where there is no call for hummidity					
Hummidity Valve Closes		PASS	AK	1/9/2014	
Release all system overrides					
All overrides are released		PASS	AK	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-9

Functional Testing

SUPPLY AIR TEMPERATURE RESET - LINEAR RESET BASED ON ZONE HEATING AND COOLING DEMAND	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DAT Decrease					
The SAT setpoint decreases to the minimum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Override the number of zones requesting DAT Increase					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		pass	JTWB	1/9/2014	
Override the number of zones requesting DAT Decrease to 6 and the number of zones requesting DAT Increase to 6					
The SAT setpoint increases to the maximum SAT setpoint (1 degree per 10 minutes)		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

DUCT STATIC PRESSURE RESET - LINEAR RESET BASED ON ZONE REQUESTS	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override the number of zones requesting DSP Decrease					
The DSP setpoint decreases to the minimum DSP setpoint		PASS	JTWB	1/9/2014	
Override the number of zones requesting DSP Increase					
The DSP setpoint increases to the maximum DSP setpoint		pass	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		YES			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan S/S			ON					
Supply Fan S/S			ON					

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Return Fan Status			ONON					
Supply Fan Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
SF VFD Speed			30/30	50	100	P			
RF VFD Speed			30/30	52	100	P			
Economizer			0	50	100	P			
Heating Vavle			0	50	100	P			
Cooling Valve			0	50	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Return Air Temperature		74.5	75			-0.5				1/8/2014	
Mixed Air Temperature		67	72			-5				1/8/2014	
Supply Air Temperature		68.6	68.5			0.1				1/8/2014	
Space Tempearture											

NOTES
p

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Supply Air Temperature Set-Pt				
	Space Temperarture Set-Pt				
	Supply DSP Set-Pt				
	Filter Dirty Set-Pt				
	Low Temperature Set-Pt.				
	High Duct Static Pressure Set-Pt				
	As-Found Conditions				
	SF VFD Speed				
	RF VFD Speed				
	Economizer				
	Heating Vavle				
	Cooling Valve				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	Return Fan On		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Heating Valve Modulates to Maintain Supply Air Temp		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Simulate NO Call for Heating						
	Supply Fan On		PASS	JTWB	1/9/2014	
	Return Fan On		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Heat Valve Closed		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	
Release Override Commands						
	All Overrides are Released		PASS	JTWB	1/9/2014	
	Supply Fan & Return Fan to Auto		PASS	JTWB	1/9/2014	
	OA & RA Dampers set for Min OSA		PASS	JTWB	1/9/2014	
	Heat Valve Set to Auto		PASS	JTWB	1/9/2014	
	Cooling Valve is Closed		PASS	JTWB	1/9/2014	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: AHU-11

Functional Testing

OCCUPIED COOLING	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Simulate a call for cooling where both the economizer and mechanical cooling are enabled					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers modulate to maintain the SAT setpoint		PASS	JTWB	1/9/2014	
Once the OA/RA/EA dampers are 100% open, mechanical cooling is enabled					not checked
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint					not checked
Simulate a call for cooling where the economizer is disabled and mechanical cooling is enabled					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	JTWB	1/9/2014	OA/EA dampers full
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve modulates to maintain SAT setpoint		PASS	JTWB	1/9/2014	
Simulate the conditions where there is no call for cooling					
Supply fan is on		PASS	JTWB	1/9/2014	
Return fan is on		PASS	JTWB	1/9/2014	
OA/RA/EA dampers are at the minimum outside airflow position		PASS	JTWB	1/9/2014	OSA @ 2x the min, u
Hot water valve is closed		PASS	JTWB	1/9/2014	
Chilled water valve is closed		PASS	JTWB	1/9/2014	
Release all system overrides					
All overrides are released		yes			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: ACU-15

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Baseboard S/S								
Supply Fan S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Baseboard Status								
Supply Fan Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: ACU-15

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
Heating Vavle									
Cooling Valve									

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Supply Air Temperature											
Outside Air Temperature											
Space Tempearture											
Return Air Temperature											

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	AHU Control Set-Points				
	Space Temperarture Set-Pt				
	As-Found Conditions				
	Heating Vavle				
	Cooling Valve				
	BB				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: ACU-15

Functional Testing

OCCUPIED HEATING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate Call for Heating					
	Supply Fan On					
	Heating Valve Modulates to Maintain Space Temp					
	BB Modulates to maintain Space Temp Set-Pt					
	Cooling Valve is Closed					
	Simulate NO Call for Heating					
	Supply Fan On					
	BB OFF					
	Heat Valve Closed					
	Cooling Valve is Closed					
	Release Override Commands					
	All Overrides are Released					

OCCUPIED COOLING		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Simulate a call for cooling					
	Supply fan is on					
	BB is OFF					
	Hot water valve is closed					
	Chilled water valve modulates to maintain Apace Temp setpoint					
	Simulate the conditions where there is no call for cooling					
	Supply fan is on					
	BB is OFF					
	Hot water valve is closed					
	Chilled water valve is closed					
	Release all system overrides					
	All overrides are released					

NOTES

VAV Terminal Units
Point-to-Point & Functional Testing

					SUPPLY AIR TEMPERATURE					HOT WATER VALVE			DAMPER			SPACE TEMPERATURE					COMMAND VAV TO FULL HEATING						COMMAND VAV TO FULL COOLING						
					Meas	DDC	Error	Re-cal'd	PASS	0% Command	100% Command	PASS	0% Command	100% Command	PASS	Meas	DDC	Error	Re-cal'd	PASS	DDC Status					PASS	DDC Status					PASS	
EQUIPMENT TAG	AREA SERVED	TERMINAL UNIT TYPE	CTRL VALVE 2-WAY/3-WAY	ASSOCIATED EQUIPMENT	(°F)	(°F)	(°F)	YES/NO	YES/NO	Observ Position	Observ Position	YES/NO	Observ Position	Observ Position	YES/NO	(°F)	(°F)	(°F)	YES/NO	YES/NO	Asspciated BB in Heating?	Damper Position (%)	Airflow Setpoint (cfm)	Airflow (cfm)	HW Valve Position (%)	YES/NO	Associated BB OFF?	Damper Position (%)	Airflow Setpoint (cfm)	Airflow (cfm)	HW Valve Position (%)	YES/NO	NOTES
VAV-1-102																																	
VAV-1-122																																	
VAV-1-206																																	
VAV-1-218																																	
VAV-1-130																																	
VAV-1-222																																	
VAV-1-204																																	
VAV-2-103																																	
VAV-2-112																																	
VAV-2-124																																	
VAV-2-203																																	
VAV-2-205																																	
VAV-2-211																																	
VAV-2-214																																	
VAV-2-218																																	
VAV-3-105																																	
VAV-3-106																																	
VAV-3-110																																	
VAV-3-117																																	
VAV-3-204																																	
VAV-3-207																																	
VAV-3-212																																	
VAV-3-216																																	
VAV-4-104																																	
VAV-4-114																																	
VAV-4-219																																	
VAV- 4-209																																	
VAV-5-107																																	
VAV-5-117																																	
VAV-5-114																																	
VAV-5-205		VAV Box														72	72	0	n/a	PASS								FULL OPEN	1500	1300	0	YES	MATCHES THE MEA
VAV-5-207		VAV Box			64	64				0	100		0	100		72.4	72				y	72	750	806	100								
VAV 5-218		VAV Box			72.8	71																											
VAV-5-209																																	
VAV-5-221																																	
VAV-5-224																																	
SAV-8-111																																	
SAV-8-131																																	
SAV-8-103																																	
VAV-9-102																																	
VAV-9-103																																	

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Cooling HX

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
CHGP-13 A S/S								
CHGP-13 B S/S								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
CHGP-13 A Status								
CHGP-13 B Status								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Cooling HX

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
CHGP-13 A VFD Speed				60/62.3	80/82	PASS			
CHGP-13 B VFD Speed				59.7		PASS			
ByPass Valve			0/0			PASS			

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ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
CHGS Temperature											
CHGR Temperature											
Well Supply Temperature											
Well Return Temperature											

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Cooling HX

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	Control Set-Points				
	CHGS Temperature Set-Pt				
	Differential Pressure Set-Pt				
	As-Found Conditions				
	CHGP-13 A VFD Speed				
	CHGP-13 B VFD Speed				
	ByPass Valve				

HX		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Adjust the CHGS Temperature setpoint up					
	By-Pass Valve Modulates to Maintain Setpoint					
	Adjust the CHGS Temperature setpoint down					
	By-Pass Valve Modulates to Maintain Setpoint					
	Release all system overrides					
	All overrides are released					

CHGP-13 A		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Disable the Pump					
	Pump is disabled					
	Enable the Pump					
	Pump is enabled					
	Release all system overrides					
	All overrides are released					
	Override the differential pressure below setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Override the differential pressure above setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Release all system overrides					
	All overrides are released					

CHGP-13 B		VALUE	PASS/FAIL	INITIALS	DATE	NOTES
	Disable the Pump					
	Pump is disabled					
	Enable the Pump					
	Pump is enabled					
	Release all system overrides					
	All overrides are released					
	Override the differential pressure below setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Override the differential pressure above setpoint					
	Pump VFD modulates to maintain the differential pressure at setpoint					
	Release all system overrides					
	All overrides are released					

NOTES

PUMPS

Point-to-Point & Functional Testing

		Point to Point					VFD Speed							FTP								
		S/S - On	S/S - Off	Diff Pressure		PASS	0% Command		50% Command		100% Command		PASS	Enable	Disable		Above Set-Pt		Below Set-Pt		PASS	
EQUIPMENT TAG	AREA SERVED	Observ Position	DDC Status	Observ Position	DDC Status	YES/NO	Observ Position	DDC Status	Observ Position	DDC Status	Observ Position	DDC Status	YES/NO	Observ Position	DDC Status	Diff Pressure Set-Pt	Observed - Pump Modulates to Meet Set-Pt	DDC Status	Observed - Pump Modulates to Meet Set-Pt	DDC Status	YES/NO	NOTES
Heated Glycol Pump 1A (VFD Spd)	Clinic Primary Heating Loop										80.7	77.1	Y									
Heated Glycol Pump 1B (VFD Spd)	Clinic Primary Heating Loop										65	63.4	Y									
Heated Glycol Pump 2A (VFD Spd)	AHU-1, 2 & 7 Heating Coils																					
Heated Glycol Pump 2B (VFD Spd)	AHU-1, 2 & 7 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 3A (VFD Spd)	AHU-1, 2 & 7 Re-Heat & Perim Heat																					
Heated Glycol Pump 3B (VFD Spd)	AHU-1, 2 & 7 Re-Heat & Perim Heat								50	50	100	100	Y									
Heated Glycol Pump 4A (VFD Spd)	AHU-3, 4 & 8 Re-Heat & Perim Heat																					
Heated Glycol Pump 4B (VFD Spd)	AHU-3, 4 & 8 Re-Heat & Perim Heat								50	50	100	100	Y									
Heated Glycol Pump 5A (VFD Spd)	AHU-3, & 8 Heating Coils																					
Heated Glycol Pump 5B (VFD Spd)	AHU-3, & 8 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 6A (VFD Spd)	AHU-5, & 9 Heating Coils																					
Heated Glycol Pump 6B (VFD Spd)	AHU-5, & 9 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 7A (VFD Spd)	AHU-4, 5 & 9 Re-Heat & Perim Heat																					
Heated Glycol Pump 7B (VFD Spd)	AHU-4, 5 & 9 Re-Heat & Perim Heat								50	50	100	100	Y									
Heated Glycol Pump 8A (VFD Spd)	AHU-4, & 6 Heating Coils																					
Heated Glycol Pump 8B (VFD Spd)	AHU-4, & 6 Heating Coils								50	50	100	100	Y									
Heated Glycol Pump 9A (Status)	Radiant Floor Tertiary Loop												Y									
Heated Glycol Pump 9B (Status)	Radiant Floor Tertiary Loop												Y									
Heated Glycol Pump 10A (VFD Spd)	AHU-11 Heat, Re-Heat & Perim Heat												Y									
Heated Glycol Pump 10B (VFD Spd)	AHU-11 Heat, Re-Heat & Perim Heat												Y									

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Point-to-Point Testing

BINARY OUTPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Heated Glycol Pump 11A (S/S)								
Heated Glycol Pump 11B (S/S)								
Heated Glycol Pump 12A (S/S)								
Heated Glycol Pump 12B (S/S)								

BINARY INPUTS								
DESCRIPTION	POINT NAME	FAIL STATE	ON/OPEN	OFF/CLOSED	PASS/FAIL	INITIALS	DATE	NOTES
Heated Glycol Pump 11A (Status)								
Heated Glycol Pump 11B (Status)								
Heated Glycol Pump 12A (Status)								
Heated Glycol Pump 12B (Status)								

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Point-to-Point Testing

ANALOG OUTPUTS									
DESCRIPTION	POINT NAME	FAIL STATE	0% CMD	50% CMD	100% CMD	PASS/FAIL	INITIALS	DATE	NOTES
HX Valve			0	50	100	P			

ANALOG INPUTS											
DESCRIPTION	POINT NAME	BAS VALUE	MEASURED	UNITS	TOLERANCE	ERROR	CALIBRATION	PASS/FAIL	INITIALS	DATE	NOTES
Glycol Temperature								PASS			
East Slab Surface Temp								PASS			
East Slab Core Temp								PASS			
East Moisture Detection								PASS			
West Slab Surface Temp								PASS			
West Slab Core Temp								PASS			
West Moisture Detection								PASS			

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Functional Testing

Set Points and As Found Conditions		VALUE	INITIALS	DATE	NOTES
	Control Set-Points				
	Idle Mode Set-Pt.				
	Idle Slab Temp Set-Pt.				
	Moisture Sensor				
	Melt Slab Set-Pt				
	OSA Warm Cutout				
	OSA Cold Cutout				
	Glycol Max Temp Set-Pt.				
	Glycol Min Temp Set-Pt.				
	As-Found Conditions				
	Heated Glycol Pump 11A (Status)				
	Heated Glycol Pump 11B (Status)				
	Heated Glycol Pump 12A (Status)				
	Heated Glycol Pump 12B (Status)				

NOTES

Facility Name: VISN 20 - Anchorage VA Healthcare System
Equipment Tag: Snowmelt System

Functional Testing

Snowmelt System	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override OAT< Idel Set-Pt					
East Pump ON					
West Pump ON					
West Slab is at Idle Slab Temp Set-Pt					
East Slab is at Idle Slab Temp Set-Pt					
Override OAT> Warm Weather Ct-Off					
East Pump OFF					
West Pump OFF					
Override OAT< Idel Set-Pt					
East Pump ON					
West Pump ON					
West Slab is at Idle Slab Temp Set-Pt					
East Slab is at Idle Slab Temp Set-Pt					
Override Moisture Sensor (Pour Water on Moisture Sensor)					
East Pump ON					
West Pump ON					
West Slab is at Melt Slab Temp Set-Pt					
East Slab is at Melt Slab Temp Set-Pt					
Override OAT< Cold Weather Ct-Off					
East Pump OFF					
West Pump OFF					

HX Valve	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Adjust the HGS Temperature setpoint up					
By-Pass Valve Modulates to Maintain HGS Temp Setpoint					
Adjust the HGS Temperature setpoint down					
By-Pass Valve Modulates to Maintain HGS Temp Setpoint					
Release all system overrides					
All overrides are released					

HGS Temp Set Point Reset	VALUE	PASS/FAIL	INITIALS	DATE	NOTES
Override slab temperature below Set-Pt					
As slab temperature rises, HGS Temperature is adjusted to maintain slab rate of tempearture					
increase below 0.2°F per minute					
Release all system overrides					
All overrides are released					

NOTES

5.0 Appendix B: Issues Log

Please see the following page for the Issues Log

#	MECH EQUIPMENT NAME	BUILDING AREA	DESCRIPTION	COMMENTS	DATE NOTED
1	ACU-15	Stairs 2, SE Corner A-wing	The stair located in the south east corner of the A-wing get extremely hot with the solar load. There seems to be no circulation of air, the RA and SA is located next to each other and the RA opening of the fan coil unit is not ducted to the RA plenum	See Tab "Issue 1" for drawings	11/22/2013
2	EF-13		Screenshot shows the speed in Hz, but reading is 97.2 so it is probably %		11/22/2013
3	AHU-9	Lab	The lab gets too hot in the summer. There are multiple large refrigerators in the space and the layout and possibly size of the current VAV and exhaust system can't remove the heat efficiently. If the lab space temperature cannot be maintained no work can be conducted until temperature is within allowable limits. Suspicious that AHU-9 is undersized.	Issue: Not able to cool space. Installed Coil is 51.7 MBH (submittals) and design size is tupposed to be 57 MBH Hypothises: cooling CHW coil is undersized. Observations: CHG temperature is too high, Primary Chilled Well Water Flowrate Too Low Assessment: TAB the coil to try to fix one of the three issues Mike Kief (FSI) agrees with this assessment. Also, the ductwork is not optimized for the fridges in the lab. Solution: re-position	11/22/2013
4	AHU-4	2nd Fl	Most comfort complaints are due to the thermostat located in another person's office. Areas where open offices were converted to individual offices are hard to control. Some of them will experience simultaneous heating and cooling as they have baseboard from one system while the air is supplied from different system, being the VAV. Part of the remodel included long runs of flex duct which reduces the airflow.	Solution: use multiple thermostats and balance using logic to determine if the baseboard should be enabled. Mike Kief (FSI) brought our attention to this problem.	11/22/2013
5		Learning Lab	The learning lab 2D116 has 12 computers and gets too warm when fully occupied.	Mike Kief (FSI) agrees with this assessment. This VAV box was functionally tested, and works as intended. VAV box probably not designed to absorb the load in this space.	11/22/2013
6	UH's	Penthouses	The unit heaters will freeze up in the penthouses.	Mike Kief (FSI) agrees with this assessment.	11/22/2013

7	AHU-8 and 9		The water contains a lot of minerals and the AHU chilled water coils will fill up with mineral deposits when the humidification is running. The static pressure goes way up and it really reduces the airflow distributed to the spaces. We clean the coils, and are testing different cleaners, but we are worried about the longevity of the coils. In addition the humidification dispersion units in AHU-8 and 9 freeze up when it's cold, and we have to remove them to let them defrost.	Mike Kief (FSI) brought our attention to this problem. TAB contractor to test the coil capacity.	11/22/2013
8	AHU-3 and 9		There are issues with evenly distributed airflow over the preheat coil in units 9 and the heating coil in AHU-3. A few pieces of cardboard is being used to re distribute airflow.	Mike Kief (FSI) agrees with this assessment.	11/22/2013
9	Chilled Water HX		Elmendorf limits the chilled water flow in the summer to prevent the underground wells from drying up. As a result, the chilled water temperature to the air handling units is between 50-52 deg F instead of 46 deg F per mechanical drawings.	Mike Kief (FSI) agrees with this assessment.	11/22/2013
10	VAV boxes	first floor (mostly)	Griswald balancing valve cartridges are becoming clogged with metalic debris, mostly on first floor.	Mike Kief (FSI) agrees with this assessment.	1/8/2014
11	AHU-3		Bas stratification in the mixing box, can cause coil freeze up and a problem for the atomizing humidifier.	Building staff remidies this with some cardboard in the unit.	1/10/2014
12	AHU-5		1. AFTER 15 MIN OF COOLING VALVE FULLY OPEN, ECONOMIZER AT 10%, MAT AT 67, THE SAT IS 59 AND THE SETPOINT IS 55, FAN SPEED 93%. ONLY 7 DEGREES OF COOLING ON THE COIL. COOLING SUPPLY TEMP IS 53 AT UNIT.	Possibly a clogged griswald valve. Check with Mike Kief if he has noticed that unit has problems meeting load.	1/10/2014
13	AHU-5		1. 1/4" GAP ON RIGHT SIDE OF OA DAMPER WHEN COMMANDED CLOSED.		1/10/2014
14	VAV 1-203		Space Temperature Sensor Failure		3/1/2014
15	VAV 1-221		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014
16	VAV 3-215		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014
17	VAV 4-216		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014

18	VAV 5-220		Space Temperature consistantly above set-point	Further investigation warranted.	3/1/2014
19	SAV 8-106		Humidity Issue, not being maintained at set-point	Further investigation warranted.	3/1/2014
20	VAV 9-102		Low CFM	Further investigation warranted.	3/1/2014
21	AHU-1		The Supply fan starts 4 hours early, should start at 6:00 am but it is starting at 2:00 am. No apparent reason.	Solution: Re-Schedule Fan to start at 6:00 am. The cooling valve is likely enabled starting at 6:00 am	3/1/2014
22	AHU-2		Fan speed does not appear to modulate with OSA temp	Potentially not an issue since the baseboard heat should take care of night time heating.	3/1/2014
23	AHU-2		Supply Fan does not shut down at night, 24/7 operation. Static pressure of 1" is maintained during off hours, when occupied SP of 1.05" to 1.37" maintained. Supply fan runs on weekend.	Solution: Schedule Supply Fan to match occupied schedule	3/1/2014
24	AHU-2		Winter Schedule shuts down @ 7:15 pm, Summer Schedule shuts down @ 10:15 pm. Supply Fan runs on weekend.	Solution: curtail unnessecary runtime	3/1/2014
25	AHU-3		Fan speed does not appear to modulate with OSA temp	Potentially not an issue since the baseboard heat should take care of night time heating.	3/1/2014
26	AHU-3		Supply fan operates longer hours than return fan. The Supply fan starts 4 hours early, should start at 6:00 am but it is starting at 2:00 am.	Solution: curtail unnessecary runtime	3/1/2014
27	AHU-4		Supply and Return Fan are 24/7. They run a lower static pressure when unoccupied, but fans are running 24/7.		3/1/2014
28	AHU-4		Supply fan runs longer hours in the summer than the winter	Solution: curtail unnessecary runtime	3/1/2014
29	Compressor		Still neet to check the air compressor runtime versus actual humidifier demand and AHU runtimes		3/1/2014

Appendix-H

For Final RCx Report

2014 TAB Report

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10 -Wasilla, Alaska 99654
Phone: (907) 373-1090
Fax: (907) 373-3586

TEST AND BALANCING REPORT

Subject Job: VA Clinic
Anchorage, Alaska

Architect:

Engineer:

Contractor: DAV Energy Solutions
1804 Garnet Ave.
San Diego, California 92109

Certified By: Ronald D. Neffendorf
Ronald D. Neffendorf
Certification Number 2955
Expires March 31, 2016

Alaska Air Balancing
NEBB
RONALD D. NEFFENDORF
CERTIFICATION
2955
Exp. 3/31/16
Air and Hydronic Systems

Date: April 14, 2014

The data presented in this report is a record of the system measurements and final adjustments that have been obtained in accordance with the current edition of the NEBB procedural standards for the testing, adjusting, and balancing of the environmental systems. Any variances from the design quantities, which exceed NEBB tolerances, are noted in the test-adjust-balance report project summary (Job Inspection Report).

3060 Lazy Eight Court #10-Wasilla, Alaska 99654
Phone: (907) 373-1090

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	C. AHU-9	Pg. 6
3.	Air Balancing Report	
	A. AHU-7, AHU-8, & AHU-9	Pg. 7
4.	Water Balancing Report	
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6.	Cooling Coil Data	Pg. 10
7.	Terms & Abbreviations	Pg. 11

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla, Alaska 99654
Phone: (907) 373-1090
April 14, 2014

JOB INSPECTION REPORT
VA Clinic
Anchorage, Alaska

AHU-7

1. Air flow was determined to be 7,718 cfm.

2. Refer to static pressure profile sheet for static readings.

AHU-8

1. Air flow was determined to be 7,580 cfm.

2. PHC ΔT: EWT 191°, LWT 175°.

3. Flow Rate: 33 gpm at time of testing.

4. Mix Air Temp: This is a 100% outside air unit.

5. Refer to static pressure sheet for static readings.

6. PHC currently has a 51 gpm Griswold installed. Original design was 36 gpm. This valve currently has no pressure drop and gpm was determined from a redundant Bell and Gossett balancing valve.

AHU-9

1. Air flow was determined to be 2,905 cfm.

2. CC ΔT Water: EWT 50°, LWT 54°.

3. CC Flow Rate: 7.0 gpm per Griswold.

4. Mix Air Temp.: This is an 100% outside air unit.

5. CC ΔT Air: EAT 42°, LAT 51°.

6. Refer to static pressure profile sheet for static readings

7. General note for CC: Entering air temperature was colder than glycol as a result the glycol was acting as a heating source rather than a cooling source.

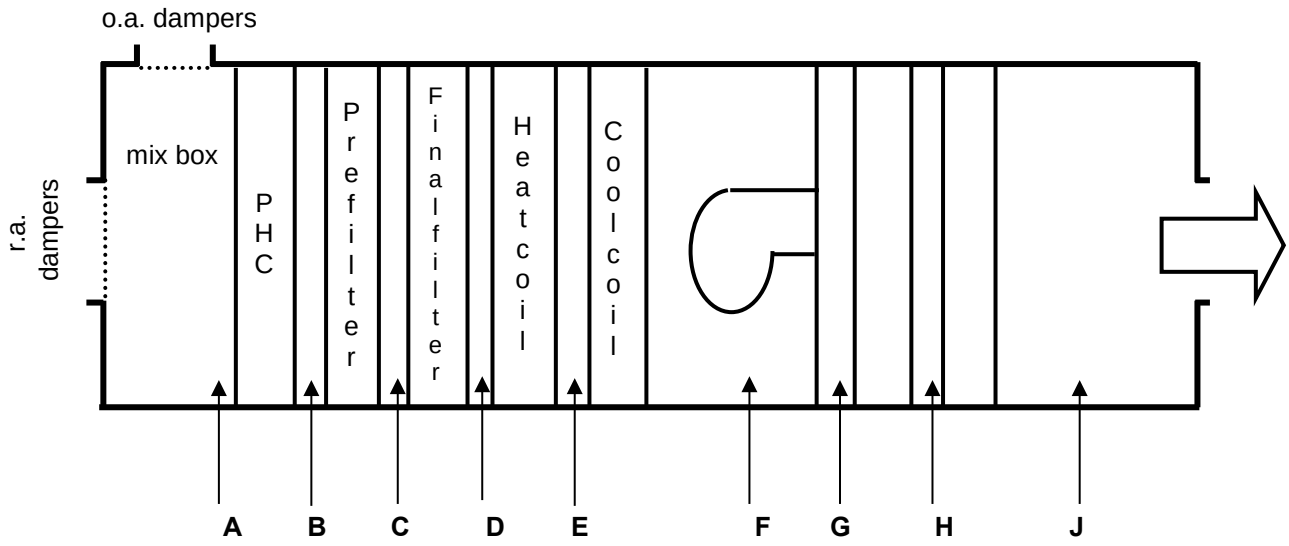
ALASKA AIR BALANCING CO.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

STATIC PRESSURE PROFILE

PROJECT NAME : New VA Clinic
LOCATION : Anchorage, Alaska



Unit	A	B	C	D	E	F	G	H	J
AHU-7	-0.27	-0.49	-0.76	-1.76	-1.92	-2.81			1.83

Remarks: _____

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

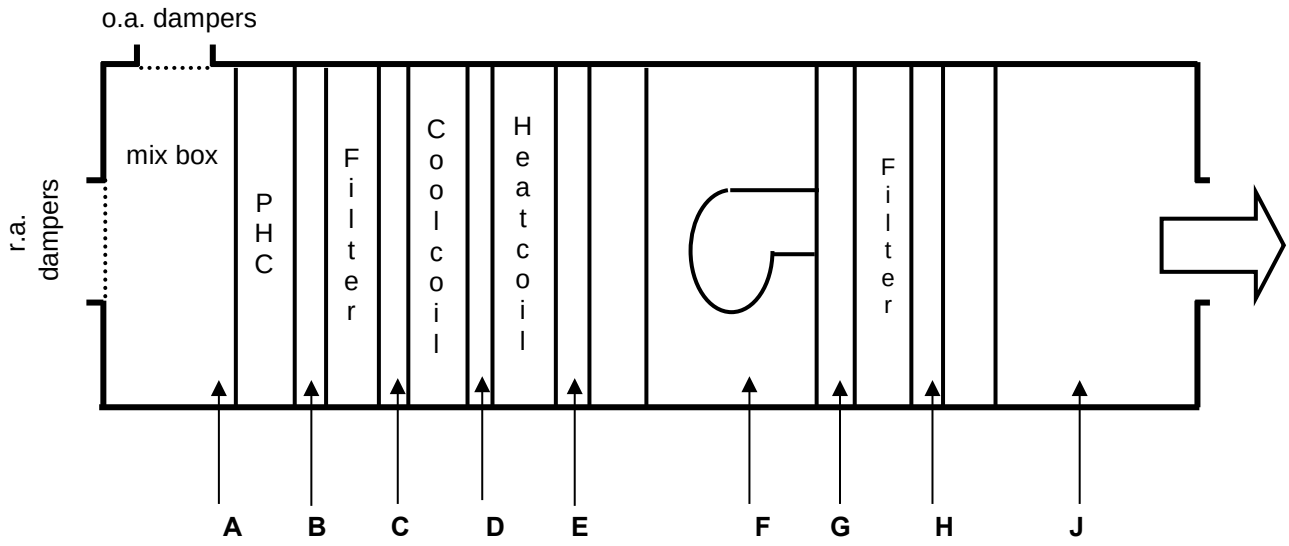
ALASKA AIR BALANCING CO.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

STATIC PRESSURE PROFILE

PROJECT NAME : New VA Clinic
LOCATION : Anchorage, Alaska



Unit	A	B	C	D	E	F	G	H	J
AHU-8	-0.36	-0.46	-1.07	-2.15	-2.36	3.67			3.15

Remarks: _____

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

ALASKA AIR BALANCING CO.

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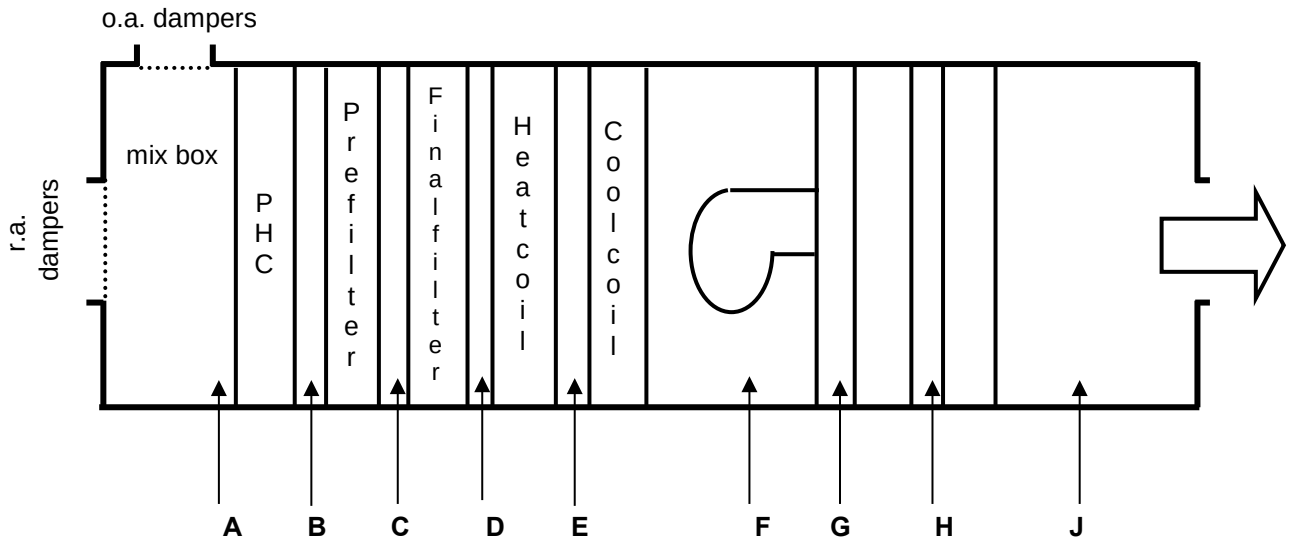
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

STATIC PRESSURE PROFILE

PROJECT NAME : New VA Clinic
LOCATION : Anchorage, Alaska



Unit	A	B	C	D	E	F	G	H	J
AHU-9	-0.27	-0.34	-0.59	-1.50	-1.63	-2.54			1.35

Remarks: _____

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

AIR BALANCING REPORT - CONSTANT VOLUME

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

Location & Room No.	Outlet Size	Outlet AK	Veloc. Req'd	**Design CFM**	OUTLET READINGS Initial Reading	Final Reading	**Final CFM**
*** AHU-7**							
** Fan Traverse (60 Hertz)	55 x 36	13.75	526	**7230**	522		**7178**
Ebtron Sensor at time of reading	30 x 30	6.25	1157	**7230**	880		**5500**
***** AHU-8**							
** Fan Traverse (54 Hertz)	56 x 39	15.15	512	**7760**	500		**7580**
Ebtron Sensor at time of reading	30 x 30	6.25	1242	**7760**	1130		**7062**
*** AHU-9**							
** Fan Traverse (60 Hertz)	37 x 27	6.37	478	**3050**	456		**2905**
Ebtron Sensor at time of reading	22 x 22	3.36	908	**3050**	875		**2940**

Remarks: * Fans run at 60 hertz all the time.
** Fan totals are per original design cfm's.
*** Per maintenance, fan always runs at this speed.

TAB Technician: Joe Sullivan Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

WATER BALANCING REPORT

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

Unit	Location & Room No.	Type	Size Inches	Design GPM	Degree Setting	Press. Drop	Final GPM
	* AHU-8 PHC (39 Hertz)	B & G	CB 2	51.00	0.0	1.6	33.00
	AHU-8 PHC (48 Hertz)	B & G	CB 2	51.00	0.0	3.2	46.00
		Griswold	3C22	51.00	No Pressure Drop		N/A
					Entering	**Leaving**	
					PSI	**PSI**	
	AHU-9 CC	Griswold	IRI2PNFF	7.00	30.0	28.0	7.00

Remarks: * 51 gpm is per new griswold installed. Old design is 36 gpm. See job inspection report.

TAB Technician: Joe Sullivan

Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

HEAT COIL DATA SHEET

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

System	PHC-8							
Location	AHU-8							
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM	7760	* 7580						
GPM	** 51.0	** 33.0						
EWT Degrees F.	186	191						
LWT Degrees F.	156	175						
EAT DB Degrees F.	-18	25						
LAT DB Degrees F.	45	54						

System								
Location								
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM								
GPM								
EWT Degrees F.								
LWT Degrees F.								
EAT DB Degrees F.								
LAT DB Degrees F.								

Remarks: * At time of traverse.
** Original griswold was 36 gpm. New griswold is 51 gpm. No drop on griswold valve.
GPM determined on redunant B & G valve.
Generla Note: Coil has a 2 psi drop, 11 psi entering and 9 psi leaving.

TAB Technician: Joe Sullivan

Date Balanced: 4/11/14

ALASKA AIR BALANCING INC.

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla Alaska 99654
Phone: (907) 373-1090

Date: April 14, 2014

COOLING COIL DATA SHEET

PROJECT NAME : VA Clinic
LOCATION : Anchorage, Alaska

System	CC-9							
Location	AHU-9							
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM	3050	* 2905						
GPM	N/A	7.0						
EWT Degrees F.	N/A	50						
LWT Degrees F.	N/A	54						
EAT DB Degrees F.	N/A	42						
LAT DB Degrees F.	N/A	50						

System								
Location								
Service								
Manufacturer								
	Design	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**
CFM								
GPM								
EWT Degrees F.								
LWT Degrees F.								
EAT DB Degrees F.								
LAT DB Degrees F.								

Remarks: * At time of traverse.
Generla Note: Coil has a 1 psi drop, 32 psi entering and 31 psi leaving.
EAT was colder than EWT, causing LAT to rise instead of decrease.

TAB Technician: Joe Sullivan

Date Balanced: 4/11/14

A Member of the National Environmental Balancing Bureau
3060 Lazy Eight Court #10-Wasilla, Alaska 99654
Phone: (907) 373-1090

TERMS & ABBREVIATIONS

AC or ACU: Air Conditioner or Air Conditioning Unit
AH or AHU: Air Handler or Air Handler Unit
AVG: Average
BHP: Brake Horsepower
CAV: Constant Air Volume
CBV: Calibrated Balancing Valve
CC: Cooling Coil
CFM: Cubic Feet per Minute
CH: Chiller
CHWS: Chilled Water Supply
CHWR: Chilled Water Return
CP: Circulating Pump
CR: Ceiling Register
CRAC: Computer Room Air Conditioner
CRU: Computer Room Unit
CT: Cooling Tower
CU: Condenser Unit
CUH: Cabinet Unit Heater
CWS: Condenser Water Supply
CWR: Condenser Water Return
D.A.: Duct Area
DAT: Discharge Air Temperature
DB: Dyr Bulb
DD: Direct Drive
DDC: Direct Digital Controls
Des.: Design
Dia.: Diameter
Disch.: Discharge
EA: Exhaust Air
EAT: Entering Air Temperature
Economizer: Controls and components that allow an air handler to logically utilize outdoor air for cooling as opposed to the use of mechanical cooling.
EF: Exhaust Fan
EG: Exhaust Grille
EMCS: Energy Management Control System
ERU: Energy Recovery Unit
E.S.P.: External Static Pressure
F.C.: Flow Coefficient
HRC: Heat Recovery Coil
EWT: Entering Water Temperature
FCU: Fan Coil Unit
FD: Fire Damper
FLA: Full Load Amperage: Maximum amperage a motor can draw.
Flow Hood: Instrument that captures air and converts the reading to cfm.
FPB: Fan Powered Box
FPM: Feet per Minute
FR: Field Report Data
FTU: Fan Terminal Unit
GPM: Gallons per Minute
HC: Heat Coil
TDH: Pressure Difference across the entering and leaving side of the pump
TDH: Pressure Difference across the entering and leaving side of the pump
HEPA: High Efficiency Particulate Arrestance
HP: Horsepower
HVAC: Heating Ventilation and Air Conditioning
HWS: Heating Water Supply
HWR: Heating Water Return
HX: Heat Exchanger
HZ: Hertz, cycle per second
In.: Inches
In w.g.: Inches of water gauge
A.K.: Correction factor to the free area need to calculate cfm
KW: Kilowatts
LAT: Leaving Air Temperature
LWG: Low Wall Grille
LWR: Low Wall Register
LWT: Leaving Water Temperature
MAU: Make-up Air Unit
MBH: 1,000 BTUH
N/A: Not Available
OSA: Outside Air
OBD: Opposed Blade Damper
△P: Pressure Drop
PH: Phase
PSI: Pounds per Square Inch
RA: Return Air
RAT: Return Air Temperature
RF: Return Fan
RH: Relative Humidity
RHC: Reheat Coil
RPM: Revolutions per Minute
RTU: Roof Top Unit
SA: Supply Air
SAT: Supply Air Temperature
S.F.: Service Factor
SF: Supply Fan
SFD: Smoke/Fire Damper
SP: Static Pressure
Sq. ft.: Square Feet
Suct.: Suction
SWG: Sidewall Grille
SWR: Sidewall Register
TAB: Test Adjust and Balance
TSP: Total Static Pressure: Difference between the entering and leaving static pressure of fan.
UH: Unit Heat
VAV: Variable Air Volume: box that contains a motorized damper that modulates airflow.
VD: Volume Damper
VFD: Variable Frequency Drive
Velgrid: Instrument that reads used velocity in feet per minute.
VVT: Variable Volume Terminal
WC: Water Column
W.G.: Water Gauges
WB: Wet Bulb

Appendix-J

For Final RCx Report

Minor & Major Recommended Corrective Action Report

VISN 20 Alaska VA Healthcare System

Simple Repair Report

APRIL 16, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
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This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126AA issued to DAV Energy Solutions, Inc. under DAV's GSA Comprehensive Professional Energy Services Blanket Purchase Agreement (BPA Task Order No. VA701-13-Q-0257). In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
TAB	Testing and Balancing

1.0 Executive Summary

1.1 INTRODUCTION

This Simple Repair Summary report, prepared by DAV Energy Solutions Inc. for the VISN 20 Alaska Health Care Systems, provides a summary of the systems testing during the monitoring periods and the discoveries made during those periods. Normally these repairs are identified during the functional testing period. However all equipment passed their functional tests and repair items were not identified until monitoring data was analyzed. This report summarizes the simple repairs that were identified during this period, along with our proposed methodology in completing these repairs within the project timeline. A “simple repair” is a defined as a repair that takes no more than 30 minutes to complete, and costs no more than $60 in materials. An Issues Log is presented in Appendix A.

This report is being completed under **Key Deliverable 10 Simple Repair Report**.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs,
4. Identify energy or capital improvement projects for implementation in the future.

The table on the following page summarizes the deliverables in the project and their status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Perf. Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	Complete
10	Repair Report Summary	**CURRENT**
11	Minor and Major Repair Recommendations Report	4/16/2014
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	Complete

The content of these deliverables is summarized in the RCx Plan.

2.0 Simple Repairs

2.1 SIMPLE REPAIR OVERVIEW

The RCx team used the following methods to identify HVAC system deficiencies:

- On-Site Observations
- Occupant Interviews
- System Condition Assessments
- Diagnostic Monitoring
- Point to Point Testing
- Functional Testing
- TAB Measurements

All deficiencies identified are documented in the Issues Log attached to this report as Appendix A.

Deficiencies are categorized as simple repairs if they can be completed in 30 minutes or less with $60 or less in materials cost. The objective of simple repairs is to improve the operation of the facility and to eliminate minor issues so they do not mask underlying major issues.

Please see below for a general summary of the deficiencies identified and those recommended for implementation as simple repairs:

- 32 total deficiencies were identified and investigated.
- 7 out of 32, or 21.9% of the deficiencies identified were categorized as simple repairs and slated for implementation by the RCx team under this project.
- 17 out of 32, or 53.1% of the deficiencies identified were categorized as Major or Minor Repairs and will be the responsibility of the VA to complete in the future if desired.
- 8 out of 32, or 25.0% of the total deficiencies identified were determined not to actually be issues after further investigation, and require no action.

2.2 SUMMARY OF SIMPLE REPAIRS PROPOSED

Simple repairs include minor maintenance tasks, system adjustments, set-point adjustments, and sensor calibration. Energy savings were not estimated for these repairs in this report. Some repairs will save energy while other repairs provide improvements with limited or no energy savings. For Measures with energy savings, the estimated amounts saved are provided in the following report, Deliverable #11.

The general summary of the simple repairs are summarized in the following list:

- **7 out of 32, or 21.9% of the simple repair issues have been targeted for action as follows:**
  - For EF-13, the BMS display shows speed in Hertz, correct units are %.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - Space Temperature sensor failure in VAV zone 1-203
    - *With approval from VA POC, this can be corrected under the RCx project scope*.
  - The Supply Fan for AHU-1 starts 4 hours early, starting at 2:00 AM daily instead of 6:00 AM as it should.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - Supply Fan for AHU-2 does not shut down at night, 24/7 operation. Static pressure of 1" is maintained during off hours, during occupied time periods a Static Pressure of 1.05" to 1.37" is maintained. The supply fan also runs on weekends. We recommend scheduling the Supply Fan to start 1 hour before the occupied schedule is to begin.
    - *This is a simple change and can be implemented by the controls operator within a few minutes (no cost estimated).*
  - Return Fan for AHU-2 winter schedule shuts down @ 7:15 pm, summer schedule shuts down @ 10:15 pm. The Supply Fan runs on the weekend. We recommend scheduling the Return Fan to start 1 hour before the occupied schedule, matching the supply fan.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - The Supply fan for AHU-3 operates longer hours than the Return fan. The Supply fan starts 4 hours early, should start at 6:00 am but it is starting at 2:00 am. Both Fans run on Saturdays for unknown reasons. We recommend scheduling the Fans to start 1 hour before the occupied schedule.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*
  - The Supply and Return fans for AHU-4 currently run 24/7 in the summer and winter. We recommend scheduling the Supply and Return Fans to start 1 hour before the occupied schedule.
    - *This is a simple change and can be implemented by controls operator within a few minutes (no cost estimated).*

A full list of recommended repairs is shown in **Appendix A**.

2.3 ACTION PLAN FOR OTHER REPAIRS

The RCx team will complete repairs only where and when authorized by the VA staff according to the prioritization and goals of the VA. There were repairs that were identified during the testing and monitoring activities of the Investigation Phase that were not corrected as part of this project. These deficiencies require

the replacement of parts or additional diagnostic labor beyond the 30-minute guideline for a simple repair and/or $60 in material costs. These items were categorized as other repairs and are summarized as follows:

- Of the 32 total deficiencies identified, 17, or 53.1% were categorized as minor or major repairs and have been assigned for repair in the future as follows:
    - Out of the 32 deficiencies identified, 9, or 28.1% were classified as minor repairs.
        - Minor repairs include ducting for the stairwell FCU, control system programming to average space temperatures for better controls and a preventative maintenance program for the Griswold valves.
    - Out of the 32 deficiencies identified, 8, or 25.0% were classified as Major repairs.
        - Major repairs include investigating and repairing the air leaks in the compressed air system for the humidification, Coil Replacements, repositioning the return registers in the Lab and RO Water Filtration System for the Humidification.

These issues are addressed in more detail in the Minor and Major Recommendations Report, Deliverable 11.

2.4 SCHEDULE

This section sets forth the detailed schedule of diagnostic testing tasks carried out at the Anchorage, Alaska VA Outpatient Clinic.

Table 0-1: Schedule of Testing Activities

Task	Tentative Date(s)	On-Site	Comments
Onsite Testing	1/6/2014 to 1/10/2014 & 4/11/2014	Yes	Functional Testing was Completed in January of 2014.
Onsite Air Flow & Water Flow Measurements	4/11/2014	Yes	A certified TAB contractor was utilized for these select measurements.
Prepare Deficiencies Log	11/22/2013 to 4/16/2014	Partial	Ongoing during functional testing and completed in the office.
Prepare Simple Repair Report and Deliver to VA for approval	4/16/2014	No	This report will summarize Simple Repairs.

All issues, including the locations and equipment affected, are summarized in the Issues Log in **Appendix A**.

Appendix-J

Minor & Major Recommended Corrective Action Report

VISN 20 Alaska VA Healthcare System

Minor & Major Repair Recommendations

APRIL 16, 2014

Prepared for:
U.S. Department of Veteran's Affairs
Alaska VA Healthcare
1201 North Muldoon Rd.
Anchorage, AK 99504

Prepared under:
Contract Number: GS-21F-126AA
Solicitation Number: VA701-13Q-0257

This report has been prepared as part of the retro-commissioning project conducted by DAV Energy Solutions, under Contract No. GS-21F-126A and Solicitation No. VA701-13-Q-0257. In preparing this report, DAV Energy Solutions, Inc. has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, DAV Energy Solutions, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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ACRONYMS

BOD	Basis of Design
VAV	Variable Air Volume
CHGS	Chilled Glycol Supply
CHGR	Chilled Glycol Return
HGS	Heating Glycol Supply
HGR	Heating Glycol Return
GPM	Gallons per Minute
HP	Horsepower
RA	Return Air
TAB	Testing and Balancing

1.0 Introduction

As part of its RCx efforts at VISN 20, DAV Energy presents the following report summarizing the Major & Minor Recommendations found during the RCx investigation. This includes recommended improvement opportunities for Indoor Environmental Quality (IEQ), infection control, operation and maintenance procedures, energy benchmarking and metering, energy efficiency projects, and other applicable capital improvements.

The main objectives of the Investigation Phase are to:

1. Compile system operation information,
2. Identify HVAC system deficiencies,
3. Improve system performance by completing 30 minute HVAC system repairs, and
4. Identify energy or capital improvement projects for implementation in the future.

This is being completed under **Key Deliverable 11 Minor & Major Recommendations Report**. The following table summarizes the deliverables included in the project and their current status:

Deliverable #	Description	Status
1	Retro-commissioning Plan	Complete
2	Scoping Meeting Minutes	Complete
3	Facility Information & Equipment Documents	Complete
4	Building Occupant Interviews & Goals	Complete
5	Facility Performance Analysis & Performance Baseline	Complete
6	Systems Diagnostic Monitoring Plan	Complete
7	Systems Diagnostic Monitoring Report	Complete
8	Systems Test Procedures and Testing Plan	Complete
9	Systems Testing Report	Complete
10	Repair Report Summary	Complete
11	**Minor and Major Repair Recommendations Report**	**Current**
12	Final Retro-commissioning Report	5/14/2014
13	Out Briefing	5/14/2014
14	Equipment List	Complete

The content of these deliverables is summarized in the RCx Plan.

2.0 Major and Minor Recommendations

2.1 SUMMARY OF RECOMMENDATIONS

During the course of site observations, staff interviews, functional performance testing, and diagnostic monitoring, various major and minor recommendations were identified. These items were evaluated for the campus. Findings for each evaluated recommendation are categorized and presented based on the following VA project objectives:

- Indoor Environmental Quality Opportunities.
- Infection Control Improvement Opportunities.
- O&M Enhancements.
- Energy Benchmarking and Metering Enhancements.
- Energy Efficiency Opportunities.
- Other Facility Improvement Opportunities.

The summary of the repair recommendations for the Anchorage Clinic is presented in the following list. A detailed description of each recommended measure is given in the following sections. **Appendix A** contains a detailed Issues Log, while **Appendix B** shows a basic overall measure list.

- Regarding ACU-15 in the South-East Stairwell: Install Return Air (RA) ductwork the remaining 6 inches through wall and install a register.
    - On the other side of the wall is intended RA plenum location, which is under the stairs. This will allow the cooling and heating system to function more effectively by supplying the air at the top of the stairs and returning it to the FCU at the bottom. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.

- Regarding the BAS: the units for EF-13 are shown in Hz but they should be in % of full speed.
    - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-9 supplying the Lab: Re-Position the return air ductwork to better capture the heat created by the refrigeration units in the space.
    - Potentially replace the cooling coil in AHU-9 with a larger coil designed to work at a low delta temperature.

- Regarding areas with higher than average occupant comfort complaints such as the portion of the second floor served by AHU-4: Use multiple thermostats and logic to average the values in order to determine if the baseboard radiant heat should be enabled.
    - Most occupant comfort complaints come from areas where the thermostat controlling the VAV zone is located in someone else’s office. Also some areas have been converted to open office cubical areas and are conditioned from more than one zone. Combined with a thermostat in an office with a closed door or a bookshelf in front of the thermostat, and we have a recipe for poorly controlled spaces.

- Regarding the Learning Lab 2D116: this space has 12 computers and has complaints of being too warm when fully occupied. The airflow should be increased to the space if possible.
    - This space was not designed to accommodate a computer lab with a classroom type setting that becomes fully occupied for periods of time. Although the team functionally tested the VAV box, it was found to be operating correctly.

- Regarding the Unit Heaters in the penthouses: the complaint is that they can freeze up in extreme winter conditions. To remedy this the units can be operated for extended hours temporarily when extremely cold conditions are forecast
    - A more in-depth solution would be to write a control routine to periodically open the unit's HW valve without the fan running if the temperature drops below a minimum level.

- Regarding the Humidification System: there is very little filtration for the humidification system, and as a result of the hard water the rate of scale build up on the AHU coils is unusually high. To remedy the problem we recommend installing a RO system to serve all humidifiers. To prevent freezing in the winter some small measure of pre-heating may be required.
    - To prevent this, a reverse osmosis water filtration system should have been part of the original design. If AHU coil capacities are suspected of becoming reduced due to scale build up then coils should be replaced on an as needed basis.

- Regarding AHU-9: Stratification in the mixing box, can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in unit 9.
    - Suggested actions to alleviate this condition are to increase the coil capacity, or to reduce airflow to the zones in an effort to reduce load on the AHU during severe weather conditions.

- Regarding the limited flow and temperature from the Elmendorf chilled water system: the Clinic experiences a low delta T in the CHG cooling loop due to flow that is below design and entering temperature above design on the chilled well water system provided by Elmendorf. Potential remedies include removing load from the CHG loop where possible.
    - For example, running the DX unit for AHU #8, Placing the IT closet cooling on DX split systems, and using auxiliary DX units for other AHUs

- Regarding the compressed air system: the RCx study determined that the amount of compressed air produced significantly exceeds the amount of compressed air needed to run all humidification systems at full. Substantial air leaks are suspected and should be investigated and corrected.
    - Air compressor was data logged and determined to be producing more than the maximum design CFM for all humidifiers combined.

- Regarding AHU-5: During functional testing it was discovered that the CHG temperature should be much lower than actual temperature per design. To remedy the situation the CHG supply temperature must be lowered or the coil must be replaced with a coil that can function at a low delta temperature.

- The coil is designed for a 22 Degree delta temperature, with a 46F supply temperature; however a supply temperature of 53F to the coil was measured. At the elevated CHG temperature the coil will never be able to perform as designed.

- Regarding VAV box Griswold valves becoming clogged with metallic debris: a preventative maintenance program should be instituted to check and replace valve cartridges periodically. Focus should be made on spaces which exhibit above average heating time, or complaints of being too cold.
  - Evidence of a valve clogged with metallic debris was shown to the team, however all VAV box functional tests were passed. First Floor VAV boxes are more likely be bad.

- Regarding AHU-3 freezing up: Stratification in the mixing box can cause the coil to freeze up and presents a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in unit 9. Ways to alleviate this problem include an OSA reset to keep dampers at a minimum position when conditions are colder than a threshold, and increasing the size of the preheat coil.
  - Staff remedy this problem by placing cardboard over parts of the coil that freeze.

- Regarding the space temperature sensor for the VAV 1-203 space: the sensor has obviously failed and should be replaced. The whole thermostat will most likely need to be replaced with a new unit.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-1 Supply Fan Schedule: it was discovered that the supply fan starts at 2:00 am daily. To improve energy efficiency this fan should be scheduled to start at 6:00 am M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-2 Supply Fan Schedule: it was discovered that the supply fan does not shut down at night. A static pressure of 1” W.C. is maintained at night, higher when occupied hours. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-2 Return Fan Schedule: it was discovered that the return fan does not shut down at night. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding AHU-3 Supply Fan Schedule: it was discovered that the supply fan does not shut down at night. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.
  - This can be corrected as a “Simple Repair” under the RCx project scope.
- Regarding AHU-4 Supply Fan and Return Fan Schedule: it was discovered that the fans do not shut down at night. Fan runs on weekend as well. To improve energy efficiency this fan should be scheduled to start one hour before the occupied schedule M-F.

- This can be corrected as a “Simple Repair” under the RCx project scope.

- Regarding the Lobby Lighting: although not a HVAC deficiency the Lobby Lighting was observed to be operating when daylight was much more than sufficient. To save energy, an Ambient Lighting Sensor should be used to secure the Lobby Lighting when ambient light levels exceed a predetermined threshold due to the large amount of windows and skylights.

- Regarding the IT closet cooling: To reduce load on the Chilled Glycol loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs have the CHG coils supplemented with DX evaporator coils served by mini-split system type air conditioning units with air cooled condenser and premium efficiency compressor. This will reduce load on the Chilled Glycol loop in addition to providing redundant cooling.

- Regarding Metering the district provided cooling that the Clinic purchases from Elmendorf: no accurate metering exists to measure the BTU’s flow rate and delta temperature of the provided chilled well water loop. We recommend installing a BTU meter to measure the Chilled Well Water Loop.
  - This is a benchmarking improvement opportunity.

- Regarding Metering the district provided heating that the Clinic purchases from Elmendorf: no accurate metering exists to measure the BTUs of heat provided. We recommend installing a BTU meter to measure the heating energy.
  - This is a benchmarking improvement opportunity.

Estimated construction/installation costs have been prepared for all recommendations. Energy savings were estimated for the recommendations in the Energy Efficiency Opportunities category to determine the benefit/cost ratios. Energy savings were calculated using spreadsheet analysis. Calculations for Energy Efficiency Opportunities have been documented and information is included in **Appendix C**.

2.2 INDOOR ENVIRONMENTAL QUALITY OPPORTUNITIES

Indoor environmental quality (IEQ) refers to the quality of a building’s environment in relation to the health and wellbeing of those who occupy space within it. IEQ is determined by many factors. The RCx team focused on IEQ factors associated with the HVAC systems including indoor temperatures, relative humidity, and ventilation levels that affect how individuals respond to the indoor environment. The results of the evaluation are presented in the following sections.

2.2.1 Occupant Comfort Improvements

SE STAIRWELL ACU-15: CONNECT RETURN AIR DUCT TO SPACE

The return air duct to the SE stairwell FCU was never finished. The duct should be connected the remaining 6 inches through the wall into the stairwell area. Please see photo at right showing where the duct should penetrate the wall and have a register installed.

The stairwell is enclosed on one side by glass windows and acts like a greenhouse in the summer, trapping heat and making the stairwell quite uncomfortable in the summer. Currently, there is no return duct connecting the FCU to the space. Supply air is delivered at the top of the stairwell near the second floor landing. If the return plenum were connected at the bottom of the stairwell better circulation would allow the FCU to effectively remove the heat as designed. We also recommend adding directional diffusers to the supply air register at the top of the stairs to direct the supply air away from the upstairs landing for optimum circulation.

The benefits of this recommended corrective action include the following:

- Improved air circulation and optimized cooling in the stairwell

This measure would be implemented by a mechanical contractor as part of a minor project. The estimated installation cost of this project is approximately $2,500.

REPOSITION RETURN AIR REGISTERS IN LAB

AHU-9 serves the Lab. The Lab space was not designed to accommodate the refrigeration units used. As a result the refrigeration units produce additional heat and the space becomes uncomfortably warm. Return air ductwork should be extended by 2 to 4 feet closer to the high cooling load equipment with registers directly above refrigeration equipment in an effort to better capture the heat produced and remove it from the Lab as quickly as possible. See photo at right. Additional airflow should also be sought through a balancing of the VAV box serving the space. AHU-9 cooling coil could be replaced at an additional expense if simpler remedies do not alleviate the comfort complaints. Supply airflow measurements were taken as part of the functional testing phase; however they showed that the system is operating as designed.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort in the Lab
- Ability to reliably control the space temperature in the Lab

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project to reposition the ductwork and registers is approximately $9,000. If the coils are to be resized the estimated expense will be approaching $50,000.

USE MULTIPLE THERMOSTATS TO BALANCE TEMPERATURE COMMAND TO OPTIMIZE BASEBOARD RADIANT HEATERS

In areas with higher than average occupant comfort complaints such as AHU-4 serving the second floor, we recommend using multiple thermostats and logic to average the values in order to determine if the baseboard radiant heat should be enabled. Most occupant comfort complaints come from areas where the thermostat controlling the VAV zone is located in an adjacent office or further. Also, some areas have been converted to open office cubical areas and are conditioned from multiple zones. Combined with a thermostat in an office with a closed door or a bookshelf in front of the thermostat, and we have a recipe for poorly controlled spaces. With the control routines in place, it is possible to be simultaneously heating and cooling the same space if there are more than one VAV box and baseboard radiant heaters serving an open office area.

This corrective action is recommended for the following systems:

- All areas with above average occupant comfort complaints that have been used as open office areas.
- Spaces served by AHU-4 on the second floor are noted to display this issue.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort
- Energy and savings from reducing simultaneous heating and cooling

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is approximately $50,000.

INCREASE AIRFLOW TO THE LEARNING LAB 2D116

The learning lab is set up similar to a classroom with 12 computers. Occupants complain that the space is too warm when fully occupied for training sessions, etc. This space was not designed to contain 12 computers and support a dense occupant load such as during a training session. In order to improve occupant comfort we recommend increasing the airflow to the VAV box serving the space.

The benefits of this recommended corrective action include the following:

- Improved occupant comfort

This measure would be implemented by a mechanical contractor as part of a TAB project. The estimated installation cost of this project is approximately $900.

REDUCE LOAD ON CHILLED GLYCOL LOOP

Because of the limited chilled water flow and temperature from the Elmendorf chilled water system the Clinic experiences a higher Chilled Glycol Cooling supply temperature as a result of the chilled water flow that is below design and entering chilled water temperature above the original design. This issue will only become worse over time.

Potential remedies include removing load from the Chilled Glycol loop wherever possible. For example, running the DX system unit for AHU-8, placing the IT closet cooling on DX split systems and using auxiliary DX units for other AHUs similar to AHU-8.

In general, the supplied chilled water temperature to the Elmendorf side of the heat exchanger is too high. The clinic was designed for specific supply temperature and flow if the supply temperature and flow rate deviate from design the hospital cannot meet its cooling loads. In order to reduce the Chilled Glycol temperature, the well water flow rate must be increased and the entering well water temperature must be lowered on the primary side of the heat exchangers.

The benefits of this recommended corrective action include the following:

- Improved Occupant Comfort
- Adequate heat removal capacity will allow AHUs to be shut off at night without fear of the building temperature rising above their ability to cool.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is approximately $3,000 per ton of additional supplementary cooling.

REDUCE CHILLED GLYCOL LOOP TEMPERATURE OR INSTALL NEW COOLING COILS TO AHU -5

Related to the previous measure, AHU-5 was observed to be unable to meet Supply Air Temperature set-point during functional testing performed in January. In winter this can be corrected by lowering the MAT set-point and bringing in a larger percentage of outside air. In summer however, the cooling coil will not be able to keep up. CHG temp should be much lower (46°F per design documents). This is a 22°F coil per design drawings; however AHU-5 was being provided 53°F glycol. This is just one example; Chilled Glycol loop temperature was above design and will therefore affect all AHUs. This issue will only become worse over time.

Potential remedies include installing larger cooling coils in AHUs which are designed for the reduced delta temperature experienced, and also lowering the CHG loop temperature.

The benefits of this recommended corrective action include the following:

- Improved Occupant Comfort
- Adequate heat removal capacity will allow AHUs to be shut off at night without fear of the building temperature rising above their ability to cool.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in estimated to be $15,000 to $25,000 per air handler.

2.2.2 Indoor Air Quality Improvement

In general, no IAQ deficiencies were found. O&M opportunities to improve IAQ were not identified.

2.3 INFECTION CONTROL IMPROVEMENT OPPORTUNITIES

The following parameters were used to evaluate the opportunities to improve infection control:

- Cleanliness of filters.
- Operability of ventilation dampers.
- Calibration of critical space or AHU temperature control sensors.
- Calibration of critical humidity control sensors.
- Space pressurization.
- Air change rates.

In general, O&M opportunities to improve infection control were not identified. Filters were clean and were observed to be on a routine changing schedule. The majority of critical areas utilize 100% OA installations. Dampers were operable for units serving patient areas for the remaining equipment. Temperature sensors were point to point tested for the critical equipment.

2.4 O&M ENHANCEMENTS

The results of the site personnel interviews, functional performance testing and diagnostic monitoring were used to evaluate O&M opportunities. Recommended corrective actions to improve the existing preventative maintenance program and identify O&M personnel training opportunities were also evaluated. The results of the evaluation are presented in the following sections.

2.4.1 Preventive Maintenance Program

INSTITUTE A PM PROGRAM TO REPLACE VAV BOX GRISWOLD VALVE CARTRIDGES

A few VAV box Griswold valves have become clogged with metallic debris over time. A preventative maintenance program should be instituted to check and replace valve cartridges periodically. Focus should be placed on spaces which exhibit above average heating time, or complaints of too cold. Evidence of a valve clogged with metallic debris was shown to the team, however all VAV box functional tests were passed. First Floor VAV boxes are more likely be clogged.

The facilities maintenance service provider (FSI) brought this issue to the RCx team's attention.

This corrective action is recommended for the following systems and buildings:

- All VAV Terminal Units, especially the first floor units.

The benefits of this recommended corrective action include the following:

- Restore heating performance

This measure would be implemented by the existing HVAC maintenance service contractor. During unoccupied hours the contractor would check and replace VAV box heating Griswold valve cartridges. This is not a time critical issue and could be done in a slow methodical process. This measure would be added to the existing scheduled PM work. The estimated implementation cost of this project is $0.00, with an ongoing cost that depends on the rate at which the valves are checked.

2.4.2 O&M Personnel Training

The overall system maintenance on the campus is excellent; the O&M personnel evidently have more than satisfactory training and experience. The personnel have a good understanding of how preventative maintenance procedures and can significantly impact the overall campus energy use and system longevity.

- Filters are changed on a routine schedule in order to maintain static pressure
- Coils are cleaned on a regular basis. Water treatment options are being investigated that can increase the coil lifespan and reduce the number that need replacement, although the hard water is effecting coils already.
- The tension of fan belts is regularly checked, and bearings are greased regularly as well as other PM items.

The RCx team does not believe that the HVAC service contractor personnel need any additional training.

2.5 ENERGY BENCHMARKING AND METERING ENHANCEMENTS

Metering opportunities and additional HVAC BAS logging enhancements were considered for enhancing the energy benchmarking capability of the campus.

INSTALL BTU METERING TO MEASURE DISTRICT HEATING AND COOLING WATER LOOPS

District Provided Heating Water and Chilled Well Water Loops currently do not have working flow measurement devices in place. To properly benchmark the energy use at the Clinic building, the energy sources obtained from Elmendorf should be metered. BTU metering involves measurement of the flow as well as the entering and leaving fluid temperatures as provided to the Clinic building.

This corrective action is recommended for the following systems and buildings:

- Chilled Well Water Loop from Elmendorf.
- Heating Hot Water Loop from Elmendorf.

The benefits of this recommended corrective action include the following:

- Improved benchmarking capabilities

This measure would be implemented by a mechanical contractor. The estimated installation cost of this project is approximately $9,000 for both loops.

2.6 ENERGY EFFICIENCY OPPORTUNITIES

During the course of testing and monitoring, various energy conservation measures (ECMs) were identified that would produce economic benefit. Economic analysis was performed for these ECMs to determine the simple payback period. Energy savings were calculated using spreadsheet analysis. The energy use of the current equipment operation was determined from data gathered in the field. Savings were calculated based on anticipated operational changes for each measure. Electric rates are based on the current utility rates which are presented in the table below.

Table 2-1: Utility Rates

Electric Utility Rate: Large Commercial	
Aggregate Rate ($/kWh)	Aggregate Rate ($/kW)
$ 0.105	$ 13.64
Gas Utility Rate: JBEAR	
Average Aggregate Gas Rate	$0.800/therm

The following table presents all of the recommended energy conservation measures that were analyzed. A summary of each recommended measure is given in the following sections.

Table 2-2: ECM Savings and Cost Summary

LOG #	MECH EQUIPMENT NAME	RECOMMENDED MEASURE	MEASURE TYPE	ECM #	ENERGY SAVINGS (kWh/yr)	ENERGY $ SAVINGS ($/yr)	EST. MEASURE COST ($)	SIMPLE PAYBACK (yrs)
10	Compressor	Investigate compressed air system for leaks, stop leaks as found.	Major	1	70,192	$ 7,370	$ 2,000	0.3
22	AHU-1	Schedule AHU-1 Supply Fan to start at 6:00 am, Monday thru Friday.	Simple	2	12,750	$ 1,339	$ -	0.0
24	AHU-2	Schedule AHU-2 Supply Fan to start 1 hour before occupied schedule daily. Since this space is not supposed to be occupied on weekends, AHU-2 Supply Fan should be secured on the weekend as well as at night.	Simple	3	41,970	$ 4,407	$ -	0.0
25	AHU-2	Schedule AHU-2 Return Fan to start 1 hour before occupied schedule daily.	Simple	4	460	$ 48	$ -	0.0
27	AHU-3	Schedule AHU-3 Supply Fan to start 1 hour before occupied schedule daily. Since this space is not supposed to be occupied on weekends, AHU-3 Supply Fan should be secured on the weekend as well as at night.	Simple	5	25,184	$ 2,644	$ -	0.0
28	AHU-4	Schedule AHU-4 Supply Fan and Return Fan to start 1 hour before occupied schedule daily. Since this space is not supposed to be occupied on weekends, Fans should be secured on the weekend as well as at night.	Simple	6	82,939	$ 8,709	$ -	0.0
29	Lobby Lighting	Install an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights.	Minor	7	26,981	$ 2,833	$ 2,500	0.9
TOTAL					**260,476**	**$ 27,350**	**$ 4,500**	**0.2**

2.6.1 ECM-1: Locate & Stop Compressed Air Leaks

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- Compressed Air System (Non-Medical)

AS-FOUND CONDITIONS

Hypothesis: Suspected Air Leaks. 1. Because load was not satisfied by original compressors 1 & 2 (20hp). VA installed 60hp comp. 2. The System was data-logged found to have an average load of 28.4 kW, which is equivalent to 38.1 bhp. We expect to see at least 4 CFM/HP @ 100 psig. Therefore, the 60hp compressor would produce about 160 CFM @ 100 psig, where the Clinic only needs approximately 40 CFM @ 100 psig per the humidification system design. HP = 0.030*P*(R0.145-1) 3. Therefore, a substantial air leak(s) is present or the original system design is incorrect.

PROPOSED MODIFICATIONS

We propose that an in-depth investigation be made into sources of air leaks in the system. Leaks should be stopped. This work could be done by an outside specialist contractor or by the in-house HVAC maintenance contractor FSI as determined by contractual obligations.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-3: Estimated Energy and Cost savings

ECM 1: Locate and Stop Compressed Air Leaks											
#	Equipment	HP	Baseline Avg kW	Baseline kWh	Max. Req'd Airflow (ACFM)	Avg. kW (post)	kWh (post)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AC-1 Curtis: OL101HTID20-A4	10	0.0	-	-	0.0	-	-	$ -	see below	
2	AC-2 Curtis: OL101HTID20-A4	10	0.0	-	-	0.0	-	-	$ -	see below	
3	AC-3 Curtis: AF-280	60	28.4	96,101	41.1	7.7	25,908	70,192	$ 7,370	see below	
TOTAL				**96,101**	**41.1**	**7.7**	**25,908**	**70,192**	**$ 7,370**	**$ 2,000**	**0.3**

Notes:

1. Baseline kWh from data logging.
2. Blended electric rated used for financial savings. No Demand Savings shown.
3. Based upon theoretical equations the CFM per brake horsepower is approximately 6.4 CFM per Hp.
4. To be conservative 4.0 CFM per Hp is used in calculations.
5. Required Max Flow Rate is from Provided Design Drawings

2.6.2 ECM-2: Schedule AHU-1 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-1 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-1 starts 4 hours before the return fan. The fans should start at 6:00 am, which is one hour before building occupancy schedule begins. AHU-1 Supply fan was also observed to be running on the weekend. The supply fan for AHU-1 has a 50 hp motor and runs on a VFD at an average speed of 45 Hz during occupied periods and 31.2 Hz during unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing a reduced schedule for the Supply Fan that starts one hour before occupancy or at 6:00 am Monday thru Friday. Weekend runtime will be eliminated.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a "simple repair" under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-4: Estimated Energy and Cost savings

ECM 2: Schedule AHU-1 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-1 Supply Fan	50	31.2	8.2	1,560	12,750	$ 1,339	no cost	immediate
TOTAL						**12,750**	**$ 1,339**	**$ -**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed from 2:00 am to 6:00 am (≈ 31.2Hz)

2.6.3 ECM-3: Schedule AHU-2 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-2 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-2 does not shut down at night, i.e. 24/7 operation. Static pressure of 1" is maintained during off hours, when occupied static pressure of 1.05" to 1.37" is maintained. The Supply Fan for AHU-2 was also observed to be running on the weekend. The supply fan for AHU-2 has a 50 hp motor and runs on a VFD at an average occupied/unoccupied speed of 30.6 Hz.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be eliminated.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-5: Estimated Energy and Cost savings

ECM 3: Schedule AHU-2 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-2 Supply Fan	50	30.6	7.8	5,380	41,970	$ 4,407	no cost	immediate
TOTAL						**41,970**	**$ 4,407**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.4 ECM-4: Schedule AHU-2 Return Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-2 Return Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Return Fan for AHU-2 runs at a different schedule in the summer and the winter. During the winter the fans shuts down at 7:15 pm as expected, however last summer the fan was being shut down at 10:15 pm, presumably to cool the building. The Supply Fan for AHU-2 was also observed to be running on the weekend but the return fan does not, schedules for supply and return fans should match. The Return Fan for AHU-2 has a 20 hp motor and runs on a VFD at an average speed of 20 Hz.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Return Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-6: Estimated Energy and Cost savings

ECM 4: Schedule AHU-2 Return Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-2 Return Fan	20	20.4	1.2	390	460	$ 48	no cost	immediate
TOTAL						**460**	**$ 48**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.5 ECM-5: Schedule AHU-3 Supply Fan to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-3 Supply Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan for AHU-3 operates longer hours than the return fan. The Supply fan starts 4 hours early, it should start at 6:00 am but it is starting at 2:00 am. The Supply Fan for AHU-3 was also observed to be running on Saturdays. The supply fan for AHU-3 has a 50 hp motor and runs on a VFD at an average speed of approximately 44.4 Hz during occupied and 35.4 Hz during unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be curtailed.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-7: Estimated Energy and Cost Savings

ECM 5: Schedule AHU-3 Supply Fan to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-3 Supply Fan	50	38.4	13.5	1,872	25,184	$ 2,644	no cost	immediate
TOTAL						**25,184**	**$ 2,644**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.6 ECM-6: Schedule AHU-4 Supply & Return Fans to Operate from 6:00 am to 7:00 pm Monday thru Friday

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-4 Supply Fan
- AHU-4 Return Fan

AS-FOUND CONDITIONS

During Trend Data Analysis it was noticed that the Supply Fan and the Return Fan for AHU-4 do not shut down at night, i.e. 24/7 operation. The fans run at a lower static pressure when unoccupied, but fans are running 24/7. A higher static is maintained for longer hours in the summer than in the winter. Both fans were observed to be running on weekends. The supply fan for AHU-4 has a 60 hp motor and runs on a VFD at an average speed of 38 Hz during occupied periods and 33.6 Hz during Unoccupied periods. The return fan for AHU-4 has a 25 hp motor and runs on a VFD at an average speed of 29.4 Hz during Unoccupied periods.

PROPOSED MODIFICATIONS

This recommended measure will save fan energy by implementing schedule for the Supply Fan that starts one hour before occupancy, or at 6:00 am Monday thru Friday. Weekend runtime will also be curtailed.

The existing controls system is capable of accomplishing the recommended schedule change. A building operator could accomplish this simple programming change. The strategy parameters would be approved by the VA site team prior to implementation. The reset strategy can be implemented with minimal impact on overall HVAC system operation, and no system outages need to be scheduled. This change can be implemented as a “simple repair” under the RCx project scope at no additional cost to the VA.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-8: Estimated Energy and Cost savings

ECM 6: Schedule AHU-4 Supply & Return Fans to run from 6:00 am to 7:00 pm M-F									
#	Equipment	HP	Avg. Speed (Hz)	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	AHU-4 Supply Fan	60	33.6	11.7	5,380	63,038	$ 6,619	no cost	immediate
1	AHU-4 Return Fan	25	29.4	3.7	5,380	19,902	$ 2,090	no cost	immediate
TOTAL						**82,939**	**$ 8,709**	**no cost**	**immediate**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.
2. Simple Repair Measure, can be repaired under the RCx project scope at no additional cost to the VA.
3. Average Speed Reduction takes into account speed during periods when fan is to be secured

2.6.7 ECM-7: Install Ambient Lighting Controls on Lobby Lighting.

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- 400-watt Metal Halide Lighting Fixtures in Lobby
- 350-watt Metal Halide Lighting Fixtures in Lobby

AS-FOUND CONDITIONS

Although not a HVAC deficiency, the lobby lighting was observed to be operating when daylight was much more than sufficient. To save energy, an Ambient Lighting Sensor should be used to secure the lobby lighting when ambient light levels are sufficient due to the large amount of windows and skylights. The lighting fixtures are metal halide of 350 to 400-watts each, and are currently controlled by a time-schedule.

PROPOSED MODIFICATIONS

We recommend installation of an Ambient Lighting Sensor (ALS) to control the lobby lighting. An ALS would be used to turn off the lobby lighting on bright sunny days when it is completely unnecessary due to the large amount of windows and skylights. The existing BAS can accommodate this change.

A controls contractor would be responsible for programming the strategy and performing functional testing of the strategy for the lighting system. The strategy parameters would be approved by the VA site team prior to implementation. The conservation strategy can be implemented with minimal impact on overall lighting system operation, and no system outages need to be scheduled.

SUMMARY OF SAVINGS

The implementation cost and energy savings are presented in the following table. The detailed calculations workbook is available in **Appendix C**.

Table 2-9: Estimated Energy and Cost savings

ECM 7: Install Ambient Lighting Controls on Lobby Lighting									
#	Fixture Description	Qty.	Fixt. Watts	Avg kW	hrs to be Reduced (pre)	kWh Saved	kWh $ Saved	Measure Cost	Simple Payback (yrs)
1	MH 400-watt Lobby Lighting Fixtures "HA/500"	20	458	9.16	2,190	20,060	$ 2,106	see below	see below
2	MH 350-watt Lobby Lighting Fixtures "HB/400"	8	395	3.16	2,190	6,920	$ 727	see below	see below
TOTAL		**28**		**12.3**		**26,981**	**$ 2,833**	**$ 2,500**	**0.9**

Notes:

1. Blended electric rated used for financial savings. No Demand Savings shown.

2.7 OTHER FACILITY IMPROVEMENT OPPORTUNITIES

Several facility improvement measures (FIMs) were identified through the retro-commissioning process. A summary of each recommended measure is given below. These measures were not evaluated to the same level of detail as the EEMs. Costs estimates are included for select measures where appropriate. The following high level information can be used by the VA staff for capital budgeting and long range planning.

2.7.1 FIM-1: Change BAS units shown for EF-13 speed

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- BAS speed value for EF-13

AS-FOUND CONDITIONS

The BAS displays the units for the speed of EF-13 as Hz; however units should be changed to % of full speed because the values displayed are above 60 making it obvious that the speed is actually being reported as a percent. Units are only thing that is not correct.

PROPOSED MODIFICATIONS

As part of the “Simple Repair” scope of the RCx project the units displayed on the BAS can be changed from “Hz” to “%” for EF-13 speed. There would be no additional cost to the VA to make this change.

2.7.2 FIM-2: Run Penthouse Unit Heaters Extended Hours Temporarily During Extreme Cold Weather

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- All unit heaters in penthouses

AS-FOUND CONDITIONS

This Issue was brought to the attention of the RCx team by the HVAC service contractor. The unit heaters in the penthouses can freeze up in extreme winter conditions. During the winter that the RCx team was at the facility the conditions were mild and this problem was not observed. An additional check would be to measure the differential pressure over the heater coil, if low that could be why freezing; however the conditions under which the issue was described are extreme cold (negative temperatures) for prolonged periods of 2 weeks or more.

PROPOSED MODIFICATIONS

If this problem is expected to occur due to especially cold forecasted conditions, the unit heaters should be operated extended hours on a short term basis to keep the penthouses above freezing. A more in-depth solution would be to write a control routine to periodically open the unit's HW valve without the fan running if the temperature drops below a minimum level as a last ditch effort to prevent coil freeze up.

This modification can be implemented by the HVAC service contractor at no additional cost to the VA.

2.7.3 FIM-3: Install RO Water Filtration Equipment for Humidification System

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- All Humidification water supplies to Humidifiers in AHUs. Service to each Penthouse would be required.

AS-FOUND CONDITIONS

The water contains a high level of minerals and the AHU chilled water coils get coated with mineral deposits when the humidification is running. The mineral deposits result in an increase in static pressure with a reduction in airflow distributed to the spaces. FSI cleans the coils, and are testing different cleaners, but we are concerned about the longevity of the coils. In addition, when the OSA temperature drops below a threshold, the humidification dispersion units in AHU-

8 and 9 freeze up. This results in staff having to remove the dispersion units to let them defrost.

PROPOSED MODIFICATIONS

Install Reverse Osmosis filtration equipment to serve the humidification systems in all penthouses. If TAB contactor determines actual coil capacities are significantly below submitted coil capacity then coils should also be replaced on an as-needed basis if AHU cannot meet load. Installing RO filtration will significantly reduce the rate of scale build up but will not repair any impact already suffered.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $75,000 not including any coil replacements.

2.7.4 FIM-4: Replace Pre-Heat Coil on AHU-9 or Reduce Load when OSA conditions are Extreme

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-9

AS-FOUND CONDITIONS

Stratification in the mixing box can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the preheat coil in AHU-9.

PROPOSED MODIFICATIONS

Chang the preheat coil to increase capacity and possibly try to reduce airflow to certain downstream zones determined to be non-critical, if able to, in an effort to reduce load on the AHU during severe weather conditions.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $25,000.

2.7.5 FIM-5: Replace Heating Coil on AHU-3

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- AHU-3

AS-FOUND CONDITIONS

Stratification in the mixing box can cause coil freeze up and a problem for the atomizing humidifier. There are issues with evenly distributed airflow over the Heating coil in AHU-3. Building staff remedies this with some cardboard placed over part of the heating coil in the unit, blocking the portion that gets hit with the most outside air to prevent it from freezing up.

PROPOSED MODIFICATIONS

Heating coil is too small or the amount of OSA is too large when conditions are severe. Recommended action is to increase size of heating coil and or reduce the amount of OSA to the minimum required by code when outside air temperature is severely cold.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $25,000.

2.7.6 FIM-6: Replace Thermostat in Zone VAV 1-203

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- Space Temperature Sensor (Thermostat) for zone VAV 1-203

AS-FOUND CONDITIONS

During monitoring data analysis it was discovered that the space temperature sensor had failed (reporting all zeroes).

PROPOSED MODIFICATIONS

The thermostat can be replaced under the “Simple Repair” scope of the RCx project at no additional cost to the VA.

2.7.7 FIM-7: Retrofit IT Equipment Cooling to DX Units

APPLICABLE BUILDINGS AND SYSTEMS

This measure is recommended for the following buildings and systems:

- IT Equipment / Server Closet Cooling FCUs

AS-FOUND CONDITIONS

While not strictly a deficiency since the existing CHG loop FCUs were found to be functioning well to remove heat from IT equipment spaces, they could be removed from the CHG loop to reduce load on the loop.

There are two issues that provoke this recommendation, #1 is the reduced capacity of the chilled glycol system due to increased well water temperatures and flow rate restrictions placed on the clinic by Elmendorf's central plant, every means to reduce load on the CHG loop should be considered. And #2 is the fact that the main CHG pumps run at night only to serve the IT space fan coil units, if the pumps were shut down on nights and weekends then there would be considerable energy savings. During winter months the AHUs can cool the building with outside air, but when conditions are warmer the reduced flow and increased well water temperature mean that some of the AHUs are run at night to prevent heat from building up beyond what can be removed, requiring nighttime pumping as well.

PROPOSED MODIFICATIONS

To reduce load on the CHG loop and thereby improve performance of the AHU cooling coils we recommend that the IT/server closet FCUs have the CHG coils replaced with DX evaporator coils served by rooftop mini-split system type air conditioning units with air cooled condenser and premium efficiency compressor. Each space would be served by a separate unit. If coil only retrofit is not practical then new indoor DX evaporator (mini split) units should be used.

This measure would be implemented by a mechanical contractor as part of a design-build project. A thorough engineering analysis and design would need to be completed to evaluate the replacement system capacities and for developing full project implementation costs. The estimated installation cost of this project is in excess of $100,000.

Appendix-K

For Final RCx Report

CFR / VA Design Guide Summary

(see Appendix-C Section 2.4)

Appendix-L

For Final RCx Report

Out-Briefing Meeting Minutes

Appendix-M

For Final RCx Report

Equipment List

VISN 20 Alaska VA Healthcare System

Equipment List

APRIL 16, 2014

Prepared for:
U.S. Department of Veteran's Affairs
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Anchorage, AK 99504

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HVAC PUMP SCHEDULE																			
#	Draw #	Tag ID	Pump Manuf	Pump Model	IMP Dia	Location	Serves	Qty Motors	Hp	Pump % Eff	GPM	Temp. (°F)	Head (ft)	Mtr Manuf	Volt	Ph	Mtr Eff %	RPM	Note
1	MH003	P-1A/1B	Armstrong	4030	10.36	1C163	VA Clinic Primary Ht Loop	2	30	83%	779	188	92	TECO	480	3	94.1%	1750	VFD
2	MH003	P-2A/2B	Armstrong	4030 BF	7.57	3A102	AHU-1, 2 & 7 Heating Coils	2	3	57%	92	188	52	TECO	480	3	89.5%	1750	VFD
3	MH003	P-3A/3B	Armstrong	4030 BF	7.46	3A102	AHU-1, 2 & 7 Re-Heat & Perim Heat	2	5	65%	172	188	49	TECO	480	3	89.5%	1750	VFD
4	MH003	P-4A/4B	Armstrong	4030	6.78	3D101	AHU-3, 4 & 8 Re-Heat & Perim Heat	2	3	69%	125	188	41	Baldor	480	3	90.2%	1750	VFD
5	MH003	P-5A/5B	Armstrong	4030	7.55	3D101	AHU-3, & 8 Heating Coils	2	2	56%	70	188	55	TECO	480	3	86.5%	1750	VFD
6	MH003	P-6A/6B	Armstrong	4030 BF	6.65	3C101	AHU-5, & 9 Heating Coils	2	1	59%	41	188	35	Baldor	480	3	85.5%	1750	VFD
7	MH003	P-7A/7B	Armstrong	4030 BF	6.86	3C101	AHU-4, 5 & 9 Re-Heat & Perim Heat	2	3	74%	157	188	41	TECO	480	3	89.5%	1750	VFD
8	MH003	P-8A	Armstrong	4380	6.188	3B100	AHU-4, & 6 Heating Coils	1	1.5	64%	79	188	36	Baldor	480	3	86.5%	1750	VFD
9	MH003	P-8B	Armstrong	4380	6.188	3B100	AHU-4, & 6 Heating Coils	1	1.5	64%	79	188	36	WEG	480	3	84.0%	1750	VFD
10	MH003	P-9A	Armstrong	4380	8	1C163	Radient Floor Tertiary Loop	1	1	38%	17	125	45	Baldor	480	3	85.5%	1750	
11	MH003	P-9B	Armstrong	4380	8	1C163	Radient Floor Tertiary Loop	1	1	38%	17	125	45	WEG	480	3	85.5%	1750	
12	MH003	P-10A/10B	Armstrong	4030 BF	3.08	2F100	AHU-11 Heat, Re-Heat & Perim Heat	2	1	42%	35	188	41	Baldor	480	3	86.5%	1750	VFD
13	MH003	P-11A/11B	Armstrong	4030 BF	9	1C163	Entrance Snowmelt Tertiary Loop	2	5	60%	112	133	72	TECO	480	3	-	1750	
14	MH003	P-12A/12B	Armstrong	4030 BF	7.86	1C163	Patio Snowmelt Tertiary Loop	2	1.5	43%	33	133	57	Baldor	480	3	86.5%	3450	
15	MH003	P-13A/13B	Armstrong	4030 BF	10.18	1C163	Primary Cooling Loop	2	20	79%	511	46	100	TECO	480	3	93.0%	1750	VFD
16	MH003	P-14A/14B	Armstrong	4030 BF	8.35	CP01	Central Plant Pri Ht Loop	2	15	82%	728	190	50	Baldor	480	3	93.0%	1750	VFD
17	MH003	P-15A/15B	unk	unk	unk	1C16X	Charge Air Cooler Loop	2	3	58%	75	127	60	unk	480	3	unk	3450	

VISN 20 Alaska: Equipment List

HEAT EXCHANGER SCHEDULE												
#	Draw #	Tag ID	Location	Serves	Description	BtuH	Pri GPM	Sec GPM	Pri EGT	Pri LGT	Sec EGT	SEC LGT
1	MH003	HX-1A&B	Central Plant	Heating System	Plate&Frame HX	10,853,000	728	779	190	160	158	188
2	MH003	HX-2A&B	VA Mech Room	Cooling System	Plate&Frame HX	4,178,000	160	511	44	66	68	46
3	MH003	HX-3	VA Mech Room	Snow Melt	Plate&Frame HX	1,619,000	113	144	188	156	108	133
3		HWG-1	VA Mech Room	DHW	Tube in Shell	410 GPH			188	170	102	120
3		HWG-2	VA Mech Room	DHW	Tube in Shell	410 GPH			188	170	102	120
3		HWG-3	PH 3D101	Softened Hot Water Generator		37 GPH						
3		HWG-4	PH 3B100	Kitchen 170F Heater		49 GPH						

VISN 20 Alaska: Equipment List

AHU SCHEDULE																			
#	Draw #	Tag ID	Manufacturer	Model #	Location	Serves	Fan Type	Arrangement	Max Length (IN)	Hp	CFM Rated	TSP (in-W.C.)	Wheel Dia	Drive	Volt	Ph	Amps	RPM	Notes
1	MH-006	AHU-1	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3A102	General Clinic			606										
2	MH-006					SUPPLY	Plug	Front Discharge		50	32640	5.9	52.88	BELT	480	3	58.4	829	VFD
3	MH-006					RETURN	Centrifugal	Front Discharge		20	27490	0.9	36	BELT	480	3	24.0	822	VFD
4	MH-006	AHU-2	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3A100	General Clinic			560										
5	MH-006					SUPPLY	Plug	Front Discharge		50	32760	5.6	52.88	BELT	480	3	58.4	828	VFD
6	MH-006					RETURN	Centrifugal	Front Discharge		20	27620	0.9	36	BELT	480	3	24.0	835	VFD
7	MH-006	AHU-3	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3D101	General Clinic			556										
8	MH-006					SUPPLY	Plug	Front Discharge		50	32890	5.8	52.88	BELT	480	3	58.4	826	VFD
9	MH-006					RETURN	Centrifugal	Front Discharge		20	28210	0.9	36	BELT	480	3	24.0	830	VFD
10	MH-006	AHU-4	Silent-Aire Manufacturing Inc.	SA-880PL-IHCV-RFH	Penthouse 3B100	General Clinic			633										
11	MH-006					SUPPLY	Plug	Front Discharge		60	35730	6.0	58.5	BELT	480	3	68.0	729	VFD
12	MH-006					RETURN	Centrifugal	Front Discharge		25	26070	0.9	40	BELT	480	3	31.0	725	VFD
13	MH-006	AHU-5	Silent-Aire Manufacturing Inc.	SA-800PL-IHCV-RFH	Penthouse 3C101	General Clinic			536										
14	MH-006					SUPPLY	Plug	Front Discharge		50	29040	6.2	43.44	BELT	480	3	58.4	1097	VFD
15	MH-006					RETURN	Centrifugal	Front Discharge		20	25650	0.9	33	BELT	480	3	24.0	418	VFD
16	MH-006	AHU-6	Silent-Aire Manufacturing Inc.	SA-540PL-IHCV-RFH	Penthouse 3B100	Lobby			212										
17	MH-006					SUPPLY	Plug	Front Discharge		25	12980	6.1	32.38	BELT	480	3	29.7	1370	VFD
18	MH-006					RETURN	Centrifugal	Front Discharge		10	11230	0.9	25	BELT	480	3	12.5	539	VFD
19	MH-006	AHU-7	Silent-Aire Manufacturing Inc.	SA-400PL-IHCM-FH	Penthouse 3A102	Dental			286										
20	MH-006					SUPPLY	Plug	Front Discharge		15	8250	4.5	21.56	BELT	480	3	18.1	2414	VFD
21	MH-006	AHU-8	Silent-Aire Manufacturing Inc.	SA-400PL-IHCM-FH	Penthouse 3D101	Surgery			271										
22	MH-006					SUPPLY	Plug	Front Discharge		15	8250	8.0	21.56	BELT	480	3	24.0	2546	VFD
23	MH-006	AHU-9	Silent-Aire Manufacturing Inc.	SA-240PL-IHCM-FH	Penthouse 3C101	Lab			254										
24	MH-006					SUPPLY	Plug	Front Discharge		7.5	3050	4.6	16.19	BELT	480	3	8.5	2779	VFD
25	MH-006	AHU-10	Silent-Aire Manufacturing Inc.		Enginer Generator Rm	Engine Generator			93										
26	MH-006					SUPPLY	Plug	Front Discharge		10	18960		25	BELT	480	3		431	
27	MH-006	AHU-11	Silent-Aire Manufacturing Inc.	SA-300BI-IHCV-R	Link Penthouse	Link			173										
28	MH-006					SUPPLY	Centrifugal	Bottom Down		7.5	4970	2.8	15	BELT	480	3	9.4	2185	VFD
29	MH-006					RETURN	Centrifugal	Front Discharge		5	4290	0.7	15	BELT	480	3	6.5	1817	VFD

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AHU HEATING / COOLING COIL SCHEDULE																	
#	Draw #	Tag ID	Serves	MBH	Pri GPM	CFM Rated	EAT Db	EAT Wb	LAT Db	LAT Wb	Pri EGT	Pri LGT	Fins/Ft	FPM	MAX APD	MAX WPD	Notes
1	MH-006	HC-1	AHU-1	353	25.3	32640	45		55		135	105	80	520	1	5	
2	MH-006	CC-1	AHU-1	610	62.6	32640	72	60	55	53	46	68	137	500	1	10	
3	MH-006	HC-2	AHU-2	357	25.6	32760	45		55		135	105	80	525	0.1	5	
4	MH-006	CC-2	AHU-2	615	63.6	32760	72	60	55	53	46	68	110	505	1	10	
5	MH-006	HC-3	AHU-3	326	23.3	32890	45		55		135	105	80	525	0.1	5	
6	MH-006	CC-3	AHU-3	615	63.6	32890	72	60	55	53	46	68	110	505	1	0	
7	MH-006	HC-4	AHU-4	534	38.3	35730	45		55		135	105	80	475	0.1	5	
8	MH-006	CC-4	AHU-4	697	72	35730	72	60	55	53	46	68	134	475	1	10	
9	MH-006	HC-5	AHU-5	329	23.6	29040	45		55		186	105	80	520	0.1	5	
10	MH-006	CC-5	AHU-5	543	54.6	29040	72	60	55	53	46	68	158	500	1	10	
11	MH-006	HC-6	AHU-6	704	50.3	12980	45		95		186	156	80	575	0.2	5	
12	MH-006	CC-6	AHU-6	243	25	12980	72	60	55	53	46	68	152	555	1	10	
13	MH-006	PHC-7	AHU-7	451	32.5	7230	-18		45		186	166	80	550	0.2	5	
14	MH-006	HC-7	AHU-7	118	8.4	7230	40		55		145	115	80	550	0.1	5	
15	MH-006	CC-7	AHU-7	156	15.5	7230	72	60	55	53	46	66	153	515	1	10	
16	MH-006	PHC-8	AHU-8	478	34.3	8360	-18		40		186	166	80	595	0.2	5	
17	MH-006	HC-8	AHU-8	124	8.9	8360	40		55		145	115	80	595	0.1	5	
18	MH-006	CC-8	AHU-8	158	18	8360	72	60	55	53	46	66	160	555	1.2	10	
19	MH-006	CC-8a	AHU-8	379		8360	65	63	47	47			138	594	1.6		+
20	MH-006	PHC-9	AHU-9	192	13.7	3050	-18		40		186	156	82	420	0.1	5	
21	MH-006	HC-9	AHU-9	90	3.6	3050	40		55		186	156	98	420	0.1	5	
22	MH-006	CC-9	AHU-9	57	6.5	3050	72	60	55	53	46	66	152	470	1	10	
23	MH-006	HC-11	AHU-11	145	10.4	4970	45		95		186	156	95	530	0.2	5	
24	MH-006	CC-11	AHU-11	53	11.7	4970	72	60	55	53	46	65	124	515	1	10	

+ Note: DX cooling coil capacity = 352 MBH

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FAN SCHEDULE												
#	Draw #	Tag ID	Location	Serves	Hp	TSP (in w.c.)	CFM Rated	Wheel Dia	Max BHP	Volt	Ph	RPM
1	MH-007	EF-1	Penthouse 3A102	General, Area A South	1.00	1.5	1990	13.5	0.9	480	3	1974
2	MH-007	EF-2	Penthouse 3A100	General, Area A North	1.50	1.5	3080	18	1.3	480	3	1444
3	MH-007	EF-3	Penthouse 3D101	General, Area D	1	1.5	2620	18	0.8	480	3	1192
4	MH-007	EF-4	Penthouse 3B100	General, Area B	3.00	1.5	6900	24.5	2.6	480	3	1030
5	MH-007	EF-5	Penthouse 3C101	General, Area C	1.00	1.5	1100	16.5	0.8	480	3	1931
6	MH-007	EF-6	illegible	illegible	0.50	0.9	2100	16	0.4	120	1	1023
7	MH-007	EF-7	Penthouse 3A100	Dentail Suite	3.00	1.5	5710	20	2.4	480	3	1318
8	MH-007	EF-8	Penthouse 3A106	Capture Hood	0.75	1.5	1070	12	0.6	480	3	2189
9	MH-007	EF-9	Penthouse 3D101	Surgery Suite	5.00	2.5	7105	24.5	4.2	480	3	1200
10	MH-007	EF-10	Penthouse 3D101	Capture Hood	0.33	1.5	490	10	0.2	120	1	2072
11	MH-007	EF-11	Penthouse 3C101	Laboratory	1.50	1.5	3260	18	1.3	480	3	1479
12	MH-007	EF-12	not used									
13	MH-007	EF-13	Penthouse 3A102	Procedure Rm. 1A253	0.75	1.5	540	10	0.7	480	3	3358
14	MH-007	EF-14	Penthouse 3A100	Procedure Rm. 1A153	0.75	1.5	540	10	0.7	480	3	3330
15	MH-007	EF-15	Penthouse 3C101	Med Gas Cyl Rm. 1C191	0.33	1.5	150	10	0.2	120	1	2224
16	MH-007	VF-1	Mech Room 1C163	Main Mechanical Room	0.75	0.25	3200	24.75	3	480	3	780
17	MH-007	VF-2	Penthouse 3A101	Electrical Room 3A101	0.125	0.25	440	12.5	0.1	120	1	1232
18	MH-007	VF-3	Penthouse 3C100	Electrical Room 3C100	0.125	0.25	500	12.5	0.1	120	1	1282
19	MH-007	VF-4	Penthouse 3D101	AHU Room 3D101	0.125	0.25	530	12.5	0.1	120	1	1305
20	MH-007	VF-5	Penthouse 3D100	Electrical Room 3D100	0.125	0.25	450	12.5	0.1	120	1	1241

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WATER COOLED AIR CONDITIONING UNIT SCHEDULE																				
#	Draw #	Tag ID	Location	Note	Capacity (MBH)	Flow (CFM)	ESP (In W.C.)	EAT (°F Db)	EAT (°F Wb)	LAT (°F Db)	LAT (°F Wb)	Flow (GPM)	EGT (°F)	LGT (°F)	MAX WPD (FT)	HP	V	PH	HZ
1	MH-010	ACU-1	TEL 1A191	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
2	MH-010	ACU-2	TEL 1A107	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
3	MH-010	ACU-3	TEL 1B134	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
4	MH-010	ACU-4	TEL 1C165	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
5	MH-010	ACU-5	TEL 1D127	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
6	MH-010	ACU-6	TEL 1D189	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
7	MH-010	ACU-7	TEL 2A191	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
8	MH-010	ACU-8	TEL 2B140	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
9	MH-010	ACU-9	TEL 2C102	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
10	MH-010	ACU-10	TEL 2C129	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
11	MH-010	ACU-11	TEL 2D127	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
12	MH-010	ACU-12	TEL 2D163	Self-Contained, Chilled-Glycol Unit With supply/Return Grilles, No reheat coil or humidifier. Provide with integral condensate pump. Provide filter box with 30% efficient filters	1 TON	600	0.3	72	60	55	46	3	46	56	7	1/4	208	1	60
13	MH-010	ACU-13	COMPUTER 2C171	Free-Standing, Self-Contained, chilled-glycol, upflow unit. Provide with integral condensate pump. Provide filter box with 30% efficient filters. Provide with infrared steam generating humidifier, 17 lbs./hour capacity	10 TONS	5650	0.5	72	60	55	46	38	46	56	25	12	460	3	60
14	MH-010			Integral Hydronic Heating Coil. Horsepower includes a 3 HP supply fan and a 6.4 KW infrared humidifier. Fluid values are based on 40% ethylene glycol	65	5650		60		80		5	188	158	15				
15	MH-010	ACU-14	COMPUTER 2C171	Free-Standing, Self-Contained, chilled-glycol, upflow unit. Provide with integral condensate pump. Provide filter box with 30% efficient filters. Provide with infrared steam generating humidifier, 17 lbs./hour capacity	10 TONS	5650	0.5	72	60	55	46	38	45	55	25	12	460	3	60
16	MH-010			Integral Hydronic Heating Coil. Horsepower includes a 3 HP supply fan and a 6.4 KW infrared humidifier. Fluid values are based on 40% ethylene glycol	65	5650		60		80		5	188	158	15				
17	MH-010	ACU-15	STAIR 2	Provide upflow free standing vertical fan coil unit with 30% filters, cooling coil, condensate pump, and bottom return.	5 TONS	2000	0.35	84	62	55	50	17	46	56	5	3/4	460	3	60
18	MH-010	ACU-16	STAIR 3	Provide horizontal fan coil unit with 30% filters, cooling coil, and condensate pump	2 TONS	800	0.35	84	62	55	50	6	46	56	5	1/2	120	1	60

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AIR ATOMIZING HUMIDIFICATION SCHEDULE							
#	Draw #	Tag ID	Serves	GPM	ACFM	Air Flow	LBS/HR
1	MH-007	H-1	AHU-1	0.62	6	32540	310
2	MH-007	H-2	AHU-2	0.63	6	33040	314
3	MH-007	H-3	AHU-3	0.63	6.1	33330	317
4	MH-007	H-4	AHU-4	0.71	6.8	37310	355
5	MH-007	H-5	AHU-5	0.57	5.5	29960	285
6	MH-007	H-6	AHU-6	0.25	2.4	12980	123
7	MH-007	H-7	AHU-7	0.3	2.9	7230	152
8	MH-007	H-8	AHU-8	0.33	3.2	7890	166
9	MH-007	H-9	AHU-9	0.13	1	1630	50
10	MH-007	H-101	DUCT	0.12	0.6	880	30
11	MH-007	H-102	DUCT	0.06	0.6	800	30
12	MH-007	H-103	DUCT	0.01	0.1	1240	5

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
1	MH-008	1-005	AHU-1	32640	461	Rectangle	102/100	2.66	0							
2	MH-008	1-010	1-005	15780	438	Rectangle	72/72	2.65	0							
3	MH-008	1-100	1-005	3150	2256	Round	16	2.19	1							
4	MH-008	1-105	1-100	680	1948	Round	8	2.11	0	VAV 1-205	680	360	360	0.5	0.4	35
5	MH-008	1-110	1-100	2470	2311	Round	14	2.01	0							
6	MH-008	1-115	1-110	300	2200	Round	5	1.79	0	VAV 1-204	300	140	140	0.5	0.4	35
7	MH-008	1-120	1-110	2170	2030	Round	14	1.98	0							
8	MH-008	1-125	1-120	470	2394	Round	6	1.72	0	VAV 1-203	470	230	230	0.5	0.4	35
9	MH-008	1-130	1-120	1700	2165	Round	12	1.77	0							
10	MH-008	1-135	1-130	300	2200	Round	5	1.52	0	VAV 1-202	300	140	140	0.5	0.4	35
11	MH-008	1-140	1-130	1400	1783	Round	12	1.82	0							
12	MH-008	1-145	1-140	750	2149	Round	8	1.63	0	VAV 1-208	750	500	500	0.5	0.4	35
13	MH-008	1-150	1-140	650	1862	Round	8	1.74	0							
14	MH-008	1-155	1-150	190	2177	Round	4	1.5	0	VAV 2-201	190	100	100	0.5	0.4	35
15	MH-008	1-160	1-150	460	2343	Round	6	1.45	1	VAV 1-207	460	170	170	0.5	0.4	35
16	MH-008	1-200	1-005	3310	2371	Round	16	2.14	2							
17	MH-008	1-205	1-200	200	2292	Round	4	2	0	VAV 1-212	200	140	140	0.5	0.4	35
18	MH-008	1-210	1-200	3110	2227	Round	16	2.13	0							
19	MH-008	1-215	1-210	690	1977	Round	8	1.96	0	VAV 1-209	690	410	410	0.5	0.4	35
20	MH-008	1-220	1-210	2420	2264	Round	14	2.05	0							
21	MH-008	1-225	1-220	360	1833	Round	6	1.04	2	VAV 1-206	360	180	180	0.5	0.4	35
22	MH-008	1-230	1-220	2060	1927	Round	14	2.04	1							
23	MH-008	1-235	1-230	230	1687	Round	5	1.94	0	VAV 1-215	230	140	140	0.5	0.4	35
24	MH-008	1-240	1-230	580	1662	Round	8	1.88	0	VAV 1-216	580	390	390	0.5	0.4	35
25	MH-008	1-245	1-230	1250	2292	Round	10	1.8	0							
26	MH-008	1-250	1-245	520	1490	Round	8	1.55	0	VAV 1-220	520	270	270	0.5	0.4	35
27	MH-008	1-255	1-245	730	2091	Round	8	1.81	0							
28	MH-008	1-260	1-255	530	1518	Round	8	1.83	0	VAV 1-221	530	360	360	0.5	0.4	35
29	MH-008	1-265	1-255	200	2292	Round	4	1.29	1	VAV 1-225	200	130	130	0.5	0.4	35
30	MH-008	1-300	1-005	5030	2306	Round	20	2.25	1							
31	MH-008	1-305	1-300	590	1690	Round	8	2.09	1	VAV 1-224	590	390	390	0.5	0.4	35
32	MH-008	1-310	1-300	2160	2021	Round	14	2.11	1	VAV 1-227	2160	700	700	0.5	0.4	35
33	MH-008	1-315	1-300	2280	2133	Round	14	2.04	0							
34	MH-008	1-320	1-315	530	1518	Round	8	2.04	0	VAV 1-223	530	350	350	0.5	0.4	35
35	MH-008	1-325	1-315	1750	2228	Round	12	1.77	0							
36	MH-008	1-330	1-325	1010	1852	Round	10	1.74	0	VAV 1-218	1010	670	670	0.5	0.4	35
37	MH-008	1-335	1-325	150	1719	Round	4	1.7	0	VAV 1-222	150	100	100	0.5	0.4	35
38	MH-008	1-340	1-325	590	1690	Round	8	1.79	0							
39	MH-008	1-345	1-340	110	1261	Round	4	1.67	0	VAV 1-226	110	70	70	0.5	0.4	35
40	MH-008	1-350	1-340	480	2445	Round	6	1.42	1	VAV 1-217	480	160	160	0.5	0.4	35
41	MH-008	1-400	1-005	4720	2163	Round	20	2.33	0							
42	MH-008	1-405	1-400	800	2292	Round	8	2.06	0	VAV 1-214	800	450	450	0.5	0.4	35
43	MH-008	1-410	1-400	3920	2218	Round	18	2.27	0							
44	MH-008	1-415	1-410	1300	2384	Round	10	2.25	0	VAV 1-211	1300	870	870	0.5	0.4	35
45	MH-008	1-420	1-410	2620	2451	Round	14	2.02	0							

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
46	MH-008	1-425	1-420	950	1742	Round	10	1.97	0	VAV 1-219	950	630	630	0.5	0.4	35
47	MH-008	1-430	1-420	1200	2200	Round	10	2.12	0	VAV 1-210	1200	800	800	0.5	0.4	35
48	MH-008	1-435	1-420	470	2394	Round	6	1.9	1	VAV 1-213	470	320	320	0.5	0.4	35
49	MH-008	1-500	1-010	4270	2415	Round	18	2.12	0							
50	MH-008	1-505	1-500	2920	2086	Round	16	1.92	0							
51	MH-008	1-510	1-505	500	1779	Round	8	1.88	0	VAV 1-103	600	320	320	0.5	0.4	35
52	MH-008	1-515	1-505	2310	2159	Round	14	1.78	0							
53	MH-008	1-520	1-515	858	1353	Round	6	1.64	0	VAV 1-106	360	360	360	0.5	0.4	35
54	MH-008	1-525	1-515	1950	2478	Round	12	1.5	0							
55	MH-008	1-530	1-525	452	1252	Round	6	1.36	0	VAV 1-102	450	240	240	0.5	0.4	35
56	MH-008	1-535	1-525	1500	1902	Round	12	1.9	0							
57	MH-008	1-540	1-535	160	2063	Round	4	1.15	1	VAV 1-101	180	90	90	0.5	0.4	35
58	MH-008	1-545	1-535	1320	2407	Round	16	1.25	1							
59	MH-008	1-550	1-545	400	2037	Round	6	1.17	0	VAV 1-111	400	400	400	0.5	0.4	35
60	MH-008	1-555	1-545	350	1850	Round	8	1.34	0	VAV 1-110	520	290	290	0.5	0.4	35
61	MH-008	1-560	1-545	320	1630	Round	8	1.38	0	VAV 1-113	320	210	210	0.5	0.4	35
62	MH-008	1-600	1-010	3170	2270	Round	16	2.24	2							
63	MH-008	1-605	1-600	850	2435	Round	8	2.2	0	VAV 1-107	850	490	490	0.5	0.4	35
64	MH-008	1-610	1-600	2320	2170	Round	14	2.22	0							
65	MH-008	1-615	1-610	210	2406	Round	4	1.94	0	VAV 1-119	210	210	210	0.5	0.4	35
66	MH-008	1-620	1-610	2110	1974	Round	14	2.23	0							
67	MH-008	1-625	1-620	490	2496	Round	6	1.84	0	VAV 1-109	490	360	360	0.5	0.4	35
68	MH-008	1-630	1-620	1620	2063	Round	12	2.11	0							
69	MH-008	1-635	1-630	280	2053	Round	5	1.9	0	VAV 1-120	280	140	140	0.5	0.4	35
70	MH-008	1-640	1-630	330	2420	Round	5	1.72	0	VAV 1-112	330	220	220	0.5	0.4	35
71	MH-008	1-645	1-630	1010	1852	Round	10	1.96	1							
72	MH-008	1-650	1-645	220	1613	Round	5	1.53	0	VAV 1-122	220	150	150	0.5	0.4	35
73	MH-008	1-655	1-645	790	2263	Round	8	1.78	0							
74	MH-008	1-660	1-655	330	2420	Round	5	1.57	0	VAV 1-126	330	210	210	0.5	0.4	35
75	MH-008	1-665	1-655	160	2343	Round	6	1.59	1	VAV 1-132	460	230	230	0.5	0.4	35
76	MH-008	1-700	1-010	5160	2361	Round	20	2.24	0							
77	MH-008	1-705	1-700	1500	2408	Round	12	1.97	1	VAV 1-131	1900	890	890	0.5	0.4	35
78	MH-008	1-710	1-700	2330	2310	Round	16	2.18	0							
79	MH-008	1-715	1-710	430	2190	Round	6	2.19	0	VAV 1-125	430	320	320	0.5	0.4	35
80	MH-008	1-720	1-710	2800	2000	Round	16	2	1							
81	MH-008	1-725	1-720	800	UNK	Round	8	2.1	0	VAV 1-130	600	600	600	0.5	0.4	35
82	MH-008	1-730	1-720	2190	2046	Round	14	2.05	0							
83	MH-008	1-735	1-730	840	1483	Round	5	1.85	0	VAV 1-129	340	120	120	0.5	0.4	35
84	MH-008	1-740	1-730	1850	2349	Round	12	1.7	0							
85	MH-008	1-745	1-740	710	2054	Round	8	1.66	0	VAV 1-128	710	670	670	0.5	0.4	35
86	MH-008	1-750	1-740	440	2241	Round	6	1.49	0	VAV 1-121	440	440	440	0.5	0.4	35
87	MH-008	1-755	1-740	800	2292	Round	8	1.53	0							
88	MH-008	1-760	1-755	200	2292	Round	4	0.9	1	VAV 1-127	200	70	70	0.5	0.4	35
89	MH-008	1-765	1-755	600	1719	Round	8	1.63	0	VAV 1-123	600	280	280	0.5	0.4	35
90	MH-008	1-800	1-010	2530	2367	Round	14	2.26	0							

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#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
91	MH-008	1-805	1-800	330	2420	Round	5	1.96	0	VAV 1-115	330	290	290	0.5	0.4	35
92	MH-008	1-810	1-800	430	2190	Round	6	2.14	0	VAV 1-118	670	670	670	0.5	0.4	35
93	MH-008	1-815	1-800	1770	2254	Round	12	2.19	0							
94	MH-008	1-820	1-815	470	2394	Round	6	1.97	0	VAV 1-117	360	250	250	0.5	0.4	35
95	MH-008	1-825	1-815	1300	2384	Round	10	2.03	0							
96	MH-008	1-830	1-825	430	2190	Round	6	1.92	0	VAV 1-116	430	430	430	0.5	0.4	35
97	MH-008	1-835	1-825	870	2492	Round	8	1.81	0							
98	MH-008	1-840	1-835	400	2037	Round	6	1.75	0	VAV 1-114	400	280	280	0.5	0.4	35
99	MH-008	1-845	1-835	470	2394	Round	6	1.72	0	VAV 1-124	360	250	250	0.5	0.4	35
100	MH-008	1-900	1-500	1340	2457	Round	10	1.54	0							
101	MH-008	1-905	1-900	600	1719	Round	8	1.96	0	VAV 1-104	600	320	320	0.5	0.4	35
102	MH-008	1-910	1-900	740	2120	Round	8	1.76	0							
103	MH-008	1-915	1-910	530	1518	Round	8	1.8	0	VAV 1-105	530	260	260	0.5	0.4	35
104	MH-008	1-920	1-910	210	2406	Round	4	1.23	1	VAV 1-108	210	140	140	0.5	0.4	35
105	MH-008	2-005	AHU-2	32760	565	Rectangle	116/72	2.33	0							
106	MH-008	2-010	2-005	18045	547	Rectangle	66/72	2.33	0							
107	MH-008	2-100	2-005	3830	2167	Round	18	1.95	0							
108	MH-008	2-105	2-100	370	1884	Round	6	1.85	0	VAV 2-206	370	260	260	0.5	0.4	35
109	MH-008	2-110	2-100	3460	2478	Round	16	1.8	0							
110	MH-008	2-115	2-110	1450	1846	Round	12	1.74	1	VAV 2-201	1450	510	510	0.5	0.4	35
111	MH-008	2-120	2-110	700	2005	Round	8	1.69	0	VAV 2-205	700	510	510	0.5	0.4	35
112	MH-008	2-125	2-110	1310	2402	Round	10	1.61	1							
113	MH-008	2-130	2-125	400	2037	Round	6	1.49	1	VAV 2-204	400	260	260	0.5	0.4	35
114	MH-008	2-135	2-125	910	1668	Round	10	1.75	0							
115	MH-008	2-140	2-135	40	2340	Round	6	1.74	0	VAV 2-202	460	330	330	0.5	0.4	35
116	MH-008	2-145	2-135	450	2292	Round	6	1.09	1	VAV 2-203	450	330	330	0.5	0.4	35
117	MH-008	2-200	2-005	1730	2203	Round	12	1.92	0							
118	MH-008	2-205	2-200	450	2292	Round	6	1.73	0	VAV 2-211	450	390	390	0.5	0.4	35
119	MH-008	2-210	2-200	1280	2347	Round	10	1.78	0							
120	MH-008	2-215	2-110	240	1760	Round	5	1.72	0	VAV 2-212	240	160	160	0.5	0.4	35
121	MH-008	2-220	2-110	1040	1907	Round	10	1.81	0							
122	MH-008	2-225	2-220	330	2420	Round	5	1.55	0	VAV 2-213	330	240	240	0.5	0.4	35
123	MH-008	2-230	2-220	710	2034	Round	8	1.72	0							
124	MH-008	2-235	2-230	390	1986	Round	6	1.59	0	VAV 2-208	390	270	270	0.5	0.4	35
125	MH-008	2-240	2-230	320	2347	Round	5	1.46	1	VAV 2-214	320	270	270	0.5	0.4	35
126	MH-008	2-300	2-005	4215	2385	Round	18	1.77	1							
127	MH-008	2-305	2-300	450	2292	Round	6	1.58	0	VAV 2-216	450	450	450	0.5	0.4	35
128	MH-008	2-310	2-300	3765	2131	Round	18	1.75	0							
129	MH-008	2-315	2-310	680	1948	Round	8	1.53	0	VAV 2-215	680	470	470	0.5	0.4	35
130	MH-008	2-320	2-310	3085	2209	Round	16	1.59	2							
131	MH-008	2-325	2-320	460	2340	Round	6	1.5	0	VAV 2-217	460	460	460	0.5	0.4	35
132	MH-008	2-330	2-320	2625	2456	Round	14	1.59	5	VAV 2-218	2625	395	395	0.5	0.4	35
133	MH-008	2-400	2-005	4375	2476	Round	18	1.84	0							
134	MH-008	2-405	2-400	2625	2456	Round	14	1.56	0	VAV 2-219	2625	395	395	0.5	0.4	35
135	MH-008	2-410	2-400	800	2300	Round	8	1.89	0	VAV 2-210	800	630	630	0.5	0.4	35

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136	MH-008	2-415	2-400	320	2347	Round	5	1.6	0	VAV 2-207	320	200	200	0.5	0.4	35
137	MH-008	2-420	2-400	630	1805	Round	8	1.84	1	VAV 2-209	630	420	420	0.5	0.4	35
138	MH-008	2-500	2-010	3280	2349	Round	16	1.74	1							
139	MH-008	2-505	2-500	760	2177	Round	8	1.76	0	VAV 2-106	760	510	510	0.5	0.4	35
140	MH-008	2-510	2-500	2520	2357	Round	14	1.63	0							
141	MH-008	2-515	2-510	590	1690	Round	8	1.62	0	VAV 2-102	590	320	320	0.5	0.4	35
142	MH-008	2-520	2-510	1930	2457	Round	12	1.29	0							
143	MH-008	2-525	2-520	440	2241	Round	6	0.96	0	VAV 2-112	440	440	440	0.5	0.4	35
144	MH-008	2-530	2-520	420	2139	Round	6	1.23	0	VAV 2-103	420	220	220	0.5	0.4	35
145	MH-008	2-535	2-520	1070	1962	Round	10	1.25	0							
146	MH-008	2-540	2-535	460	2340	Round	6	1.27	0	VAV 2-104	460	240	240	0.5	0.4	35
147	MH-008	2-545	2-535	610	1748	Round	8	1.22	0							
148	MH-008	2-550	2-545	460	2340	Round	6	1.22	0	VAV 2-108	460	320	320	0.5	0.4	35
149	MH-008	2-555	2-545	150	1719	Round	4	1.02	1	VAV 2-105	150	70	70	0.5	0.4	35
150	MH-008	2-600	2-010	780	2235	Round	8	1.8	0							
151	MH-008	2-605	2-600	320	1630	Round	6	1.79	0	VAV 2-115	320	320	320	0.5	0.4	35
152	MH-008	2-610	2-600	400	2340	Round	6	1.53	1	VAV 2-111	400	340	340	0.5	0.4	35
153	MH-008	2-700	2-010	8120	2202	Round	26	1.97	0							
154	MH-008	2-705	2-700	570	1633	Round	8	2.03	0	VAV 2-123	570	410	410	0.5	0.4	35
155	MH-008	2-710	2-700	360	1833	Round	6	1.89	0	VAV 2-124	360	280	280	0.5	0.4	35
156	MH-008	2-715	2-700	7190	2289	Round	24	1.81	1							
157	MH-008	2-720	2-715	600	1719	Round	8	1.74	2	VAV 2-126	700	670	670	0.5	0.4	35
158	MH-008	2-725	2-715	6590	2496	Round	22	1.63	0							
159	MH-008	2-730	2-725	340	2482	Round	5	1.71	0	VAV 2-127	340	230	230	0.5	0.4	35
160	MH-008	2-735	2-725	6250	2368	Round	22	1.59	0							
161	MH-008	2-740	2-735	470	2394	Round	6	1.41	0	VAV 2-116	470	390	390	0.5	0.4	35
162	MH-008	2-745	2-735	5780	2190	Round	22	1.57	0							
163	MH-008	2-750	2-745	600	1719	Round	8	1.5	0	VAV 2-128	600	600	600	0.5	0.4	35
164	MH-008	2-755	2-745	270	1980	Round	5	1.63	0	VAV 2-117	270	130	130	0.5	0.4	35
165	MH-008	2-760	2-745	4910	2251	Round	20	1.41	0							
166	MH-008	2-765	2-760	580	1692	Round	8	1.33	0	VAV 2-118	580	380	380	0.5	0.4	35
167	MH-008	2-770	2-760	4330	2450	Round	20	1.28	0							
168	MH-008	2-775	2-770	220	1613	Round	5	1.53	0	VAV 2-129	220	150	150	0.5	0.4	35
169	MH-008	2-780	2-770	4110	2326	Round	18	1.27	0							
170	MH-008	2-785	2-780	430	2190	Round	6	1.06	0	VAV 2-119	430	430	430	0.5	0.4	35
171	MH-008	2-790	2-780	3680	2082	Round	18	1.27	0							
172	MH-008	2-791	2-790	220	1687	Round	5	1.39	0	VAV 2-120	230	150	150	0.5	0.4	35
173	MH-008	2-792	2-790	3450	2471	Round	16	1.07	0							
174	MH-008	2-793	2-792	2010	1880	Round	14	1.04	0	VAV 2-131	2355	395	395	0.5	0.4	35
175	MH-008	2-794	2-792	1440	1833	Round	12	1.22	0							
176	MH-008	2-795	2-794	260	1907	Round	5	1.11	2	VAV 2-130	260	180	180	0.5	0.4	35
177	MH-008	2-796	2-794	1180	2163	Round	10	1.07	0							
178	MH-008	2-797	2-796	550	1576	Round	8	1.08	0	VAV 2-121	550	370	370	0.5	0.4	35
179	MH-008	2-798	2-796	630	1895	Round	8	0.95	1	VAV 2-113	630	550	550	0.5	0.4	35
180	MH-008	2-800	2-010	5180	2374	Round	20	1.93	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
181	MH-008	2-805	2-800	430	2190	Round	6	1.77	0	VAV 2-110	430	430	430	0.5	0.4	35
182	MH-008	2-810	2-800	450	2292	Round	6	1.75	0	VAV 2-114	450	450	450	0.5	0.4	35
183	MH-008	2-815	2-800	4300	2433	Round	18	1.81	0							
184	MH-008	2-820	2-815	2890	2070	Round	16	1.66	0							
185	MH-008	2-825	2-820	210	2496	Round	4	1.36	0	VAV 2-122	210	140	140	0.5	0.4	35
186	MH-008	2-830	2-820	2680	1919	Round	16	1.53	0	VAV 2-125	2355	395	395	0.5	0.4	35
187	MH-008	2-900	2-815	1410	1795	Round	12	1.79	0							
188	MH-008	2-905	2-900	460	2340	Round	6	1.77	0	VAV 2-109	460	430	430	0.5	0.4	35
189	MH-008	2-910	2-900	950	1742	Round	10	1.7	0							
190	MH-008	2-915	2-910	350	1783	Round	6	1.15	0	VAV 2-107	350	350	350	0.5	0.4	35
191	MH-008	2-920	2-910	600	1719	Round	8	1.63	0	VAV 2-101	600	320	320	0.5	0.4	35
192	MH-008	3-005	AHU-3	32890	577	Rectangle	72/114	2.56	0							
193	MH-008	3-010	3-005	16330	454	Rectangle	72/72	2.56	0							
194	MH-008	3-100	3-005	3800	2150	Round	18	2.26	0							
195	MH-008	3-105	3-100	1330	2439	Round	10	1.89	1							
196	MH-008	3-110	3-105	440	2241	Round	6	1.77	0	VAV 3-201	440	290	290	0.5	0.4	35
197	MH-008	3-115	3-105	890	1632	Round	10	2.07	0							
198	MH-008	3-120	3-115	450	2292	Round	6	1.79	0	VAV 3-203	450	340	340	0.5	0.4	35
199	MH-008	3-125	3-115	440	2241	Round	6	1.52	2	VAV 3-204	440	300	300	0.5	0.4	35
200	MH-008	3-130	3-100	2470	2311	Round	14	2.01	1							
201	MH-008	3-135	3-130	420	2139	Round	6	1.83	0	VAV 3-202	420	300	300	0.5	0.4	35
202	MH-008	3-140	3-130	2050	1918	Round	14	2.07	0							
203	MH-008	3-145	3-140	450	2292	Round	6	1.8	0	VAV 3-206	450	300	300	0.5	0.4	35
204	MH-008	3-150	3-140	1600	2037	Round	12	1.89	1	VAV 3-205	1600	410	410	0.5	0.4	35
205	MH-008	3-200	3-005	4820	2209	Round	20	2.24	0							
206	MH-008	3-205	3-200	290	2127	Round	5	2.08	0	VAV 3-210	290	140	140	0.5	0.4	35
207	MH-008	3-210	3-200	4530	2076	Round	20	2.2	0							
208	MH-008	3-215	3-210	370	1884	Round	6	2.12	0	VAV 3-208	370	290	290	0.5	0.4	35
209	MH-008	3-220	3-210	4160	2354	Round	18	1.92	1							
210	MH-008	3-225	3-220	810	2320	Round	8	1.94	0	VAV 3-212	810	550	550	0.5	0.4	35
211	MH-008	3-230	3-220	3350	2399	Round	16	1.85	0							
212	MH-008	3-235	3-230	920	1687	Round	10	1.83	4							
213	MH-008	3-240	3-235	500	1433	Round	8	1.46	0	VAV 3-218	500	330	330	0.5	0.4	35
214	MH-008	3-245	3-235	420	2139	Round	6	1.31	1	VAV 3-221	420	390	390	0.5	0.4	35
215	MH-008	3-250	3-230	2430	2273	Round	14	1.73	1							
216	MH-008	3-255	3-250	610	1748	Round	8	1.68	0	VAV 3-215	610	610	610	0.5	0.4	35
217	MH-008	3-260	3-250	1820	2317	Round	12	1.29	5							
218	MH-008	3-265	3-260	930	1705	Round	10	1.29	0	VAV 3-222	930	350	350	0.5	0.4	35
219	MH-008	3-270	3-260	890	1632	Round	10	1.38	1	VAV 3-220	890	730	730	0.5	0.4	35
220	MH-008	3-300	3-005	6580	2493	Round	22	2.13	0							
221	MH-008	3-305	3-300	690	1977	Round	8	2.06	0	VAV 3-207	690	520	520	0.5	0.4	35
222	MH-008	3-310	3-300	5890	2231	Round	22	2.09	1							
223	MH-008	3-315	3-310	4320	2445	Round	18	1.84	0							
224	MH-008	3-320	3-315	700	2005	Round	8	1.68	0	VAV 3-211	700	360	360	0.5	0.4	35
225	MH-008	3-325	3-315	3620	2049	Round	18	2	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
226	MH-008	3-330	3-325	1440	1833	Round	12	1.93	0	VAV 3-214	1440	970	970	0.5	0.4	35
227	MH-009	3-335	3-325	2180	2039	Round	14	1.89	0							
228	MH-009	3-340	3-335	430	2190	Round	6	1.54	0	VAV 3-216	430	280	280	0.5	0.4	35
229	MH-009	3-345	3-335	1750	2228	Round	12	1.79	0							
230	MH-009	3-350	3-345	410	2088	Round	6	1.52	0	VAV 3-217	410	270	270	0.5	0.4	35
231	MH-009	3-355	3-345	1340	2457	Round	10	1.44	4							
232	MH-009	3-360	3-355	1090	1999	Round	10	1.64	0	VAV 3-219	1090	720	720	0.5	0.4	35
233	MH-009	3-365	3-355	250	1833	Round	5	1.14	2	VAV 3-223	250	250	250	0.5	0.4	35
234	MH-009	3-370	3-310	1570	1999	Round	12	1.99	1							
235	MH-009	3-375	3-370	330	2420	Round	5	1.74	0	VAV 3-209	330	220	220	0.5	0.4	35
236	MH-009	3-380	3-370	1240	2274	Round	10	1.97	1	VAV 3-213	1240	280	280	0.5	0.4	35
237	MH-009	3-400	3-010	4700	2154	Round	20	2.22	4							
238	MH-009	3-405	3-400	450	2292	Round	6	2.03	0	VAV 3-115	450	450	450	0.5	0.4	35
239	MH-009	3-410	3-400	4250	2405	Round	18	1.99	0							
240	MH-009	3-415	3-410	490	2496	Round	6	2	0	VAV 3-110	490	430	430	0.5	0.4	35
241	MH-009	3-420	3-410	3760	2128	Round	18	2.01	0							
242	MH-009	3-425	3-420	830	2378	Round	8	1.69	2	VAV 3-109	830	440	440	0.5	0.4	35
243	MH-009	3-430	3-420	1930	2457	Round	12	1.76	0							
244	MH-009	3-435	3-430	330	2420	Round	5	1.46	0	VAV 3-106	330	330	330	0.5	0.4	35
245	MH-009	3-440	3-430	1600	2037	Round	12	1.8	0							
246	MH-009	3-445	3-440	36	1833	Round	6	1.7	0	VAV 3-104	360	340	340	0.5	0.4	35
247	MH-009	3-450	3-440	1240	2274	Round	10	1.63	0							
248	MH-009	3-455	3-450	460	2343	Round	6	1.41	0	VAV 3-103	460	310	310	0.5	0.4	35
249	MH-009	3-460	3-450	330	2420	Round	5	0.9	1	VAV 3-101	330	290	290	0.5	0.4	35
250	MH-009	3-465	3-450	450	2292	Round	6	1.52	0	VAV 3-102	450	450	450	0.5	0.4	35
251	MH-009	3-470	3-420	1000	1833	Round	10	1.92	1							
252	MH-009	3-475	3-470	130	1490	Round	4	1.82	0	VAV 3-108	130	90	90	0.5	0.4	35
253	MH-009	3-480	3-470	870	2492	Round	8	1.54	0							
254	MH-009	3-485	3-480	290	2127	Round	5	1.45	0	VAV 3-128	320	200	200	0.5	0.4	35
255	MH-009	3-490	3-480	580	1662	Round	8	1.63	1	VAV 3-107	580	410	410	0.5	0.4	35
256	MH-009	3-500	3-010	3980	2252	Round	18	2.2	0							
257	MH-009	3-505	3-500	330	2420	Round	5	1.93	0	VAV 3-119	330	290	290	0.5	0.4	35
258	MH-009	3-510	3-500	440	2241	Round	6	1.96	0	VAV 3-118	440	440	440	0.5	0.4	35
259	MH-009	3-515	3-500	3210	2299	Round	16	2.03	0							
260	MH-009	3-520	3-515	2280	2133	Round	14	1.73	4							
261	MH-009	3-525	3-520	420	2139	Round	6	1.54	0	VAV 3-116	420	270	270	0.5	0.4	35
262	MH-009	3-530	3-520	1860	2368	Round	12	1.58	0							
263	MH-009	3-535	3-530	880	1613	Round	10	1.61	0	VAV 3-114	880	590	590	0.5	0.4	35
264	MH-009	3-540	3-530	980	1797	Round	10	1.56	0							
265	MH-009	3-545	3-540	420	2139	Round	6	1.35	4	VAV 3-112	420	320	320	0.5	0.4	35
266	MH-009	3-550	3-540	560	1604	Round	8	1.33	0	VAV 3-105	560	360	360	0.5	0.4	35
267	MH-009	3-600	3-515	930	1705	Round	10	1.95	5							
268	MH-009	3-605	3-600	450	2292	Round	6	1.68	4	VAV 3-122	450	340	340	0.5	0.4	35
269	MH-009	3-610	3-600	180	2445	Round	6	1.6	0							
270	MH-009	3-615	3-610	230	1687	Round	5	1.61	0	VAV 3-127	290	140	140	0.5	0.4	35

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
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271	MH-009	3-620	3-610	25	1833	Round	5	1.59	1	VAV 3-124	250	170	170	0.5	0.4	35
272	MH-009	3-700	3-010	7650	2435	Round	24	2.14	0							
273	MH-009	3-705	3-700	4570	2095	Round	20	2.12	0							
274	MH-009	3-710	3-705	690	1977	Round	8	2.03	1	VAV 3-126	690	460	460	0.5	0.4	35
275	MH-009	3-715	3-705	3880	2200	Round	18	1.68	1	VAV 3-125	3880	54	54	0.5	0.4	35
276	MH-009	3-720	3-700	1510	1923	Round	12	2.04	1							
277	MH-009	3-725	3-720	700	2005	Round	8	1.91	0	VAV 3-120	700	700	700	0.5	0.4	35
278	MH-009	3-730	3-720	490	2496	Round	6	1.63	0	VAV 3-121	490	330	330	0.5	0.4	35
279	MH-009	3-735	3-720	320	2347	Round	5	1.46	1	VAV 3-123	320	210	210	0.5	0.4	35
280	MH-009	3-740	3-700	1570	1999	Round	12	2.07	1							
281	MH-009	3-745	3-740	560	1604	Round	8	2	0	VAV 3-117	560	290	290	0.5	0.4	35
282	MH-009	3-750	3-740	1010	1852	Round	10	1.97	0							
283	MH-009	3-755	3-750	51	1460	Round	8	1.96	0	VAV 3-113	510	510	510	0.5	0.4	35
284	MH-009	3-760	3-750	500	1461	Round	6	1.53	1	VAV 3-111	500	330	330	0.5	0.4	35
285	MH-009	4-005	AHU-4	35730	435	Rectangle	60/197	2.74	0							
286	MH-009	4-040	4-005	35730	626	Rectangle	60/137	2.74	0							
287	MH-009	4-015	4-010	11850	544	Rectangle	56/56	2.74	0							
288	MH-009	4-400	4-005	4960	2274	Round	20	2.44	0							
289	MH-009	4-105	4-100	19210	2445	Round	12	2.41	0	VAV 4-202	1920	1850	1850	0.5	0.4	35
290	MH-009	4-110	4-100	3040	1720	Round	18	2.52	0	VAV 4-201	3040	1820	1820	0.5	0.4	35
291	MH-009	4-200	4-005	5110	2342	Round	20	2.34	1							
292	MH-009	4-205	4-200	400	2037	Round	6	2.09	1	VAV 4-204	400	270	270	0.5	0.4	35
293	MH-009	4-210	4-200	4710	215	Round	20	2.15	2							
294	MH-009	4-215	4-210	1080	1980	Round	10	2.08	0	VAV 4-209	1080	720	720	0.5	0.4	35
295	MH-009	4-220	4-210	3900	2207	Round	18	2.08	0							
296	MH-009	4-225	4-220	810	2321	Round	8	1.78	0	VAV 4-210	810	540	540	0.5	0.4	35
297	MH-009	4-230	4-220	3490	2500	Round	16	1.87	0							
298	MH-009	4-235	4-230	640	1833	Round	8	1.79	0	VAV 4-213	640	420	420	0.5	0.4	35
299	MH-009	4-240	4-230	2850	2041	Round	16	1.94	0							
300	MH-009	4-245	4-240	300	2200	Round	5	1.6	0	VAV 4-226	300	150	150	0.5	0.4	35
301	MH-009	4-250	4-240	2550	2385	Round	14	1.77	0							
302	MH-009	4-255	4-250	810	2320	Round	8	1.8	0	VAV 4-214	810	54	54	0.5	0.4	35
303	MH-009	4-260	4-250	1740	2215	Round	12	1.72	0							
304	MH-009	4-265	4-260	410	2088	Round	6	1.42	0	VAV 4-229	410	250	250	0.5	0.4	35
305	MH-009	4-270	4-260	1330	2439	Round	10	1.39	4							
306	MH-009	4-275	4-270	790	2263	Round	8	1.5	0	VAV 4-216	790	530	530	0.5	0.4	35
307	MH-009	4-280	4-270	540	1547	Round	8	1.59	0							
308	MH-009	4-285	4-280	170	1948	Round	4	0.9	1	VAV 4-219	170	110	110	0.5	0.4	35
309	MH-009	4-290	4-280	370	1884	Round	6	1.45	0	VAV 4-218	370	250	250	0.5	0.4	35
310	MH-009	4-300	4-005	7490	1384	Round	24	2.08	4							
311	MH-009	4-305	4-300	4850	2223	Round	20	2.04	0							
312	MH-009	4-310	4-305	560	1604	Round	8	1.96	0	VAV 4-227	560	370	370	0.5	0.4	35
313	MH-009	4-315	4-305	4290	2428	Round	18	1.79	0							
314	MH-009	4-320	4-315	1120	2053	Round	10	1.72	1							
315	MH-009	4-325	4-320	250	1833	Round	5	1.65	0	VAV 4-221	250	170	170	0.5	0.4	35

AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
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316	MH-009	4-330	4-320	870	2492	Round	8	1.51	0							
317	MH-009	4-335	4-330	200	2292	Round	4	1.28	0	VAV 4-222	200	140	140	0.5	0.4	35
318	MH-009	4-340	4-330	670	1919	Round	8	1.61	0							
319	MH-009	4-345	4-340	410	2088	Round	6	1.22	1	VAV 4-220	410	100	100	0.5	0.4	35
320	MH-009	4-350	4-340	260	1907	Round	5	1.55	0	VAV 4-217	260	180	180	0.5	0.4	35
321	MH-009	4-355	4-300	2640	2470	Round	14	1.93	1							
322	MH-009	4-360	4-355	1020	1870	Round	10	1.92	0	VAV 4-225	1020	640	640	0.5	0.4	35
323	MH-009	4-365	4-355	1020	1870	Round	10	1.91	1	VAV 4-212	1020	990	990	0.5	0.4	35
324	MH-009	4-370	4-315	3170	2270	Round	16	1.72	1							
325	MH-009	4-375	4-370	1540	1961	Round	12	1.65	0	VAV 4-211	1540	390	390	0.5	0.4	35
326	MH-009	4-380	4-370	1020	1870	Round	10	1.67	1	VAV 4-215	1020	910	910	0.5	0.4	35
327	MH-009	4-400	4-005	2110	1974	Round	14	2.48	0							
328	MH-009	4-405	4-400	400	2037	Round	6	2.32	0	VAV 4-206	400	270	270	0.5	0.4	35
329	MH-009	4-410	4-400	1710	2177	Round	12	2.32	0							
330	MH-009	4-415	4-410	300	2200	Round	5	2.13	0	VAV 4-207	300	190	190	0.5	0.4	35
331	MH-009	4-420	4-410	1410	1795	Round	12	2.35	1	VAV 4-224	1410	1410	1410	0.5	0.4	35
332	MH-009	4-500	4-005	4650	2131	Round	20	2.47	0							
333	MH-009	4-505	4-500	2380	2226	Round	14	2.25	0							
334	MH-009	4-510	4-505	340	2494	Round	5	1.9	0	VAV 4-205	340	230	230	0.5	0.4	35
335	MH-009	4-515	4-505	2040	1908	Round	14	2.28	0							
336	MH-009	4-520	4-515	750	2149	Round	8	2.1	0	VAV 4-223	750	750	750	0.5	0.4	35
337	MH-009	4-525	4-515	1290	2365	Round	10	2.23	2	VAV 4-208	1290	860	860	0.5	0.4	35
338	MH-009	4-530	4-500	2270	2123	Round	14	2.32	0							
339	MH-009	4-535	4-530	410	2088	Round	6	2.13	0	VAV 4-203	410	250	250	0.5	0.4	35
340	MH-009	4-540	4-530	1860	2368	Round	12	2.38	0	VAV 4-228	1860	310	310	0.5	0.4	35
341	MH-009	4-600	4-010	2970	2127	Round	16	2.43	0							
342	MH-009	4-605	4-600	1680	2139	Round	12	2.36	0							
343	MH-009	4-610	4-605	580	1662	Round	8	2.31	0	VAV 4-102	580	580	580	0.5	0.4	35
344	MH-009	4-615	4-605	1360	2494	Round	10	2.28	0	VAV 4-101	1360	380	380	0.5	0.4	35
345	MH-009	4-620	4-600	1290	2365	Round	10	2.27	1							
346	MH-009	4-625	4-620	340	2494	Round	5	1.91	1	VAV 4-104	340	220	220	0.5	0.4	35
347	MH-009	4-630	4-620	950	1742	Round	10	2.34	0							
348	MH-009	4-635	4-630	420	2139	Round	6	2.12	0	VAV 4-103	420	280	280	0.5	0.4	35
349	MH-009	4-640	4-630	530	1518	Round	8	2.34	0							
350	MH-009	4-645	4-640	250	1833	Round	5	2.05	1	VAV 4-120	25	170	170	0.5	0.4	35
351	MH-009	4-650	4-640	280	2053	Round	5	2.13	0	VAV 4-105	280	140	140	0.5	0.4	35
352	MH-009	4-700	4-010	3990	2258	Round	18	2.41	0							
353	MH-009	4-705	4-700	470	2394	Round	6	2.14	0	VAV 4-122	470	470	470	0.5	0.4	35
354	MH-009	4-710	4-700	3520	1992	Round	18	2.39	0							
355	MH-009	4-715	4-710	1820	2317	Round	12	2.19	0	VAV 4-109	1820	1450	1450	0.5	0.4	35
356	MH-009	4-720	4-710	1700	2165	Round	12	2.22	0							
357	MH-009	4-725	4-720	270	1980	Round	5	2.13	0	VAV 4-106	270	200	200	0.5	0.4	35
358	MH-009	4-730	4-720	1430	1821	Round	12	2.22	1							
359	MH-009	4-735	4-730	110	1261	Round	4	2.23	0	VAV 4-110	110	100	100	0.5	0.4	35
360	MH-009	4-740	4-730	1320	2420	Round	10	1.91	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
361	MH-009	4-745	4-740	360	1833	Round	6	1.79	1	VAV 4-113	360	240	240	0.5	0.4	35
362	MH-009	4-750	4-740	960	1760	Round	10	1.99	0							
363	MH-009	4-755	4-750	250	1833	Round	5	1.87	0	VAV 4-116	250	170	170	0.5	0.4	35
364	MH-009	4-760	4-750	710	2034	Round	8	1.8	0							
365	MH-009	4-765	4-760	270	1980	Round	5	1.66	0	VAV 4-117	270	180	180	0.5	0.4	35
366	MH-009	4-770	4-760	440	2241	Round	6	1.61	0							
367	MH-009	4-775	4-770	110	1261	Round	4	1.56	1	VAV 4-118	110	80	80	0.5	0.4	35
368	MH-009	4-780	4-770	330	2420	Round	5	1.49	0	VAV 4-112	330	220	220	0.5	0.4	35
369	MH-009	4-800	4-010	4550	2086	Round	20	2.46	0							
370	MH-009	4-805	4-800	1150	2108	Round	10	2.23	1	VAV 4-107	1150	880	880	0.5	0.4	35
371	MH-009	4-810	4-800	3400	2435	Round	16	2.26	0							
372	MH-009	4-815	4-810	360	1833	Round	6	2.22	0	VAV 4-108	360	360	360	0.5	0.4	35
373	MH-009	4-820	4-810	3040	2177	Round	16	2.26	0							
374	MH-009	4-825	4-820	290	2127	Round	5	2.04	1	VAV 4-111	290	220	220	0.5	0.4	35
375	MH-009	4-830	4-820	2750	1970	Round	16	2.28	0							
376	MH-009	4-835	4-830	590	1690	Round	8	2.2	0	VAV 4-121	590	80	80	0.5	0.4	35
377	MH-009	4-840	4-830	2160	2021	Round	14	2.21	0							
378	MH-009	4-845	4-840	1230	2255	Round	10	2.17	0	VAV 4-114	1230	870	870	0.5	0.4	35
379	MH-009	4-850	4-840	930	1705	Round	10	2.17	0							
380	MH-009	4-855	4-850	650	1862	Round	8	1.97	0	VAV 4-115	650	630	630	0.5	0.4	35
381	MH-009	4-860	4-850	280	2053	Round	5	1.99	0	VAV 4-119	280	190	190	0.5	0.4	35
382	MH-009	5-005	AHU-5	29150	530	Rectangle	104/76	2.85	0							
383	MH-009	5-010	5-005	11935	473	Rectangle	60/60	2.85	0							
384	MH-009	5-100	5-005	7210	2295	Round	24	2.42	1							
385	MH-009	5-105	5-100	360	1833	Round	6	2.36	4	VAV 5-201	360	180	180	0.5	0.4	35
386	MH-009	5-110	5--100	6850	2180	Round	24	2.4	0							
387	MH-009	5-115	5-110	1160	2127	Round	10	2.18	0	VAV 5-205	131	890	890	0.5	0.4	35
388	MH-009	5-120	5-110	5698	2155	Round	22	2.35	0							
389	MH-009	5-125	5-120	720	2063	Round	8	2.05	4	VAV 5-202	720	280	280	0.5	0.4	35
390	MH-009	5-130	5-120	4970	2278	Round	20	2.19	0							
391	MH-009	5-135	5-130	180	2063	Round	4	2.11	0	VAV 5-206	180	120	120	0.5	0.4	35
392	MH-009	5-140	5-130	4790	2196	Round	20	2.13	0							
393	MH-009	5-145	5-140	1280	2347	Round	10	1.9	0	VAV 5-211	1280	690	690	0.5	0.4	35
394	MH-009	5-150	5-140	3410	1986	Round	18	2.15	0							
395	MH-009	5-155	5-150	940	1724	Round	10	2.09	0	VAV 5-207	940	840	840	0.5	0.4	35
396	MH-009	5-160	5-150	2570	2404	Round	14	1.91	0							
397	MH-009	5-165	5-160	290	2127	Round	5	1.68	0	VAV 5-212	290	200	200	0.5	0.4	35
398	MH-009	5-170	5-160	2280	2133	Round	14	1.88	0							
399	MH-009	5-175	5-170	200	2292	Round	4	1.38	0	VAV 5-203	200	100	100	0.5	0.4	35
400	MH-009	5-180	5-170	2080	1946	Round	14	1.86	0							
401	MH-009	5-185	5-180	1040	1907	Round	10	1.77	0	VAV 5-208	1040	680	680	0.5	0.4	35
402	MH-009	5-190	5-180	440	2241	Round	6	1.47	0	VAV 5-204	440	250	250	0.5	0.4	35
403	MH-009	5-195	5-180	600	1719	Round	8	1.75	2	VAV 5-209	600	200	200	0.5	0.4	35
404	MH-009	5-200	5-005	1070	1962	Round	10	2.51	1	VAV 5-210	1070	720	720	0.5	0.4	35
405	MH-009	5-300	5-005	8920	2419	Round	26	2.45	0							

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
406	MH-009	5-305	5-300	1430	1821	Round	12	2.35	0	VAV 5-213	1430	950	950	0.5	0.4	35
407	MH-009	5-310	5-300	7490	2384	Round	24	2.34	1							
408	MH-009	5-315	5-310	2150	2011	Round	14	2.27	0	VAV 5-220	2150	1500	1500	0.5	0.4	35
409	MH-009	5-320	5-310	5340	2448	Round	20	2.25	0							
410	MH-009	5-325	5-320	350	1783	Round	6	2.34	0	VAV 5-214	350	230	230	0.5	0.4	35
411	MH-009	5-330	5-320	4990	2287	Round	20	2.22	0							
412	MH-009	5-335	5-330	1020	1870	Round	10	2.14	0	VAV 5-221	1020	420	420	0.5	0.4	35
413	MH-009	5-340	5-330	3970	2247	Round	18	2.14	0							
414	MH-009	5-345	5-340	250	1833	Round	5	2.15	0	VAV 5-215	250	160	160	0.5	0.4	35
415	MH-009	5-350	5-340	3720	2105	Round	18	1.96	4							
416	MH-009	5-355	5-350	26	1907	Round	5	1.91	0	VAV 5-216	260	170	170	0.5	0.4	35
417	MH-009	5-360	5-350	3460	2478	Round	16	1.76	0							
418	MH-009	5-365	5-360	1800	2292	Round	12	1.63	0	VAV 5-222	1800	1200	1200	0.5	0.4	35
419	MH-009	5-370	5-360	1660	2114	Round	12	1.75	0							
420	MH-009	5-375	5-370	260	1907	Round	5	1.58	0	VAV 5-217	260	130	130	0.5	0.4	35
421	MH-009	5-380	5-370	1400	1783	Round	12	1.8	0							
422	MH-009	5-385	5-380	850	2435	Round	8	1.4	4	VAV 5-223	850	280	280	0.5	0.4	35
423	MH-009	5-390	5-380	550	1576	Round	8	1.75	0							
424	MH-009	5-395	5-390	220	1613	Round	5	1.36	0	VAV 5-218	220	16	16	0.5	0.4	35
425	MH-009	5-396	5-390	330	2420	Round	5	1.32	0							
426	MH-009	5-397	5-396	200	2292	Round	4	0.9	0	VAV 5-224	200	90	90	0.5	0.4	35
427	MH-009	5-398	5-396	130	1490	Round	4	1.41	2	VAV 5-219	130	90	90	0.5	0.4	35
428	MH-009	5-400	5-010	8420	2284	Round	26	2.5	0							
429	MH-009	5-405	5-400	420	2139	Round	6	2.36	1	VAV 5-114	420	380	380	0.5	0.4	35
430	MH-009	5-410	5-400	8000	2170	Round	26	2.46	0							
431	MH-009	5-415	5-410	480	2445	Round	6	2.16	1	VAV 5-106	480	220	220	0.5	0.4	35
432	MH-009	5-420	5-410	7520	2394	Round	24	2.2	1							
433	MH-009	5-425	5-420	210	2406	Round	4	1.94	1	VAV 5-102	210	210	210	0.5	0.4	35
434	MH-009	5-430	5-420	7310	2327	Round	24	2.17	0							
435	MH-009	5-435	5-430	1820	2318	Round	12	2.12	0	VAV 5-101	1820	970	970	0.5	0.4	35
436	MH-009	5-440	5-430	5490	2080	Round	22	2.17	0							
437	MH-009	5-445	5-540	640	1833	Round	8	2.04	0	VAV 5-107	640	640	640	0.5	0.4	35
438	MH-009	5-450	5-540	4850	2233	Round	20	1.83	4							
439	MH-009	5-455	5-550	650	1862	Round	8	1.69	0	VAV 5-108	650	450	450	0.5	0.4	35
440	MH-009	5-460	5-550	4200	2377	Round	18	1.87	0							
441	MH-009	5-465	5-560	700	2005	Round	8	1.54	4	VAV 5-119	700	310	310	0.5	0.4	35
442	MH-009	5-470	5-560	3500	1981	Round	18	1.78	0							
443	MH-009	5-475	5-570	350	1783	Round	6	1.29	1	VAV 5-103	350	230	230	0.5	0.4	35
444	MH-009	5-480	5-570	170	1980	Round	5	1.17	0	VAV 5-111	270	130	130	0.5	0.4	35
445	MH-009	5-485	5-570	2880	2063	Round	16	1.67	0							
446	MH-009	5-490	5-585	1240	2274	Round	10	1.47	0	VAV 5-104	1240	1240	1240	0.5	0.4	35
447	MH-009	5-491	5-585	1640	2088	Round	12	1.61	0							
448	MH-009	5-492	5-591	850	2435	Round	8	1.42	0	VAV 5-105	850	490	490	0.5	0.4	35
449	MH-009	5-493	5-591	790	2263	Round	8	1.34	1							
450	MH-009	5-494	5-493	410	2088	Round	6	1.22	0	VAV 5-109	410	270	270	0.5	0.4	35

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AIR HANDELER SUPPLY DUCT AND VAV SCHEDULE																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)
451	MH-009	5-495	5-493	380	1935	Round	6	1.13	1	VAV 5-118	380	70	70	0.5	0.4	35
452	MH-009	5-500	5-010	3600	2037	Round	18	2.5	5							
453	MH-010	5-505	5-500	690	1977	Round	8	2.37	0	VAV 5-112	690	320	320	0.5	0.4	35
454	MH-010	5-510	5-500	2910	2084	Round	16	2.38	1							
455	MH-010	5-515	5-520	440	2241	Round	6	2.02	0	VAV 5-117	440	260	260	0.5	0.4	35
456	MH-010	5-520	5-520	2470	2311	Round	14	2.23	0							
457	MH-010	5-525	5-520	1080	1980	Round	10	2.16	0	VAV 5-113	1080	320	320	0.5	0.4	35
458	MH-010	5-530	5-520	1390	1770	Round	12	2.32	0							
459	MH-010	5-535	5-530	390	1986	Round	6	2.08	1	VAV 5-115	390	270	270	0.5	0.4	35
460	MH-010	5-540	5-530	340	2494	Round	5	1.82	0	VAV 5-116	340	160	160	0.5	0.4	35
461	MH-010	5-545	5-530	660	1891	Round	8	2.17	1	VAV 5-11-	660	410	410	0.5	0.4	35
462	MH-010	7-005	AHU-7	7230	2301	Round	24	0.97	0							
463	MH-010	7-010	7-005	2850	2041	Round	16	0.89	0							
464	MH-010	7-100	7-005	2310	2161	Round	14	0.75	5							
465	MH-010	7-105	7-100	490	2495	Round	6	0.49	0	VAV 7-206	490	330	330	0.5	0.4	35
466	MH-010	7-110	7-100	1820	2317	Round	12	0.64	0							
467	MH-010	7-115	7-110	240	1760	Round	5	0.6	0	VAV 7-204	240	120	120	0.5	0.4	35
468	MH-010	7-120	7-110	1580	2012	Round	12	0.66	0							
469	MH-010	7-125	7-120	1190	2182	Round	10	0.49	0	VAV 7-202	1190	770	770	0.5	0.4	35
470	MH-010	7-130	7-120	390	1986	Round	6	0.5	2	VAV 7-201	390	200	200	0.5	0.4	35
471	MH-010	7-200	7-005	1790	2279	Round	12	0.86	0							
472	MH-010	7-205	7-200	260	1907	Round	5	0.78	0	VAV 7-207	260	120	120	0.5	0.4	35
473	MH-010	7-210	7-200	1530	1948	Round	12	0.75	4							
474	MH-010	7-215	7-210	640	1833	Round	8	0.66	0	VAV 7-208	640	640	640	0.5	0.4	35
475	MH-010	7-220	7-210	890	1632	Round	10	0.59	1	VAV 7-209	890	590	590	0.5	0.4	35
476	MH-010	7-300	7-010	1820	2317	Round	12	0.45	0							
477	MH-010	7-305	7-300	150	1910	Round	12	0.45	0	VAV 7-205	1500	1500	1500	0.5	0.4	35
478	MH-010	7-310	7-300	320	2347	Round	5	0.45	5	VAV 7-203	320	320	320	0.5	0.4	35
479	MH-010	7-400	7-010	1030	1889	Round	10	0.7	1	VAV 7-210	1030	1030	1030	0.5	0.4	35
480	MH-010	9-005	AHU-9	3050	2098	Round	16	1.33	2							
481	MH-010	9-010	9-005	460	2184	Round	6	0.93	0	VAV 9-101	460	460	460	0.5	0.4	35
482	MH-010	9-015	9-005	2470	2311	Round	14	1.11	1							
483	MH-010	9-020	9-015	2030	1899	Round	14	1.05	0	VAV 9-102	2030	2030	2030	0.5	0.4	35
484	MH-010	9-025	9-015	440	2241	Round	6	0.9	1	VAV 9-103	440	440	440	0.5	0.4	35

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
1	MH-004	RHC 1-101	VAV 1-101	1778	0.5	90	55	72	188	158	10x8	144	0.2	5
2	MH-004	RHC 1-102	VAV 1-102	4743	0.5	240	55	72	188	158	10x8	144	0.2	5
3	MH-004	RHC 1-103	VAV 1-103	6324	0.5	320	55	72	188	158	11x10	144	0.2	5
4	MH-004	RHC 1-104	VAV 1-104	6324	0.5	320	55	72	188	158	11x10	144	0.2	5
5	MH-004	RHC 1-105	VAV 1-105	5,138	0.5	260	55	72	188	158	11x10	144	0.2	5
6	MH-004	RHC 1-106	VAV 1-106	9,625	0.6	360	55	78	188	158	10x8	144	0.2	5
7	MH-004	RHC 1-107	VAV 1-107	9,683	0.6	490	55	72	188	158	14x12	144	0.2	5
8	MH-004	RHC 1-108	VAV 1-108	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
9	MH-004	RHC 1-109	VAV 1-109	9,625	0.6	360	55	78	188	158	11x10	144	0.2	5
10	MH-004	RHC 1-110	VAV 1-110	7,754	0.5	290	55	78	188	158	11x10	144	0.2	5
11	MH-004	RHC 1-111	VAV 1-111	10,695	0.7	400	55	78	188	158	10x8	144	0.2	5
12	MH-004	RHC 1-112	VAV 1-112	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
13	MH-004	RHC 1-113	VAV 1-113	4,150	0.5	210	55	72	188	158	11x10	144	0.2	5
14	MH-004	RHC 1-114	VAV 1-114	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
15	MH-004	RHC 1-115	VAV 1-115	7,754	0.5	290	55	78	188	158	10x8	144	0.2	5
16	MH-004	RHC 1-116	VAV 1-116	11,497	0.8	430	55	78	188	158	11x10	144	0.2	5
17	MH-004	RHC 1-117	VAV 1-117	4,590	0.5	250	55	72	188	158	10x8	144	0.2	5
18	MH-004	RHC 1-118	VAV 1-118	17,915	1.2	670	55	78	188	158	11x10	144	0.2	5
19	MH-004	RHC 1-119	VAV 1-119	5,615	0.5	210	55	78	188	158	10x8	144	0.2	5
20	MH-004	RHC 1-121	VAV 1-121	11,765	0.8	440	55	78	188	158	10x8	144	0.2	5
21	MH-004	RHC 1-122	VAV 1-122	2,964	0.5	150	55	72	188	158	10x8	144	0.2	5
22	MH-004	RHC 1-123	VAV 1-123	7,486	0.5	280	55	78	188	158	11x10	144	0.2	5
23	MH-004	RHC 1-124	VAV 1-124	4,941	0.5	250	55	72	188	158	10x8	144	0.2	5
24	MH-004	RHC 1-125	VAV 1-125	6,324	0.5	320	55	72	188	158	11x10	144	0.2	5
25	MH-004	RHC 1-126	VAV 1-126	4,150	0.5	210	55	72	188	158	10x8	144	0.2	5
26	MH-004	RHC 1-127	VAV 1-127	1,383	0.5	70	55	72	188	158	10x8	144	0.2	5
27	MH-004	RHC 1-128	VAV 1-128	13,241	0.9	670	55	72	188	158	11x10	144	0.2	5
28	MH-004	RHC 1-129	VAV 1-129	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
29	MH-004	RHC 1-130	VAV 1-130	11,857	0.8	600	55	72	188	158	11x10	144	0.2	5
30	MH-004	RHC 1-131	VAV 1-131	17,589	1.2	890	55	72	188	158	19x18	144	0.2	5
31	MH-004	RHC 1-132	VAV 1-132	4,545	0.5	230	55	72	188	158	11x10	144	0.2	5
32	MH-004	RHC 1-201	VAV 1-201	1,976	0.5	100	55	72	188	158	10x8	144	0.2	5
33	MH-004	RHC 1-202	VAV 1-202	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
34	MH-004	RHC 1-203	VAV 1-203	4,545	0.5	230	55	72	188	158	11x10	144	0.2	5
35	MH-004	RHC 1-204	VAV 1-204	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
36	MH-004	RHC 1-205	VAV 1-205	7,114	0.5	360	55	72	188	158	11x10	144	0.2	5
37	MH-004	RHC 1-206	VAV 1-206	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
38	MH-004	RHC 1-207	VAV 1-207	3,359	0.5	170	55	72	188	158	11x10	144	0.2	5
39	MH-004	RHC 1-208	VAV 1-208	9,881	0.5	500	55	72	188	158	14x12	144	0.2	5
40	MH-004	RHC 1-209	VAV 1-209	8,102	0.7	410	55	72	188	158	11x10	144	0.2	5
41	MH-004	RHC 1-210	VAV 1-210	15,810	0.5	800	55	72	188	158	17x14	144	0.2	5
42	MH-004	RHC 1-211	VAV 1-211	17,193	1	870	55	72	188	158	17x14	144	0.2	5
43	MH-004	RHC 1-212	VAV 1-212	2,766	1.1	140	55	72	188	158	10x8	144	0.2	5
44	MH-004	RHC 1-213	VAV 1-213	6,324	0.5	320	55	72	188	158	10x8	144	0.2	5
45	MH-004	RHC 1-214	VAV 1-214	8,893	0.5	450	55	72	188	158	11x10	144	0.2	5
46	MH-004	RHC 1-216	VAV 1-216	3,162	0.5	390	55	72	188	158	11x10	144	0.2	5
47	MH-004	RHC 1-217	VAV 1-217	13,241	0.5	160	55	72	188	158	10x8	144	0.2	5
48	MH-004	RHC 1-218	VAV 1-218	12,450	0.9	670	55	72	188	158	14x12	144	0.2	5
49	MH-004	RHC 1-219	VAV 1-219	5,336	0.8	630	55	72	188	158	14x12	144	0.2	5
50	MH-004	RHC 1-220	VAV 1-220	7,114	0.5	270	55	72	188	158	10x8	144	0.2	5
51	MH-004	RHC 1-221	VAV 1-221	1,976	0.5	360	55	72	188	158	11x10	144	0.2	5
52	MH-004	RHC 1-222	VAV 1-222	6,917	0.5	100	55	72	188	158	10x8	144	0.2	5
53	MH-004	RHC 1-223	VAV 1-223	7,707	0.5	350	55	72	188	158	11x10	144	0.2	5
54	MH-004	RHC 1-224	VAV 1-224	2,569	0.5	380	55	72	188	158	11x10	144	0.2	5
55	MH-004	RHC 1-225	VAV 1-225	1,383	0.5	130	55	72	188	158	10x8	144	0.2	5
56	MH-004	RHC 1-226	VAV 1-226	13,834	0.5	70	55	72	188	158	10x8	144	0.2	5
57	MH-004	RHC 1-227	VAV 1-227	6,324	0.9	700	55	72	188	158	19x18	144	0.2	5
58	MH-004	RHC 2-101	VAV 2-101	6,324	0.5	320	55	72	188	158	11x10	144	0.2	5
59	MH-004	RHC 2-102	VAV 2-102	6,324	0.5	320	55	72	188	158	11x10	144	0.2	5
60	MH-004	RHC 2-103	VAV 2-103	4,347	0.5	220	55	72	188	158	11x10	144	0.2	5
61	MH-004	RHC 2-104	VAV 2-104	4,743	0.5	240	55	72	188	158	10x8	144	0.2	5
62	MH-004	RHC 2-105	VAV 2-105	1,383	0.7	70	55	72	188	158	10x8	144	0.2	5
63	MH-004	RHC 2-106	VAV 2-106	10,079	0.6	510	55	72	188	158	14x12	144	0.2	5
64	MH-004	RHC 2-107	VAV 2-107	9,358	0.5	350	55	78	188	158	10x8	144	0.2	5
65	MH-004	RHC 2-108	VAV 2-108	6,324	0.8	320	55	72	188	158	10x8	144	0.2	5
66	MH-004	RHC 2-109	VAV 2-109	11,497	0.8	430	55	78	188	158	11x10	144	0.2	5
67	MH-004	RHC 2-110	VAV 2-110	11,498	0.5	430	55	78	188	158	10x8	144	0.2	5
68	MH-004	RHC 2-111	VAV 2-111	6,719	0.8	340	55	72	188	158	10x8	144	0.2	5
69	MH-004	RHC 2-112	VAV 2-112	11,764	0.7	440	55	78	188	158	11x10	144	0.2	5

VISN 20 Alaska: Equipment List

TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
70	MH-004	RHC 2-113	VAV 2-113	10,869	0.8	550	55	72	188	158	11x10	144	0.2	5
71	MH-004	RHC 2-114	VAV 2-114	12,032	0.6	450	55	78	188	158	11x10	144	0.2	5
72	MH-004	RHC 2-115	VAV 2-115	8,556	0.5	320	55	78	188	158	11x10	144	0.2	5
73	MH-004	RHC 2-116	VAV 2-116	7,708	0.5	390	55	72	188	158	11x10	144	0.2	5
74	MH-004	RHC 2-118	VAV 2-118	7,510	0.5	380	55	72	188	158	11x10	144	0.2	5
75	MH-004	RHC 2-119	VAV 2-119	11,498	0.8	430	55	78	188	158	10x8	144	0.2	5
76	MH-004	RHC 2-120	VAV 2-120	2,964	0.5	150	55	72	188	158	10x8	144	0.2	5
77	MH-004	RHC 2-121	VAV 2-121	7,312	0.5	370	55	72	188	158	11x10	144	0.2	5
78	MH-004	RHC 2-122	VAV 2-122	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
79	MH-004	RHC 2-123	VAV 2-123	8,102	0.5	410	55	72	188	158	11x10	144	0.2	5
80	MH-004	RHC 2-124	VAV 2-124	5,534	0.5	280	55	72	188	158	11x10	144	0.2	5
81	MH-004	RHC 2-125	VAV 2-125	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
82	MH-004	RHC 2-126	VAV 2-126	13,241	0.9	670	55	72	188	158	11x10	144	0.2	5
83	MH-004	RHC 2-127	VAV 2-127	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
84	MH-004	RHC 2-128	VAV 2-128	11,857	0.8	600	55	72	188	158	14x12	144	0.2	5
85	MH-004	RHC 2-129	VAV 2-129	2,964	0.5	150	55	72	188	158	10x8	144	0.2	5
86	MH-004	RHC 2-130	VAV 2-130	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
87	MH-004	RHC 2-131	VAV 2-131	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
88	MH-004	RHC 2-201	VAV 2-201	10,079	0.7	510	55	72	188	158	17x14	144	0.2	5
89	MH-004	RHC 2-202	VAV 2-202	8,823	0.6	330	55	78	188	158	11x10	144	0.2	5
90	MH-004	RHC 2-203	VAV 2-203	8,823	0.6	330	55	78	188	158	11x10	144	0.2	5
91	MH-004	RHC 2-204	VAV 2-204	5,138	0.5	260	55	72	188	158	11x10	144	0.2	5
92	MH-004	RHC 2-205	VAV 2-205	10,079	0.7	510	55	72	188	158	11x10	144	0.2	5
93	MH-004	RHC 2-206	VAV 2-206	5,138	0.5	260	55	72	188	158	10x8	144	0.2	5
94	MH-004	RHC 2-207	VAV 2-207	3,952	0.5	200	55	72	188	158	10x8	144	0.2	5
95	MH-004	RHC 2-208	VAV 2-208	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
96	MH-004	RHC 2-209	VAV 2-209	8,300	0.5	420	55	72	188	158	11x10	144	0.2	5
97	MH-004	RHC 2-210	VAV 2-210	12,450	0.8	630	55	72	188	158	14x12	144	0.2	5
98	MH-004	RHC 2-211	VAV 2-211	10,427	0.7	390	55	78	188	158	11x10	144	0.2	5
99	MH-004	RHC 2-212	VAV 2-212	3,162	0.5	160	55	72	188	158	10x8	144	0.2	5
100	MH-004	RHC 2-213	VAV 2-213	4,743	0.5	240	55	72	188	158	10x8	144	0.2	5
101	MH-004	RHC 2-214	VAV 2-214	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
102	MH-004	RHC 2-215	VAV 2-215	12,567	0.8	470	55	78	188	158	11x10	144	0.2	5
103	MH-004	RHC 2-216	VAV 2-216	8,893	0.6	450	55	72	188	158	10x8	144	0.2	5
104	MH-004	RHC 2-217	VAV 2-217	9,091	0.6	460	55	72	188	158	10x8	144	0.2	5
105	MH-004	RHC 2-218	VAV 2-218	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
106	MH-004	RHC 2-219	VAV 2-219	7,806	0.5	395	55	72	188	158	19x18	144	0.2	5
107	MH-004	RHC 3-101	VAV 3-101	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
108	MH-004	RHC 3-102	VAV 3-102	12,032	0.8	450	55	78	188	158	11x10	144	0.2	5
109	MH-004	RHC 3-103	VAV 3-103	6,126	0.5	310	55	72	188	158	11x10	144	0.2	5
110	MH-004	RHC 3-104	VAV 3-104	6,719	0.5	340	55	72	188	158	11x10	144	0.2	5
111	MH-004	RHC 3-105	VAV 3-105	7,114	0.5	360	55	72	188	158	11x10	144	0.2	5
112	MH-004	RHC 3-106	VAV 3-106	8,823	0.6	330	55	78	188	158	11x10	144	0.2	5
113	MH-004	RHC 3-107	VAV 3-107	8,102	0.5	410	55	72	188	158	11x10	144	0.2	5
114	MH-004	RHC 3-109	VAV 3-109	8,695	0.6	440	55	72	188	158	11x10	144	0.2	5
115	MH-004	RHC 3-110	VAV 3-110	11,497	0.8	430	55	78	188	158	11x10	144	0.2	5
116	MH-004	RHC 3-111	VAV 3-111	6,521	0.5	330	55	72	188	158	11x10	144	0.2	5
117	MH-004	RHC 3-112	VAV 3-112	6,324	0.5	320	55	72	188	158	10x8	144	0.2	5
118	MH-004	RHC 3-113	VAV 3-113	10,079	0.7	510	55	72	188	158	11x10	144	0.2	5
119	MH-004	RHC 3-114	VAV 3-114	11,660	0.8	590	55	72	188	158	14x12	144	0.2	5
120	MH-004	RHC 3-115	VAV 3-115	12,032	0.8	450	55	78	188	158	11x10	144	0.2	5
121	MH-004	RHC 3-116	VAV 3-116	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
122	MH-004	RHC 3-117	VAV 3-117	5,731	0.5	290	55	72	188	158	11x10	144	0.2	5
123	MH-004	RHC 3-118	VAV 3-118	11,764	0.8	440	55	78	188	158	11x10	144	0.2	5
124	MH-004	RHC 3-119	VAV 3-119	7,754	0.5	290	55	78	188	158	10x8	144	0.2	5
125	MH-004	RHC 3-120	VAV 3-120	13,834	0.9	700	55	72	188	158	11x10	144	0.2	5
126	MH-004	RHC 3-121	VAV 3-121	6,521	0.5	330	55	72	188	158	10x8	144	0.2	5
127	MH-004	RHC 3-122	VAV 3-122	6,719	0.5	340	55	72	188	158	10x8	144	0.2	5
128	MH-004	RHC 3-123	VAV 3-123	4,150	0.5	210	55	72	188	158	10x8	144	0.2	5
129	MH-004	RHC 3-124	VAV 3-124	3,359	0.5	170	55	72	188	158	10x8	144	0.2	5
130	MH-004	RHC 3-125	VAV 3-125	10,672	0.7	540	55	72	188	158	10x8	144	0.2	5
131	MH-004	RHC 3-126	VAV 3-126	9,091	0.6	460	55	72	188	158	17x14	144	0.2	5
132	MH-004	RHC 3-128	VAV 3-128	5,347	0.5	200	55	78	188	158	19x18	144	0.2	5
133	MH-004	RHC 3-201	VAV 3-201	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
134	MH-004	RHC 3-202	VAV 3-202	5,928	0.5	300	55	72	188	158	11x10	144	0.2	5
135	MH-004	RHC 3-203	VAV 3-203	6,719	0.5	340	55	72	188	158	10x8	144	0.2	5
136	MH-004	RHC 3-204	VAV 3-204	5,928	0.5	300	55	72	188	158	11x10	144	0.2	5
137	MH-004	RHC 3-205	VAV 3-205	8,102	0.5	410	55	72	188	158	19x18	144	0.2	5
138	MH-004	RHC 3-206	VAV 3-206	5,928	0.5	300	55	72	188	158	11x10	144	0.2	5

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
139	MH-004	RHC 3-207	VAV 3-207	10,276	0.7	520	55	72	188	158	11x10	144	0.2	5
140	MH-004	RHC 3-208	VAV 3-208	5,731	0.5	290	55	72	188	158	10x8	144	0.2	5
141	MH-004	RHC 3-209	VAV 3-209	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
142	MH-004	RHC 3-211	VAV 3-211	7,114	0.5	360	55	72	188	158	11x10	144	0.2	5
143	MH-004	RHC 3-212	VAV 3-212	10,869	0.7	550	55	72	188	158	14x12	144	0.2	5
144	MH-004	RHC 3-213	VAV 3-213	5,533	0.5	280	55	72	188	158	17x14	144	0.2	5
145	MH-004	RHC 3-214	VAV 3-214	19,170	1.3	970	55	72	188	158	19x18	144	0.2	5
146	MH-004	RHC 3-215	VAV 3-215	12,055	0.8	610	55	72	188	158	14x12	144	0.2	5
147	MH-004	RHC 3-216	VAV 3-216	5,533	0.5	280	55	72	188	158	11x10	144	0.2	5
148	MH-004	RHC 3-217	VAV 3-217	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
149	MH-004	RHC 3-218	VAV 3-218	6,521	0.5	330	55	72	188	158	11x10	144	0.2	5
150	MH-004	RHC 3-219	VAV 3-219	14,229	0.9	720	55	72	188	158	17x14	144	0.2	5
151	MH-004	RHC 3-220	VAV 3-220	14,427	1	730	55	72	188	158	14x12	144	0.2	5
152	MH-004	RHC 3-221	VAV 3-221	7,707	0.5	390	55	72	188	158	11x10	144	0.2	5
153	MH-004	RHC 3-222	VAV 3-222	6,917	0.5	350	55	72	188	158	14x12	144	0.2	5
154	MH-004	RHC 3-223	VAV 3-223	4,940	0.5	250	55	72	188	158	10x8	144	0.2	5
155	MH-004	RHC 4-101	VAV 4-101	7,510	0.5	380	55	72	188	158	14x12	144	0.2	5
156	MH-004	RHC 4-102	VAV 4-102	11,462	0.8	580	55	72	188	158	14x12	144	0.2	5
157	MH-004	RHC 4-103	VAV 4-103	5,533	0.5	280	55	72	188	158	11x10	144	0.2	5
158	MH-004	RHC 4-104	VAV 4-104	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
159	MH-004	RHC 4-106	VAV 4-106	3,953	0.5	200	55	72	188	158	11x10	144	0.2	5
160	MH-004	RHC 4-107	VAV 4-107	17,391	1.1	880	55	72	188	158	17x14	144	0.2	5
161	MH-004	RHC 4-108	VAV 4-108	7,114	0.5	360	55	72	188	158	10x8	144	0.2	5
162	MH-004	RHC 4-109	VAV 4-109	28,656	1.9	1450	55	72	188	158	19x18	144	0.2	5
163	MH-004	RHC 4-110	VAV 4-110	1,976	0.5	100	55	72	188	158	10x8	144	0.2	5
164	MH-004	RHC 4-111	VAV 4-111	4,347	0.5	220	55	72	188	158	10x8	144	0.2	5
165	MH-004	RHC 4-112	VAV 4-112	4,328	0.5	220	55	72	188	158	10x8	144	0.2	5
166	MH-004	RHC 4-113	VAV 4-113	4,743	0.5	240	55	72	188	158	10x8	144	0.2	5
167	MH-004	RHC 4-114	VAV 4-114	17,193	1.1	870	55	72	188	158	17x14	144	0.2	5
168	MH-004	RHC 4-115	VAV 4-115	12,451	0.8	630	55	72	188	158	11x10	144	0.2	5
169	MH-004	RHC 4-116	VAV 4-116	3,359	0.5	170	55	72	188	158	10x8	144	0.2	5
170	MH-004	RHC 4-117	VAV 4-117	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
171	MH-004	RHC 4-118	VAV 4-118	1,581	0.5	80	55	72	188	158	10x8	144	0.2	5
172	MH-004	RHC 4-119	VAV 4-119	3,755	0.5	190	55	72	188	158	10x8	144	0.2	5
173	MH-004	RHC 4-120	VAV 4-120	3,359	0.5	170	55	72	188	158	10x8	144	0.2	5
174	MH-004	RHC 4-121	VAV 4-121	830	0.5	80	55	65	188	158	11x10	144	0.2	5
175	MH-004	RHC 4-122	VAV 4-122	8,289	0.6	470	55	72	188	158	14x12	144	0.2	5
176	MH-004	RHC 4-201	VAV 4-201	35,968	2.4	1820	55	72	188	158	23x18	144	0.2	5
177	MH-004	RHC 4-202	VAV 4-202	32,260	2.1	1850	55	70	188	158	17x14	144	0.2	5
178	MH-004	RHC 4-203	VAV 4-203	4,940	0.5	250	55	72	188	158	11x10	144	0.2	5
179	MH-004	RHC 4-205	VAV 4-205	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
180	MH-004	RHC 4-206	VAV 4-206	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
181	MH-004	RHC 4-207	VAV 4-207	3,755	0.5	190	55	72	188	158	10x8	144	0.2	5
182	MH-004	RHC 4-208	VAV 4-208	71,984	4.7	860	55	72	188	158	27x18	144	0.2	5
183	MH-004	RHC 4-209	VAV 4-209	14,229	0.9	720	55	72	188	158	17x14	144	0.2	5
184	MH-004	RHC 4-210	VAV 4-210	10,672	0.7	540	55	72	188	158	14x12	144	0.2	5
185	MH-004	RHC 4-211	VAV 4-211	7,707	0.5	390	55	72	188	158	19x18	144	0.2	5
186	MH-004	RHC 4-212	VAV 4-212	19,565	1.3	990	55	72	188	158	19x18	144	0.2	5
187	MH-004	RHC 4-213	VAV 4-213	8,300	0.5	420	55	72	188	158	11x10	144	0.2	5
188	MH-004	RHC 4-214	VAV 4-214	10,672	0.7	540	55	72	188	158	14x12	144	0.2	5
189	MH-004	RHC 4-215	VAV 4-215	20,158	0.9	720	55	72	188	158	17x14	144	0.2	5
190	MH-004	RHC 4-216	VAV 4-216	10,474	0.7	530	55	72	188	158	11x10	144	0.2	5
191	MH-004	RHC 4-217	VAV 4-217	3,557	0.5	180	55	72	188	158	10x8	144	0.2	5
192	MH-004	RHC 4-218	VAV 4-218	4,940	0.5	250	55	72	188	158	10x8	144	0.2	5
193	MH-004	RHC 4-219	VAV 4-219	2,173	0.5	110	55	72	188	158	10x8	144	0.2	5
194	MH-004	RHC 4-220	VAV 4-220	1,976	0.5	100	55	72	188	158	10x8	144	0.2	5
195	MH-004	RHC 4-221	VAV 4-221	1,976	0.5	170	55	72	188	158	10x8	144	0.2	5
196	MH-004	RHC 4-222	VAV 4-222	2,766	0.5	140	55	72	188	158	10x8	144	0.2	5
197	MH-004	RHC 4-223	VAV 4-223	14,822	1	750	55	72	188	158	11x10	144	0.2	5
198	MH-004	RHC 4-224	VAV 4-224	27,866	1.8	1410	55	72	188	158	17x14	144	0.2	5
199	MH-004	RHC 4-225	VAV 4-225	12,648	0.8	640	55	72	188	158	14x12	144	0.2	5
200	MH-004	RHC 4-227	VAV 4-227	7,312	0.5	370	55	72	188	158	11x10	144	0.2	5
201	MH-004	RHC 4-228	VAV 4-228	6,126	0.5	310	55	72	188	158	19x18	144	0.2	5
202	MH-004	RHC 4-229	VAV 4-229	4,940	0.5	250	55	72	188	158	11x10	144	0.2	5
203	MH-004	RHC 5-101	VAV 5-101	19,170	1.3	970	55	72	188	158	17x14	144	0.2	5
204	MH-004	RHC 5-102	VAV 5-102	4,150	1.3	210	55	72	188	158	10x8	144	0.2	5
205	MH-004	RHC 5-103	VAV 5-103	4,545	0.5	230	55	72	188	158	10x8	144	0.2	5
206	MH-004	RHC 5-104	VAV 5-104	23,188	0.5	1240	55	72	188	158	14x12	144	0.2	5
207	MH-004	RHC 5-105	VAV 5-105	9,683	1.7	710	55	72	188	158	14x12	144	0.2	5

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TERMINAL RE-HEAT COIL SCHEDULE														
#	Draw #	Tag ID	Serves	BtuH	GPM	CFM Rated	EAT	LAT	EGT	LGT	Coil Size	Fins/Ft	MAX APD	MAX WPD
208	MH-004	RHC 5-106	VAV 5-106	5,882	0.9	220	55	78	188	158	10x8	144	0.2	5
209	MH-004	RHC 5-107	VAV 5-107	12,648	0.5	640	55	72	188	158	11x10	144	0.2	5
210	MH-004	RHC 5-108	VAV 5-108	8,893	0.8	450	55	72	188	158	11x10	144	0.2	5
211	MH-004	RHC 5-109	VAV 5-109	5,336	0.6	270	55	72	188	158	10x8	144	0.2	5
212	MH-004	RHC 5-110	VAV 5-110	8,102	0.5	410	55	72	188	158	11x10	144	0.2	5
213	MH-004	RHC 5-111	VAV 5-111	2,569	0.5	130	55	72	188	158	10x8	144	0.2	5
214	MH-004	RHC 5-112	VAV 5-112	8,556	0.5	320	55	78	188	158	11x10	144	0.2	5
215	MH-004	RHC 5-113	VAV 5-113	8,556	0.6	320	55	78	188	158	14x12	144	0.2	5
216	MH-004	RHC 5-114	VAV 5-114	7,510	0.6	380	55	72	188	158	17x14	144	0.2	5
217	MH-004	RHC 5-115	VAV 5-115	5,336	0.5	270	55	72	188	158	10x8	144	0.2	5
218	MH-004	RHC 5-116	VAV 5-116	3,162	0.5	160	55	72	188	158	10x8	144	0.2	5
219	MH-004	RHC 5-117	VAV 5-117	5,138	0.5	260	55	72	188	158	10x8	144	0.2	5
220	MH-004	RHC 5-118	VAV 5-118	813	0.5	70	55	65	188	158	11x10	144	0.2	5
221	MH-005	RHC 5-201	VAV 5-201	3,557	0.5	180	55	72	188	158		144	0.2	5
222	MH-005	RHC 5-202	VAV 5-202	5,533	0.5	280	55	72	188	158		144	0.2	5
223	MH-005	RHC 5-203	VAV 5-203	1,976	0.5	100	55	72	188	158		144	0.2	5
224	MH-005	RHC 5-204	VAV 5-204	4,940	0.5	250	55	72	188	158		144	0.2	5
225	MH-005	RHC 5-205	VAV 5-205	17,589	1.2	890	55	72	188	158		144	0.2	5
226	MH-005	RHC 5-206	VAV 5-206	2,371	0.5	120	55	72	188	158		144	0.2	5
227	MH-005	RHC 5-207	VAV 5-207	16,601	1.1	840	55	72	188	158		144	0.2	5
228	MH-005	RHC 5-208	VAV 5-208	13,438	0.9	680	55	72	188	158		144	0.2	5
229	MH-005	RHC 5-209	VAV 5-209	3,952	0.5	200	55	72	188	158		144	0.2	5
230	MH-005	RHC 5-210	VAV 5-210	14,229	0.9	720	55	72	188	158		144	0.2	5
231	MH-005	RHC 5-211	VAV 5-211	11,462	0.8	690	55	72	188	158		144	0.2	5
232	MH-005	RHC 5-212	VAV 5-212	3,952	0.5	200	55	72	188	158		144	0.2	5
233	MH-005	RHC 5-213	VAV 5-213	18,775	1.2	950	55	72	188	158		144	0.2	5
234	MH-005	RHC 5-214	VAV 5-214	4,545	0.5	230	55	72	188	158		144	0.2	5
235	MH-005	RHC 5-215	VAV 5-215	3,162	0.5	160	55	72	188	158		144	0.2	5
236	MH-005	RHC 5-216	VAV 5-216	3,359	0.5	170	55	72	188	158		144	0.2	5
237	MH-005	RHC 5-218	VAV 5-218	3,162	0.5	160	55	72	188	158		144	0.2	5
238	MH-005	RHC 5-219	VAV 5-219	1,778	0.5	90	55	72	188	158		144	0.2	5
239	MH-005	RHC 5-220	VAV 5-220	29,644	2.1	1500	55	72	188	158		144	0.2	5
240	MH-005	RHC 5-221	VAV 5-221	8,300	0.5	420	55	72	188	158		144	0.2	5
241	MH-005	RHC 5-222	VAV 5-222	23,715	1.6	1200	55	72	188	158		144	0.2	5
242	MH-005	RHC 5-223	VAV 5-223	5,533	0.5	280	55	72	188	158		144	0.2	5
243	MH-005	RHC 5-224	VAV 5-224	1,778	0.5	90	55	72	188	158		144	0.2	5
244	MH-005	RHC 7-201	VAV 7-201	3,952	0.5	200	55	72	188	158		144	0.2	5
245	MH-005	RHC 7-202	VAV 7-202	15,217	1.4	770	55	72	188	158		144	0.2	5
246	MH-005	RHC 7-203	VAV 7-203	6,324	0.5	320	55	72	188	158		144	0.2	5
247	MH-005	RHC 7-204	VAV 7-204	2,171	0.5	120	55	72	188	158		144	0.2	5
248	MH-005	RHC 7-205	VAV 7-205	28,050	2	1500	55	72	188	158		144	0.2	5
249	MH-005	RHC 7-206	VAV 7-206	6,170	0.5	230	55	72	188	158		144	0.2	5
250	MH-005	RHC 7-208	VAV 7-208	12,648	0.8	640	55	72	188	158		144	0.2	5
251	MH-005	RHC 7-209	VAV 7-209	11,660	0.8	580	55	72	188	158		144	0.2	5
252	MH-005	RHC 7-210	VAV 7-210	19,368	1.4	1030	55	72	188	158		144	0.2	5
253	MH-005	RHC 8-101	VAV 8-101	47,347	3.1	1630	55	80	188	158		144	0.2	5
254	MH-005	RHC 8-102	VAV 8-102	25,576	1.8	880	55	80	188	158		144	0.2	5
255	MH-005	RHC 8-103	VAV 8-103	9,782	0.6	490	55	72	188	158		144	0.2	5
256	MH-005	RHC 8-104	VAV 8-104	10,927	0.7	470	55	72	188	158		144	0.2	5
257	MH-005	RHC 8-105	VAV 8-105	1,779	0.5	90	55	72	188	158		144	0.2	5
258	MH-005	RHC 8-106	VAV 8-106	2,964	0.5	150	55	72	188	158		144	0.2	5
259	MH-005	RHC 8-107	VAV 8-107	3,952	0.5	200	55	72	188	158		144	0.2	5
260	MH-005	RHC 8-108	VAV 8-108	3,360	0.6	400	55	75	188	158		144	0.2	5
261	MH-005	RHC 8-109	VAV 8-109	13,718	0.9	590	55	75	188	158		144	0.2	5
262	MH-005	RHC 8-110	VAV 8-110	7,207	0.5	310	55	75	188	158		144	0.2	5
263	MH-005	RHC 8-111	VAV 8-111	9,765	0.6	420	55	75	188	158		144	0.2	5
264	MH-005	RHC 8-112	VAV 8-112	3,162	0.5	160	55	72	188	158		144	0.2	5
265	MH-005	RHC 8-113	VAV 8-113	6,685	0.5	250	55	78	188	158		144	0.2	5
266	MH-005	RHC 8-114	VAV 8-114	6,952	0.5	260	55	78	188	158		144	0.2	5
267	MH-005	RHC 8-115	VAV 8-115	9,998	0.7	430	55	75	188	158		144	0.2	5
268	MH-005	RHC 9-101	VAV 9-101	9,091	0.6	460	55	72	188	158		144	0.2	5
269	MH-005	RHC 9-102	VAV 9-102	40,119	2.6	2030	55	72	188	158		144	0.2	5
270	MH-005	RHC 9-103	VAV 9-103	8,695	0.6	440	55	72	188	158		144	0.2	5

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AHU-8 DUCT & AIR VALVE SCHEDULE																	
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out (in w.c.)	Elbow Qty.	Unit #	CFM MAX	CFM MIN	CFM HEATING	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)	Note
1	MH-010	8-005	AHU-8	7940	4878	Round	26	2.94	0								
2	MH-010	8-100	8-005	3700	2094	Round	18	2.58	2								Variable Vol. Air Valve
3	MH-010	8-105	8-100	650	1802	Round	8	2.44	1	SAV 8-115	650	430	430	0.6	0.5	35	
4	MH-010	8-110	8-100	3050	2184	Round	16	2.35	4								Constant Vol. Air Valve
5	MH-010	8-115	8-110	420	2189	Round	6	2.3	0	SAV 8-111	420	420	420	0.6	0.5	35	
6	MH-010	8-120	8-110	2630	2460	Round	14	2.08	0								Variable Vol. Air Valve
7	MH-010	8-125	8-120	440	2241	Round	6	1.88	0	SAV 8-113	440	250	250	0.6	0.5	35	
8	MH-010	8-130	8-120	2190	2049	Round	14	2.12	0								Variable Vol. Air Valve
9	MH-010	8-135	8-130	440	2241	Round	6	1.95	0	SAV 8-114	440	260	260	0.6	0.5	35	Variable Vol. Air Valve
10	MH-010	8-140	8-130	290	2127	Round	5	1.3	0	SAV 8-112	290	160	160	0.6	0.5	35	
11	MH-010	8-145	8-130	1460	1859	Round	12	1.87	5								Constant Vol. Air Valve
12	MH-010	8-150	8-145	490	2496	Round	6	1.58	0	SAV 8-103	490	490	490	0.6	0.5	35	Two-Position Air Valve
13	MH-010	8-155	8-145	880	1778	Round	10	1.83	1	SAV 8-102	660	350	350	0.6	0.5	35	
14	MH-010	8-200	8-005	4330	2450	Round	10	2.5	0								
15	MH-010	8-205	8-200	2750	1970	Round	16	2.53	1								Constant Vol. Air Valve
16	MH-010	8-210	8-205	200	2252	Round	4	2.3	0	SAV 8-107	200	200	200	0.6	0.5	35	
17	MH-010	8-215	8-205	2550	2385	Round	14	2.27	0								Constant Vol. Air Valve
18	MH-010	8-220	8-215	150	1719	Round	4	2.36	0	SAV 8-106	150	150	150	0.6	0.5	35	Constant Vol. Air Valve
19	MH-010	8-225	8-215	470	2394	Round	6	1.94	1	SAV 8-104	470	470	470	0.6	0.5	35	
20	MH-010	8-230	8-215	1930	2457	Round	12	2.11	0								Variable Vol. Air Valve
21	MH-010	8-235	8-230	300	2200	Round	5	2.04	0	SAV 8-105	300	90	90	0.6	0.5	35	Two-Position Air Valve
22	MH-010	8-240	8-230	1630	2075	Round	12	2.18	0	SAV 8-101	1220	650	650	0.6	0.5	35	
23	MH-010	8-245	8-200	1580	2012	Round	12	2.46	0								Variable Vol. Air Valve
24	MH-010	8-250	8-245	870	2492	Round	8	2.19	0	SAV 8-109	870	590	590	0.6	0.5	35	
25	MH-010	8-255	8-245	710	2034	Round	8	2.4	0								Constant Vol. Air Valve
26	MH-010	8-260	8-255	400	2037	Round	6	2.18	0	SAV 8-108	400	400	400	0.6	0.5	35	Constant Vol. Air Valve
27	MH-010	8-265	8-255	310	2274	Round	5	2.48	0	SAV 8-110	310	310	310	0.6	0.5	35	Two-Position Air Valve

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EF-9 DUCT & AIR VALVE SCHEDULE (replaces EF-11 schedule)																
#	Draw #	Tag ID	Upstream Duct #	CFM	Vel (FPM)	Shape	Size Dia. (IN.)	Static Out (in w.c.)	Elbow Quanitity	Unit #	CFM MAX	CFM MIN	PD (in w.c.)	Runout SP (in w.c.)	NC Rating (MAX dB)	Note
1	MH-010	11-005	EF-11	7105	2349	Round	24	1.33	2							
2	MH-010	11-100	11-005	2760	1977	Round	16	1.1	0							
3	MH-010	11-105	11-100	950	1742	Round	10	1.13	0							
4	MH-010	11-110	11-105	490	2496	Round	6	0.78	0	EAV 8-111	490	490	0.6	0.5	35	Constant Vol. Air Valve
5	MH-010	11-115	11-105	460	2343	Round	6	0.66	0							
6	MH-010	11-116	11-115	200	2292	Round	4	0.52	0	EAV 8-116	200	200	0.6	0.5	35	Constant Vol. Air Valve
7	MH-010	11-117	11-115	260	1907	Round	5	0.53	3	EAV 8-112	260	140	0.6	0.5	35	Variable Vol. Air Valve
8	MH-010	11-120	11-100	1810	2305	Round	12	0.87	0							
9	MH-010	11-125	11-120	430	2190	Round	6	0.74	0	EAV 8-115	430	390	0.6	0.5	35	Variable Vol. Air Valve
10	MH-010	11-130	11-120	1380	1757	Round	12	0.94	1							
11	MH-010	11-135	11-130	280	2053	Round	5	0.72	1	EAV 8-110	280	280	0.6	0.5	35	Constant Vol. Air Valve
12	MH-010	11-140	11-130	1100	2017	Round	10	0.63	4							
13	MH-010	11-145	11-140	740	2120	Round	8	0.47	0	EAV 8-109	740	530	0.6	0.5	35	Variable Vol. Air Valve
14	MH-010	11-150	11-140	360	1833	Round	6	0.61	0	EAV 8-108	360	360	0.6	0.5	35	Constant Vol. Air Valve
15	MH-010	11-200	11-005	4625	2120	Round	20	0.98	2							
16	MH-010	11-205	11-200	2180	2039	Round	14	0.85	1							
17	MH-010	11-210	11-205	300	2200	Round	5	0.61	0	EAV 8-107	300	300	0.6	0.5	35	Constant Vol. Air Valve
18	MH-010	11-215	11-205	1880	2394	Round	12	0.59	0							
19	MH-010	11-220	11-215	140	1604	Round	4	0.7	0	EAV 8-106	140	140	0.6	0.5	35	Constant Vol. Air Valve
20	MH-010	11-225	11-215	1740	2215	Round	12	0.57	0							
21	MH-010	11-230	11-225	270	1980	Round	5	0.41	0	EAV 8-105	270	80	0.6	0.5	35	Variable Vol. Air Valve
22	MH-010	11-235	11-225	1320	1872	Round	12	0.63	0	EAV 8-101	1320	520	0.6	0.5	35	Two-Position Air Valve
23	MH-010	11-240	11-200	2445	2287	Round	14	0.79	0							
24	MH-010	11-245	11-240	330	2420	Round	5	0.43	1	EAV 8-113	330	230	0.6	0.5	35	Variable Vol. Air Valve
25	MH-010	11-250	11-240	2115	1978	Round	14	0.81	0							
26	MH-010	11-255	11-250	330	2420	Round	5	0.4	1	EAV 8-114	330	230	0.6	0.5	35	Variable Vol. Air Valve
27	MH-010	11-260	11-250	1785	2273	Round	12	0.64	0							
28	MH-010	11-265	11-260	495	1418	Round	8	0.59	1	EAV 8-103	495	495	0.6	0.5	35	Constant Vol. Air Valve
29	MH-010	11-270	11-260	1290	2365	Round	10	0.53	0							
30	MH-010	11-275	11-270	420	2139	Round	6	0.45	0	EAV 8-104	420	420	0.6	0.5	35	Constant Vol. Air Valve
31	MH-010	11-280	11-270	710	2492	Round	8	0.43	0	EAV 8-102	710	280	0.6	0.5	35	Two-Position Air Valve

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DUCT PRESSURE CLASS SCHEDULE				
#	Unit #	Service	Positive (P) or Negative (N) Pressure	Minimum Pressure Class (W.G. IN)
1	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	OSA PLENUM	N	1
2	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	SUPPLY TO VAV BOX	P	3
3	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	VAV BOX TO DIFFUSER	P	1
4	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	RETURN DUCT	N	2
5	AHU-1, AHU-2, AHU-3, AHU-4, AHU-5	RELIEF PLENUM	P	1
6	AHU-6, AHU-11	OSA INTAKE	N	1
7	AHU-6, AHU-11	SUPPLY DUCT	P	2
8	AHU-6, AHU-11	RETURN DUCT	N	2
9	AHU-6, AHU-11	RELIEF DUCT	P	1
10	AHU-7, AHU-9	OSA INTAKE	N	1
11	AHU-7, AHU-9	SUPPLY TO VAV BOX	P	3
12	AHU-7, AHU-9	VAV BOX TO DIFFUSER	P	1
13	AHU-8	OSA PLENUM	P&N	1
14	AHU-8	SUPPLY TO AIR VALVE	P	4
15	AHU-8	AIR VALVE TO DIFFUSER	P	1
16	AHU-10	OSA INTAKE	N	1
17	AHU-10	SUPPLY DUCT	P	2
18	EF-1, EF-2, EF-3, EF-4, EF-5, EF-12	EXHAUST DUCT	N	2
19	EF-1, EF-2, EF-3, EF-4, EF-5, EF-12	EXHAUST DISCHARGE	P	2
20	EF-6	EXHAUST DUCT	N	3
21	EF-7, EF-8, EF-9, EF-10, EF-11	EXHAUST DUCT	N	3
22	EF-7, EF-8, EF-9, EF-10, EF-11	EXHAUST DISCHARGE	P	2
23	EF-13, EF-14	EXHAUST DUCT	N	2
24	EF-13, EF-14	EXHAUST DISCHARGE	P	2

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DIFFUESER / REGISTER / GRILLE SCHEDULE									
#	Designation	Type	Face Size or Length	Inlet/ Neck Size	Throw Direction	Max APD (In W.C.)	Max NC Rating	Material	Note
1	SA	Supply Slot Diffuser	48"	6"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
2	SB	Supply Slot Diffuser	48"	8"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
3	SC	Supply Slot Diffuser	48"	10"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
4	SD	Supply Slot Diffuser	48"	12"	See Plans	0.1	30	Steel	Provide 4 Slots, 1" Width. Inlect Connection is Oval.
5	SE	Supply Slot Diffuser	24"	8"	See Plans	0.1	30	Steel	Provide 2 Slots, 1" Width. Inlect Connection is Oval.
6	SF	Supply Slot Diffuser	24"	10"	See Plans	0.1	30	Steel	Provide 4 Slots, 1" Width. Inlect Connection is Oval.
7	SG	Supply Grill	24" X 24"	6"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
8	SH	Supply Grill	24" X 24"	8"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
9	SI	Supply Grill	24" X 24"	10"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
10	SJ	Supply Grill	24" X 24"	12"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
11	SK	Supply Grill	24" X 24"	14"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
12	SL	Supply Grill	24" X 24"	16"	See Plans	0.1	30	Steel	Perforated Grille. Lay-in.
13	SN	Spot Diffuser	10"%%c	27" X 14"	See Plans	0.1	30	Aluminum	Dual Round Spot Diffusers With Rotatable Body Capable Of 30%/d-Rotation From CL.
14	SO	Supply Grill	48"	48" X 6"	See Plans	0.15	30	Aluminum	Linear Bar Grille, 1/2" Spacing, 1/4" Bars, 0%/d Deflection, 200 CFM/FT At 0.06 IN W.C.
15	SP	Supply Grill	42" X 14"	40" X 12"	See Plans	0.1	30	Aluminum	Drum Louver.
16	SQ	Supply Grill	20" X 8"	18" X 6"	See Plans	0.1	30	Aluminum	Drum Louver.
17	SR	Supply Grill	36"	36" X 4"	See Plans	0.1	30	Aluminum	Linear Bar Grille, 1/2" Spacing, 1/4" Bars, 0%/d Deflection, 120 CFM/FT At 0.06 IN W.C.
18	SS	Supply Grill	36" X 42"	36" X 42"	See Plans	0.12	45	Steel	Surface Mount. 3/4" Blade Spacing.
19	ST	Supply Grill	48" X 42"	48" X 42"	See Plans	0.12	45	Steel	Surface Mount. 3/4" Blade Spacing.
20	SU	Supply Grill	12" X 12"	6"	See Plans	0.1	30	Steel	Perforated Grille. Surface Mount.
21	SV	Supply Grill	24" X 48"	8"	Laminar	0.1	30	Stainless Steel	Surface Mount.
22	SW	Supply Grill	12" X 48"	6"	[16]	0.1	30	Stainless Steel	Surface Mount.
23	SX	Supply Grill	12" X 72"	6"	[16]	0.1	30	Stainless Steel	Surface Mount.
24	SY	Supply Grill	12" X 66"	8"	[16]	0.1	30	Stainless Steel	Surface Mount.
25	SZ	Supply Grill	12" X 72"	8"	[16]	0.1	30	Stainless Steel	Surface Mount.
26	SAA	Supply Grill	24" X 24"	10"	See Plans	0.1	30	Stainless Steel	Perforated Grille. Lay-in.
27	EA	Exhaust Grille	24" X 24"	6"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
28	EB	Exhaust Grille	24" X 24"	8"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
29	EC	Exhaust Grille	24" X 24"	10"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
30	ED	Exhaust Grille	24" X 24"	12"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
31	EE	Exhaust Grille	24" X 24"	14"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
32	EF	Exhaust Grille	24" X 24"	16"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
33	EG	Exhaust Grille	24" X 24"	18" X 18"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.

#	Designation	Type	Face Size or Length	Inlet/ Neck Size	Throw Direction	Max APD (In W.C.)	Max NC Rating	Material	Note
34	EH	Exhaust Grille	8" X 8"	6" X 6"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
35	EI	Exhaust Grille	10" X 10"	8" X 8"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
36	EJ	Exhaust Grille	12" X 12"	10" X 10"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
37	EK	Exhaust Grille	14" X 14"	12" X 12"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
38	EL	Exhaust Grille	18" X 18"	16" X 16"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
39	EM	Exhaust Grille	20" X 20"	18" X 18"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
40	EN	Exhaust Grille	16" X 16"	14" X 14"	N/A	0.1	30	Stainless Steel	Perforated Grille. 3/4" Blade Spacing.
41	EO	Exhaust Grille	14" X 14"	12" X 12"	N/A	0.1	30	Stainless Steel	Perforated Grille. 3/4" Blade Spacing.
42	RA	Return Grille	24" X 24"	6"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
43	RB	Return Grille	24" X 24"	8"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
44	RC	Return Grille	24" X 24"	10"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
45	RD	Return Grille	24" X 24"	12"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
46	RE	Return Grille	24" X 24"	14"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
47	RF	Return Grille	24" X 24"	16"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
48	RG	Return Grille	24" X 24"	18" X 18"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
49	RH	Return Grille	8" X 8"	6" X 6"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
50	RI	Return Grille	10" X 10"	8" X 8"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
51	RJ	Return Grille	12" X 12"	10" X 10"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
52	RK	Return Grille	14" X 14"	12" X 12"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
53	RL	Return Grille	18" X 18"	16" X 16"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
54	RM	Return Grille	20" X 20"	18" X 18"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
55	RN	Return Grille	60"	60" X 6"	See Plans	0.1	30	Aluminum	Linear Bar Grille, 1/2" Spacing, 1/4" Bars, 0%%d Deflection, 200 CFM/FT At 0.06 IN W.C.
56	RO	Return Grille	26" X 26"	24" X 24"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
57	RP	Return Grille	50" X 26"	48" X 24"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
58	RQ	Return Grille	14" X 10"	12" X 8"	N/A	0.1	30	Steel	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
59	RR	Return Slot	48"	6" X 46"	N/A	0.1	30	Steel	Provide 4 Slots, 1" Width. Surface Mounts.
60	TA	Transfer Grille	24" X 24"	6" X 6"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
61	TB	Transfer Grille	24" X 24"	8" X 8"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
62	TC	Transfer Grille	24" X 24"	10" X 10"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
63	TD	Transfer Grille	24" X 24"	12" X 12"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
64	TE	Transfer Grille	24" X 24"	14" X 14"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
65	TF	Transfer Grille	24" X 24"	16" X 16"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
66	TG	Transfer Grille	24" X 24"	18" X 18"	N/A	0.1	30	Steel	Perforated Grille. Lay-in.
67	TH	Transfer Grille	8" X 8"	6" X 6"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
68	TI	Transfer Grille	10" X 10"	8" X 8"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.

#	Designation	Type	Face Size or Length	Inlet/ Neck Size	Throw Direction	Max APD (In W.C.)	Max NC Rating	Material	Note
69	TJ	Transfer Grille	12" X 12"	10" X 10"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
70	TK	Transfer Grille	14" X 14"	12" X 12"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
71	TL	Transfer Grille	18" X 18"	16" X 16"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.
72	TM	Transfer Grille	20" X 20"	18" X 18"	N/A	0.1	30	Aluminum	Egg-Crate With 1/2x1/2x1 Core. Surface Mount.

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FINNED TUBE SCHEDULE							
#	Draw #	Tag ID	Btu/LF	EGT	LGT	Fins/Ft	Notes
1	MH003	FTR-1	1340	188	158	60	
2	MH003	FTR-2	1040	188	158	60	8
3	MH003	FTR-3	1340	188	158	60	5
4	MH003	FTR-4	1340	188	158	48	
5	MH003	FTR-5	1340	188	158	48	7
6	MH003	FTR-6	1040	188	158	60	8

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TERMINAL HEATING UNIT SCHEDULE											
#	Draw #	Tag ID	MBH	Hp	CFM Rated	EGT	LGT	Volt	Ph	RPM	Notes
1	MH003	UH-1	3.9	0.04	280	188	158	120	1		
2	MH003	UH-2	18.3	0.05	815	188	158	120	1		
3	MH003	UH-3	55.46	0.17	1760	188	158	120	1		
4	MH003	CUH-1	58.1	0.07	623	188	158	120	1	925	
5	MH003	CUH-2	73.4	0.07	786	188	158	120	1	935	7
6	MH003	CUH-3	21.2	0.07	245	188	158	120	1	750	
7	MH003	CUH-4	48.9	0.07	574	188	158	120	1	925	
8	MH003	CUH-5	131	1.00	3624	188	158	120	1		
9	MH003	RCP-1	1.68			188	158				5
10	MH003	EUH-1	3 kW	0.04	400			240	1	1550	6

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EXHAUST HOOD SCHEDULE								
#	Draw #	Tag ID	Location	Serves	Size W X L (IN)	Exhaust Air CFM	Exhaust Air Fan No.	Note
1	MH-010	EH-1	Sub Sterile 1D223	Autoclave	36 X 18	490	EF-10	Capture hood and associated ductwork to be stainless steel.
2	MH-010	EH-2	Lab 2B147	Dental Lab	36 X 30	770	EF-8	Capture hood and associated ductwork to be stainless steel.
3	MH-010	EH-3	Lab 2B147	Dental Lab	36 X 48	580	EF-8	Capture hood and associated ductwork to be stainless steel.
4	MH-010	EH-4	Canteen 2B10	Kitchen	42 X 84	2100	EF-6	Capture hood and associated ductwork to be stainless steel. Provide commercial kitchen hood: type 1, medium duty wall mounted canopywith water wahs and wet chemical fire suppresion system.

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FILTER SCHEDULE								
#	Draw #	Tag ID	Serves	%Eff	CFM Rated	VA Grade	MAX APD-Final	PD (in w.c.)
1	MH-007	F-1	AHU-1	30%	32540	D	1	0.33
2	MH-007	F-2	AHU-1	85%	32540	B	1.2	0.6
3	MH-007	F-3	AHU-2	30%	33040	D	1	0.33
4	MH-007	F-4	AHU-2	85%	33040	B	1.2	0.6
5	MH-007	F-5	AHU-3	30%	32040	D	1	0.33
6	MH-007	F-6	AHU-3	85%	32040	B	1.2	0.6
7	MH-007	F-7	AHU-4	30%	35870	D	1	0.33
8	MH-007	F-8	AHU-4	85%	35870	B	1.2	0.6
9	MH-007	F-9	AHU-5	30%	28540	D	1	0.33
10	MH-007	F-10	AHU-5	85%	28540	B	1.2	0.6
11	MH-007	F-11	AHU-6	30%	12480	D	1	0.33
12	MH-007	F-12	AHU-6	60%	12480	C	1.2	0.4
13	MH-007	F-13	AHU-7	30%	7230	D	1	0.33
14	MH-007	F-14	AHU-7	30%	7230	C	1.2	0.4
15	MH-007	F-15	AHU-7	85%	7230	B	1.2	0.6
16	MH-007	F-16	AHU-8	30%	7890	D	1	0.33
17	MH-007	F-17	AHU-8	30%	7890	D	1	0.33
18	MH-007	F-18	AHU-8	95%	7890	A	1.2	0.75
19	MH-007	F-19	AHU-9	30%	3050	D	1	0.33
20	MH-007	F-20	AHU-9	30%	3050	D	1	0.33
21	MH-007	F-21	AHU-9	85%	3050	B	1.2	0.6
22	MH-007	F-22	AHU-10	30%	18223	D	1	0.33
23	MH-007	F-23	AHU-11	30%	4970	D	1	0.33
24	MH-007	F-24	EF-13	30%	500	D	1	0.33
25	MH-007	F-25	EF-13	100%	500	HEPA	2	1
26	MH-007	F-26	EF-14	30%	500	D	1	0.33
27	MH-007	F-27	EF-14	100%	500	HEPA	2	1
28	MH-007	F-28	SAV 8-101	95%	1220	A	1	0.33
29	MH-007	F-29	SAV 8-102	95%	660	A	1	0.33
30	MH-007	F-30	PR-32	100%	470	HEPA	1	0.5

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EXPANSION TANK SCHEDULE								
#	Draw #	Tag ID	Location	Serves	Tank Vol. (GAL)	Acc. Vol. (GAL)	PSIG	ΔT
1	MH003	ET-1	VA Mech Room	Heating System	211	84	50	32
2	MH003	ET-2	VA Mech Room	Cooling System	68	34	50	22
3	MH003	ET-3	VA Mech Room	Snow Melt	68	34	12	130
4	MH003	ET-4	Engine Generator Rm	EG Jacket Water	22	11	12	190
5	MH003	ET-5	Engine Generator Rm	EG After Cooler	13	11	12	135

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OTHER EQUIPMENT LIST																
#	Draw #	Tag ID	Description	BtuH	Tons	# Mtr	Hp	CFM Rated	Gal.	Stack Exh Temp.	LAT	Pri EGT	Pri LGT	Water Press. Drop (psig)	Volt	Ph
1	MH002	CC-1	Charge Air Cooler	592620				1558		488	136	127	145	2.75		
2	MH002	CU-1	DX Condensing Unit		30	2	1								460	3
3	MH002	AC-1 & AC-3	Air Atomizing Air Compressor FS Recip M#OL101HTID20-A4			2	10	71.2	200						480	3
5	Pict IMG_0292	AC-3	Air Atomizing Air Compressor FS Curtis Rotary Screw M #VS 60D S #AF-280			1	60	80 to 280							460	3
6	Pict IMG_0496	AT-1	Compressed Air Storage Tank (est 200 Gallon)						200							
7	Pict IMG_0652	AD-1	Compressed Air Dryer ZEKS M #250HSGA4GFZ													

SECTION 07432
COMPOSITE PREFINISHED METAL PANELS AT STAIR TOWER PENTHOUSE

PART 1 - GENERAL:

1.1 DESCRIPTION:
This section includes design, manufacture, and installation of exterior and interior composite prefinished metal panels and wall attachment and support systems (CPMP).

1.2 RELATED WORK:
A. Sealants: Section 07920; SEALANTS.
B. Color of finishes: Section 09050, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULE.
C. Field painting: Section 09900; PAINTING.

1.3 DRAWING INTENT:
The drawings are generic in nature and are not intended to show a particular manufacturer's products.

1.4 APPLICABLE PUBLICATIONS:
A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.
B. Aluminum Association, Incorporated (AA):
ADM-00 ..... Aluminum Design Manual.
DAF 45-03 ..... Designation System for Aluminum Finishes.
35-00 ..... Specification for Aluminum Sheet Metal Work in Building Construction.
TR3-04 ..... Guidelines for Minimizing Water Staining of Aluminum.
C. American Architectural Manufacturers Association (AAMA):
Manual #10 ..... Care and Handling of Architectural Aluminum form Shop to Site.
2605-02 ..... Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
D. American Society of Testing and Materials (ASTM):
B69-01a ..... Standard Specification for Rolled Zinc.
B209-96 ..... Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
B209M-96 ..... Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
B221-04a ..... Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
B221M-04 ..... Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes [Metric].
C920-05 ..... Standard Specification for Elastomeric Joint Sealants.
C1184-05 ..... Standard Specification for Structural Silicone Sealants.
D1781-98(04) ..... Standard Test Method for Climbing Drum Peel for Adhesives.
E84-01 ..... Standard Test Method for Surface Burning Characteristics of Building Materials.
E108-00 ..... Test Method for Fire Tests of Building Construction and Materials.
E330-97E01 ..... Standard Test Method for the Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
E. ICC Evaluation Service (ICBO-ES):
AC25-92 ..... Acceptance Criteria for Unitized Metal Composite Wall Panels.

AC25-05 ..... Proposed Revisions to the Acceptance Criteria for Unitized Metal Composite Wall Panels.

1.5 DEFINITIONS:

A. Building Official:
The words building official shall mean the Government.

B. Duration of use:
The words duration of use as used in IBC § 1407.7 and elsewhere shall be defined as twenty five (25) years after the after the date of Final Acceptance.

C. Owner:
The word owner shall mean the Government.

D. Unitized Metal Composite Material Wall Panels:
The words unitized metal composite material wall panels shall mean the Work described herein.

1.6 QUALITY ASSURANCE:

A. CPMP shall be designed in accordance with IBC § 1407, IBC, ASCE 7, and as specified herein.

B. CPMP deflection shall not exceed L/175 at Design Loads or L/60 at Design Loads with a Safety Factor of 3.

C. CPMP shall accommodate an ambient temperature range from -30.00 degrees Celsius (-22 degrees Fahrenheit) to 32.22 degrees Celsius (90 degrees Fahrenheit) and appropriate surface heating.

D. Acceptance Criteria:
CPMP accepted under ICBO-ES AC25-92 shall be required to comply with the revised criteria described in ICBO-ES AC25-05.

E. Wind Loads:
1. Wind Loads shall be determined in accordance with IBC § 2404, IBC § 1609.1.
2. Basic Wind Speed V_{3s} = 49 meters per second (110 miles per hour) per MOA 3 Second Gust Wind Speed Map.
3. Exposure Category = B.
4. Importance Factor I_w = 1.15.

F. IBC Quality Assurance Plan For Wind Requirements:
IBC Quality Assurance Plan for Wind Requirements is not required.

G. Testing, Wind:
CPMP, maximum panel size, shall be tested in accordance with ASTM E 330 Procedure A to the above maximum wind loads, with a safety factor of 3 and a hold time of 60 seconds and a maximum deflection of L/60.

H. Seismic:
1. Seismic Use Group = III.
2. Seismic Factor I_E = 1.50.
3. S_{DS} = 1.006.
4. S_{D1} = 0.559.
5. S_S = 1.509.
6. S_1 = 0.559.
6. Seismic Design Category = D.

I. IBC Quality Assurance Plan For Seismic Resistance:
1. IBC Quality Assurance Plan is required per IBC § 1705.1.4.2.
2. The following comprises the entire Quality Assurance Plan required by IBC § 1705.1:
   a. Special Inspections per IBC § 1704 are not required.
   b. IBC Special Inspections are not required per IBC § 1707.6.
   c. Special Testing is not required per IBC § 1708.
   d. Structural Observations are not required per IBC § 1709.
   e. Structural testing is not required.

K. Labeling:
CPMP shall be labeled per IBC § 1703.5.

L. Qualifications:
1. Manufacturer shall be ISO 9002 certified for the herein specified Products, or shall be regularly engaged in the manufacture of products specified in this section, whose products have been in satisfactory use, under similar service conditions, for not less than ten (10) years.
2. Fabricator shall meet IBC § 1704.2.2 requirements.

3. Engineers shall be currently registered Professional Engineers specializing in structural engineering in the state where the project is located.
3. Installer shall be regularly engaged in the installation of products specified in this section, with a minimum of five (5) years of experience.

1.7 SUBMITTALS:

A. In accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
B. Qualifications:
Submit evidence that engineer meets the requirements specified.
C. Certificates:
Submit Certificates that certify that the Composite Prefinished Metal Panels and Systems comply with the requirements of the appropriate Evaluation, or equal.
D. Design Calculations:
1. Submit design calculations showing that the Composite Prefinished Metal Panels and Systems can resist all design loads specified herein, indicated on the Drawings, and required by the IBC.
2. Calculations shall be signed and sealed by a registered Professional Engineer specializing in structural Engineering, with a current license.
E. Manufacturer's Literature and Data:
1. Submit Product Data and applicable Evaluation Report for Composite Prefinished Metal Panel and Systems.
2. Submit Installation Instructions for Composite Prefinished Metal Panel and Systems.
3. Submit Maintenance Data for composite prefinished metal panel and systems.
F. Shop Drawings:
1. Shop drawings shall consist of detailed, dimensioned, drawings showing the fabrication and erection of the exterior and interior composite Prefinished metal panels, aluminum sub-framing, flashing, and accessories.
2. Submit dimensioned elevations and plans of each panel keyed to dimensioned elevations and plans of panel assemblages.
3. Submit details of interfaces between panels and adjacent work.
4. Coordinate shop drawings with shop drawings of other work including, curtain wall, storefront, doors, windows, phenolic composite plastic panels.
5. Coordinate joint locations with joint locations of other work to reflect design intent expressed in the drawings.
H. Samples:
1. Samples shall be a minimum of 300 mm [12.0 inches (1'-0)] by 300 mm [12.0 inches (1'-0)].
2. Submit samples for composite prefinished metal panel and systems.

1.8 DELIVERY, STORAGE, AND HANDLING:

A. Packaging, and Labeling:
1. Products shall be in sealed containers that legibly show name, specification number, batch number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer.
2. Provide packaging that will resist excessive moisture and handling abuse.
3. Products shall be packaged for extended over seas shipping; including, but not limited to, shipping by sea going barge to Alaska.
B. Inspection:
1. CPMP shall be inspected for IBC § 1703.5 required labeling.
2. Sealants and adhesive shall be immediately inspected in accordance with Section 07920; SEALANTS.
3. Do not uncrate material until ready for use except for inspection.
4. Immediately upon arrival of the Product at the job site, inspect Product for damage and labeling.

C. Storage:
Products shall be stored above grade in structures protected from the weather.

D. Handling:
Products shall only be handled in accordance with Installation Instructions.

PART 2 - PRODUCTS:

2.1 POLYVINYLIDENE FLUORIDE (PVDF) COATED, ALUMINUM SHEET:

A. Aluminum Sheet shall comply with the requirements of ASTM Alloy AA3003, other characteristics shall be selected by manufacturer and as specified herein.

B. Sheet thickness for aluminum composite prefinished metal panels shall be a minimum of 0.508 mm [0.020 inches], nominal.

C. Sheet shall have polyvinylidene fluoride (PVDF) coating on the exposed surfaces.

D. Provide strippable plastic film over exposed coated surfaces.

2.2 PRE-WEATHERED, ZINC ALLOY SHEET:

A. Pre-weathered, zinc alloy sheet shall comply with the requirements of ASTM B 69, Alloy Z41320, other characteristics shall be selected by manufacturer and as specified herein.

B. Sheet thickness for zinc composite prefinished metal panels shall be a minimum of 0.508 mm [0.020 inches], nominal.

C. Sheet thickness for solid zinc panels shall be a minimum of 1.25 mm [0.0625 inches (1/16)], nominal.

D. Provide strippable plastic film over exposed pre-weathered surfaces.

2.3 POLYVINYLIDENE FLUORIDE(PVDF)COATED, ALUMINUM COMPOSITE PREFINISHED METAL PANELS:

A. Polyvinylidene fluoride (PVDF) coated, aluminum composite prefinished metal panels shall consist of two (2) sheets of aluminum with a core of low density polyethylene heat bonded to both the inner and outer aluminum face sheets.

B. Minimum core to face sheet bond strength shall be 214 pounds per square inch (PSI) using a vertically oriented pull when tested in accordance with ASTM D 1781.

C. Minimum core to face sheet peel strength shall be 115 Newton millimeter per millimeter (N mm/mm) when tested in accordance with ASTM D 1781.

D. Core shall not show evidence of either cohesive or adhesive failure below the above specified values when tested in accordance with ASTM D 1781.

E. Exposed aluminum surfaces shall have a polyvinylidene fluoride (PVDF) finish.

F. Maximum panel bow shall be 0.8 percent of the panel width or length.

G. Panels shall be 4 mm [0.1875 inches (3/16)] thick, nominal.

H. Panels shall have a maximum Flame Spread Index of 25 when tested in accordance with the requirements of ASTM E 84.

I. Panels shall have a maximum Smoke Developed Index of 450 when tested in accordance with the requirements of ASTM E 84.

J. Panels shall comply with the requirements indicated on the Drawings, as specified herein, IBC and appropriate Evaluation Report.

2.4 PRE-WEATHERED, ZINC ALLOY COMPOSITE PREFINISHED METAL PANELS:

A. Pre-weathered, zinc alloy composite prefinished metal panels shall consist of two (2) sheets of pre-weathered, zinc alloy sheet with a core of low density Polyethylene heat bonded to both the inner and outer pre-weathered, zinc alloy face sheets.

B. Minimum core to face sheet bond strength shall be 214 pounds per square inch (PSI) using a vertically oriented pull when tested in accordance with ASTM D 1781.

C. Minimum core to face sheet peel strength shall be 115 Newton millimeter per millimeter (N mm/mm) when tested in accordance with ASTM D 1781.

D. Core shall not show evidence of either cohesive or adhesive failure below the above specified values when tested in accordance with ASTM D 1781.

E. Exposed zinc alloy surfaces shall have a pre-weathered finish.

F. Maximum panel bow shall be 0.8 percent of the panel width or length.
G. Panels shall be 4 mm [0.1875 inches (3/16)] thick, nominal.

2.5 FASTENERS, STAINLESS STEEL:

A. Bolts shall be Alloy S30400 (Type 304), hex headed, with other characteristics selected by manufacturer.
B. Nuts shall be hex nuts, Alloy S30400 (Type 304), with other characteristics selected by manufacturer.
C. Screws, Self-Drilling and Self-Tapping shall be Alloy S41000 (Type 410), hex washer headed, self-tapping, and self-drilling with drill point, gauge, and length selected by manufacturer.
D. Washers shall be Alloy 18/8, with other characteristics selected by manufacturer.

2.6 FLEXIBLE SHEET FLASHING:

A. Neoprene or EPDM sheet, minimum 0.060 inch thickness.
B. Provide Flexible Sheet Flashing where indicated on the Drawings, or required by the Installation Instructions, or where necessary to prevent water infiltration behind the roofing.

2.7 SEALANT, STRUCTURAL:

Sealant shall comply with the requirements of ASTM C1184 and the appropriate ICC-ES evaluation report.

2.8 SEALANTS, BUILDING:

Sealant shall comply shall comply with the requirements of ASTM C920 Type S, Grade NS, Class 50, Use NT, G, A and O, and shall be compatible with polyvinylidene fluoride (PVDF) coated aluminum and zinc.

2.9 METAL WALL PANEL SYSTEM TYPE 1:

A. Metal panel systems shall consist of supporting members and accessories necessary to provide a complete, functional "rout and return dry seal" system.
B. Pre-weathered zinc alloy composite prefinished metal panels; or 1.25 mm pre-weathered, zinc alloy sheet reinforced as required on the obverse side.
C. Composite prefinished metal wall panels or pre-weathered, zinc alloy sheet shall be manufactured into pans using the rout and return dry seal method and adhered to an extruded aluminum frame using structural sealant.
D. Panels shall be reinforced using Extruded Aluminum Stiffeners adhered to Panel's observe side at a minimum of 300 mm [12.0 inches (1'-0)] on center and extruded aluminum frame using structural sealant, with additional stainless steel sheet metal screws through the frame and stiffener.
E. System shall have a maximum Flame Spread Index of 25 when tested in accordance with the requirements of ASTM E 84.
F. System shall have a maximum Smoke Developed Index of 450 when tested in accordance with the requirements of ASTM E 84.
G. System shall comply with the requirements of indicated on the drawings, as specified herein, IBC, and appropriate ICC-ES evaluation report.

2.10 METAL WALL PANEL SYSTEM TYPE 2:

A. Metal panel systems shall consist of polyvinylidene fluoride (PVDF) coated, aluminum composite prefinished metal panels and supporting members and accessories necessary to provide a complete, functional "rout and return dry seal" system.
B. Composite prefinished metal wall panels shall be manufactured into pans using the rout and return dry seal method and adhered to an extruded aluminum frame using structural sealant.
C. Panels shall be reinforced using extruded aluminum stiffeners adhered to panel's observe side at a minimum of 300 mm [12.0 inches (1'-0)] on center and extruded aluminum frame using structural sealant, with additional stainless steel sheet metal screws through the frame and stiffener.
D. Panels shall be attached to additional extruded aluminum framing members.
E. Framing members shall be attached to building framing with stainless steel sheet metal screws.
F. System shall have a maximum Flame Spread Index of 25 when tested in accordance with the requirements of ASTM E 84.

G. System shall have a maximum Smoke Developed Index of 450 when tested in accordance with the requirements of ASTM E 84.
H. Color per Section 09050, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULE.
I. System shall comply with the requirements of indicated on the Drawings, as specified herein, IBC, and appropriate ICC-ES evaluation report, or equal.

PART 3 - EXECUTION:

3.1 DESIGN:
A. Design composite prefinished metal panels and composite prefinished metal panel wall systems in accordance with the requirements indicated on the Drawings, as specified herein, IBC, and the appropriate evaluation report.
B. Submit qualifications, certificates, design calculations and data, product data, installation instructions, shop drawings, samples, and warranties.
C. Redesign and resubmit design calculations and shop drawings as necessary, until accepted by the Government.
D. The above specified submittals are condition precedent for proceeding with the Work.

3.2 EXAMINATION OF SURROUNDING WORK:
Verify that the surrounding work is complete, and adequate for the installation or application of the work.

3.3 COORDINATION:
A. Verify field conditions affecting the design, construction, and installation of the panels.
B. Coordinate with adjacent work.

3.4 FIELD MEASUREMENTS:
Make all field measurements necessary to fabricate and install the Work.

3.5 INSTALLATION:
install in accordance with the requirements of applicable evaluation report, installation instructions, material safety data sheet (MSDS), shop drawings, and as specified herein.

3.5 FIELD QUALITY CONTROL:
A. Tolerances:
Products shall not vary from a true horizontal or vertical more than 1.5875 mm [0.0625 inches (1/16)] in any 91 mm [36 inches (3'-0)]; and 3.175 mm [0.125 inches (1/8)] in 3048 mm [120 inches (10'-0)].
B. Defects:
Products defects shall be all items that effect the visual appearance or function of the Products, which shall be solely determined by the Contracting Officer.

3.6 CLEANING:
A. Remove protective film, if applicable.
B. Remove and dispose of construction debris.
C. Clean in accordance with AAMA Manual #10, maintenance instructions, and warranty, if required.

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SECTION 07465
PREFINISHED METAL SIDING AT HVAC PENTHOUSES

PART 1 - GENERAL:

1.1 DESCRIPTION:
This section specifies polyvinylidene fluoride (PVDF) resin coated galvanized, sheet steel siding, flashing, and trim and polyvinylidene fluoride (PVDF) resin coated sheet aluminum trim, and accessories.

1.2 RELATED WORK:
A. Sealant: Section 07920, SEALANTS AND CAULKING.
B. Color of finish: Section 09050, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULES.

1.3 QUALITY ASSURANCE:
A. Siding, flashing, trim, and accessories shall be designed in accordance with the requirements of IBC, ASCE 7, and as specified herein.
B. Wind Loads:
1. Wind Loads shall be determined in accordance with IBC § 1609.1, ASCE 7 § 6, ASCE 7 § 9.6.2.10 and as further specified herein.
2. Basic Wind Speed V_{3s} = 49 meters per second (110 miles per hour) per MOA 3 Second Gust Wind Speed Map.
3. Exposure Category = B.
4. Importance Factor I_w = 1.15 per IBC § 1609.5 and Table 1604.5.
5. IBC Quality Assurance Plan for Wind Requirements:
IBC Quality Assurance Plan for Wind Requirements is not.
6. IBC Special Inspections:
IBC Special Inspections are not required per IBC § 1704.
C. Resistance to Water Infiltration:
Siding shall show no infiltration at seams, edges, flashings, counter flashings and penetrations when subjected to a rainfall of 127 mm (5 inches) per hour with 44.7 meters per second(100 miles per hour) wind.
D. Thermal Movement:
1. Design temperatures shall be based on minimum and maximum recorded temperatures.
2. Siding shall be capable of withstanding thermal movement based on a temperature range of 5.5 degrees Celsius (10 degrees Fahrenheit) below design low air temperature and 60.0 degrees Celsius (140 degrees Fahrenheit) for mill finish and light colors or 82.23 degrees Celsius (180 degrees Fahrenheit) for dark colors.
3. Provide for expansion and contraction of siding components due to ambient temperature and solar heat gain.
4. Accommodate movement due to temperature change without buckling, undue stress on structural elements, reduction of performance, or other damaging effects.
E. Deflection:
Panel deflection shall not exceed L/140.
F. Manufacturer's Qualifications:
Manufacturer shall be ISO 9002 certified for the herein specified Products, or regularly engaged in the manufacture of products specified in this section, whose products have been in satisfactory use, under similar service conditions, for not less than five (5) years.
G. Installer's Qualifications:
Installer shall be factory trained, licensed, or certified for installation of the specified siding, and have satisfactory installed, under similar service conditions, siding for not less than two (2) years

1.4 SUBMITTALS:
A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
B. Manufacturer's Literature And Data:
1. Submit Product Data for Prefinished Metal Siding.
2. Submit Installation Instructions for Prefinished Metal Siding.
3. Submit Maintenance Instructions, including periodic cleaning requirements necessary to meet owner warranty obligations.

C. Shop Drawings:
   1. Elevations shall indicate fastener type, size, and spacing for corner and field cladding conditions as determined in accordance with IBC and MBMA MBSM requirements and supporting calculations.
   2. Submit Shop Drawings for Prefinished Metal Siding.
D. Samples:
   1. Samples shall be a minimum of 305 mm (12.0 inches) square.
   2. Submit Samples for siding, trim and flashing.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Packaging, and Labeling:
   1. Products shall be in sealed containers that legibly show: designated name, specification number, quantity, date of manufacture, manufacturer's directions including any warnings and special precautions, and name of manufacturer.
   2. Provide packaging that will resist excessive moisture and handling abuse.
   3. Products shall be packaged for extended over seas shipping; including, but not limited to, shipping by sea going barge to Alaska.
B. Inspection:
   1. Do not uncrate material until ready for use except for inspection.
   2. Immediately upon arrival of the Product at the job site, inspect Product for damage.
C. Storage:
   1. Metals shall be stored above grade on pallets, protected from the weather.
   2. Sealants shall be stored in heated facilities.

1.1 APPLICABLE PUBLICATIONS:

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
B. Aluminum Association (AA);
   DAF 45-80 ..... Designation System for Aluminum Finishes.
C. American Architectural Manufacturers Association (AAMA):
   609&610-02 ..... Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
   621-02 ..... Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanize (HDG) and Zinc-Aluminum Coated Steel Substrates.
   2604-05 ..... Voluntary Specifications for High Performance Organic Coatings on Architectural Extrusions and Panels.
   CW 10-04 ..... Care and Handling of Architectural Aluminum from Shop to Site.
D. American Society of Testing and Materials (ASTM):
   A653/A653M-97 ..... Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   B209-06 ..... Standard Specification Aluminum and Aluminum-Alloy, Sheet and Plate.
   B209M-06 ..... Standard Specification Aluminum and Aluminum-Alloy, Sheet and Plate (Metric).
   C920-05 ..... Standard Specification for Elastomeric Joint Sealants.
   C1193-05a ..... Standard Guide for Use of Joint Sealants.
   D1056-00 ..... Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
   F2329-05 ..... Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
E. Metal Buildings Manufacturers Association (MBMA):
   MBSM-02 ..... Metal Building Systems Manual.

F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): ASMM-87 ..... Architectural Sheet Metal Manual, 4th Ed.

PART 2 - PRODUCTS:

2.1 ZINC-COATED (GALVANIZED) OR ZINC-IRON ALLOY GALVANNEALED) STEEL SHEET:

A. Zinc-coated (galvanized) or zinc-iron (galvannealed) coated sheet steel shall comply with the requirements of ASTM A653/A653M, Coating G90, mill phosphatized other characteristics shall be selected by manufacturer and as specified herein.

B. Finish shall be polyvinylidene fluoride (PVDF) resin coated as specified herein.

2.2 ALUMINUM, SHEET:

A. Aluminum sheet shall comply with the requirements of ASTM B209 or B209M, with alloy and temper as selected by manufacturer, except as specified herein.

B. Flashing shall be Alloy 6065 Temper T5 and minimum flashing thickness shall be 1.58 mm (0.062 inch).

C. Premanufactured corners shall be Alloy 3003 H14 or Alloy 3004 H14 and minimum thickness 1.27 mm (0.050 inches).

D. Finish shall be polyvinylidene fluoride (PVDF) resin coated as specified herein.

2.3 FASTENERS, STAINLESS STEEL:

A. Screws shall be Alloy S41000 (Type 410), self-tapping, and self-drilling with drill point, as selected by manufacturer.

B. Exposed fasteners shall be prefinished with color to match siding with neoprene gasket or washer.

2.4 FASTENERS, GALVANIZED:

A. Fasteners shall be hot-dipped galvanized shall comply with the requirements of ASTM

B. Exposed fasteners shall be prefinished with color to match siding with neoprene gasket or washer.

2.5 SEALANT:

A. Sealant shall be a one part silicone sealant, acetoxy, alkoxy (neutral), or methoxy (neutral) cure, low modulus complying with the requirements of ASTM C 920 Type S Class 25 Grade NS Use NT and as specified herein.

B. Sealant shall be capable of primerless bonding to polyvinylidene fluoride (PVDF) resin coated surfaces in addition to other building surfaces.

C. Color shall be clear.

2.6 FINISH:

A. Polyvinylidene fluoride (PVDF) resin coating on aluminum shall comply with AAMA 2604 and AA-M12-C42-R1X.

B. Polyvinylidene fluoride (PVDF) resin coating on zinc coating shall comply with AAMA 621.

D. Color shall be as specified in Section 09050, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULES.

E. Provide strippable plastic film.

2.7 PREFINISHED METAL SIDING:

A. Prefinished metal siding shall be galvanized or galvannealed sheet steel with a factory applied polyvinylidene fluoride finish exterior finish and manufacturer's standard finish on the interior or concealed side.

B. Panel thickness shall be selected so that maximum deflection is not exceeded when negatively loaded, but no less than 0.9537 mm (0.0375 inch) base metal thickness.

C. Profile shall be approximately 38 mm (1-1/2 inch) square repeating box.

2.8 INSIDE AND OUTSIDE CORNER TRIM AT SIDING:

A. Inside and outside corner trim shall be custom manufactured from polyvinylidene fluoride (PVDF) resin coated aluminum sheet to fit siding profile.

B. Trim shall have fastening flanges extending a minimum of 75 mm (3 inches) behind siding.
C. Trim shall have welded mitered corners.

2.9 SHEET METAL CLOSURES AT SIDING:

A. Closures shall be custom manufactured from polyvinylidene fluoride (PVDF) resin coated. zinc-coated (galvanized) or zinc-iron coated (galvannealed) sheet steel.
B. Closures shall completely close off open space between siding and sheathing when siding is cut normal to siding face.
C. Closure color shall match siding color.
D. Provide closures wherever siding cut is exposed to view and not covered by trim.

2.10 FLEXIBLE CLOSURES:

A. Flexible Closures shall be closed cell neoprene rubber in accordance with the requirements of ASTM D 1056, Type 2, Class A, Grade 1.
B. Flexible Closures shall be factory die cut to required configuration, with an allowance for 5 to 10 percent compression when in place.
C. Provide Flexible Closures at all siding cuts.

2.11 FLEXIBLE SHEET FLASHING:

A. Neoprene or EPDM sheet, minimum 0.060 inch thickness.
B. Provide flexible sheet flashing where indicated on the drawings, or required by the installation instructions, or where necessary to prevent water infiltration behind the prefinished metal siding.

PART 3 - EXECUTION:

3.1 DESIGN:

A. Design siding in accordance with the requirements indicated on the drawings, and as specified herein.
B. Redesign and resubmit design calculations and shop drawings as necessary, until accepted by the Government.
A. Cost of redesigns and resubmittals shall be borne solely by the Contractor.

3.2 COORDINATION:

Contractor shall coordinate prefinished metal siding, sheet metal closures, flashing, and trim work with other work requiring coordinated installation.

3.3 EXAMINATION:

A. Verify that substrate or structural system to receive work of this section is complete, properly sized, and is laid out correctly in plan and elevations.
B. Correct unacceptable substrate installations before start of metal panel erection.

3.4 FIELD MEASUREMENTS:

Contractor shall make all field measurements necessary to fabricate and install the metal roofing Work.

3.5 PRE-INSTALLATION REQUIREMENTS:

A. Air retarder shall be installed over entire wall surface in accordance with Section 07195, AIR RETARDER.
B. Self-adhesive sheet membrane underlayment shall be installed at building corners, door, and window openings in accordance with Section 07305, SELF-ADHESIVE SHEET MEMBRANE UNDERLAYMENT.

3.6 SIDING INSTALLATION:

A. Install inside and outside trim and flashing overlapped by siding.
B. Install siding vertically as indicated on the drawings with flexible closures and sheet metal closures on exposed siding cuts.
C. Install sealant at all end and side laps.
D. Touch-up all exposed cut edges with touch-up paint.
E. Remove protective coverings from prefinished metal surfaces after each panel is installed.
F. Install flashing that overlaps siding.

G. Fasten panels to structure as necessary to comply with performance criteria, allowing for expansion and contraction due to temperature variations and building movement.

3.7 CLEANING:

A. Remove and dispose of construction debris.
B. Remove protective coverings from prefinished metal surfaces after each panel is installed.
C. Clean in accordance with maintenance instructions and warranty requirements, if required.

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