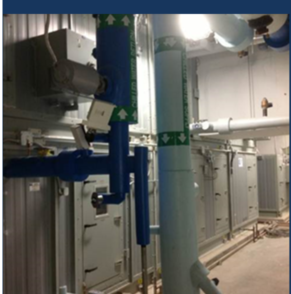
HCA Mechanical, Electrical, and Plumbing (MEP) Design Guidelines for Hospitals



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INTRODUCTION

Apply the guidelines contained in this document in the design of HCA acute care hospital projects. These are guidelines only and the design consultant may deviate from these guidelines whenever his/her experience and judgment dictates that it is in the best interest of the project, or that the guidelines contradict the design requirements of the AHJ (authority having jurisdiction). It is required that any deviations from the above guidelines or questions about the applicability of a guideline be discussed with HCA FacilitiGroup as early as possible in the design schedule.

The intent of these guidelines is to foster designs which:

1. strike a balance between functional efficiency, operational simplicity, maintainability, reliability, and sustainability;
2. are innovative;
3. have an appropriate application of materials and systems;
4. are safe;
5. are user friendly;
6. maximize assets to full life cycle through consideration of operations; and
7. comply with applicable building codes and acute care licensing objectives.

HCA desires the highest quality facility that can be constructed within the budget. Consideration of operating cost reductions, including energy consumption and maintenance is required. In evaluating alternatives, it should be remembered that each project is budgeted and must conform to a financial pro forma. As a general guideline, HCA wishes to evaluate incremental investments for systems upgrades, energy conservation, etc. These alternatives should be evaluated against the project pro forma, i.e., the alternative is within budget and has an acceptable return on investment (20% or better). Any such alternatives should be discussed and coordinated with HCA FacilitiGroup and Design & Construction prior to inclusion in the project.

These guidelines are organized by the major infrastructure disciplines - Fire Suppression, Plumbing, HVAC, Electrical and Electronic Safety and Security. These disciplines conform to Divisions 21, 22, 23, 26, and 28, respectively, as defined in Construction Specification Institute's Master Format 2014. The information for specific equipment is organized by the recommended CSI MF14 section numbers. These section numbers are intended as a directive for the design consultant to use these specific section numbers without modification.

Minor variations between the CSI MF14 standard may be found. Where HCA has no preference for certain equipment, comments are not provided.

For air handling units, chillers, boilers, VAV/CAV terminal units, cooling towers, air and water flow rate measuring devices, BAS (DDC Building Automation systems), power generation equipment and electrical switchgear, switchboard and panels, it is our intent that no manufacturers other than those contained in this document be included in your project's specification. If a substitution is absolutely necessary, submit alternative manufacturer's product to HCA FacilitiGroup for consideration prior to including it in the specification for the above equipment. Products that have been successfully specified by a consulting firm in the past may be incorporated into the design only if approved by HCA FacilitiGroup.

In the Appendix, there are guide specifications, BAS summary graphics, checklists, sequences of operations, and schematics. The Design Engineer should incorporate all applicable information into the contract documents for a project, modified for specific project requirements and conditions. For the standard details also provided in the Appendix, the Design Engineer should incorporate the intent shown on the details in a project's contract drawings. This can be done by creating unique details for each project or by modifying office standard details to convey the information shown. HCA provides a CAD version of the details so the Design Engineer has a starting point to keep standard details consistent throughout all projects. These details need to be modified for site conditions and not simply copied. If the Design Engineer feels changes or clarifications are needed to any of the details, these should be discussed with HCA Corporate Manager of Engineering FacilitiGroup.

The Design Consultant's questions and recommendations to the HCA Guideline are always welcome. Please contact HCA FacilitiGroup at any time for suggestions or clarifications. HCA is appreciative of the contributions in the form of specifications, details, and checklists from design consultants, contractors, manufacturer's representatives, vendors and others to continuously improve the content of these guidelines. It is our goal to maintain a friendly forum with our design consultants that encourages the free exchange of ideas, information and experience. Only through this open and honest interchange, will we be able to change and maintain these guidelines in a state that is useful to both HCA and the Partner Design Consultants.

Throughout the Guideline, the Design Consultant is instructed to contact HCA FacilitiGroup for direction or simply to inform the engineer of the design path. In these cases, the respective FacilitiGroup Engineering Manager is to be the primary point of contact. The following is a list of the FacilitiGroup Engineering Managers and the hospitals each is responsible for:

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Central & West Texas Division	**Continental Division**
Las Palmas Las Palmas Del Sol South Austin Medical Center St Davids Medical Center St Davids Medical Center – Round Rock St Davids Medical Center-Georgetown Hospital St Davids Medical Center-Heart Hospital of Austin St Davids Medical Center-North Austin MC St Davids Medical Center-Round Rock St Davids Medical Center-St Davids Rehabilitation St Davids Surgical Hospital	North Suburban Presbyterian St. Luke's Rose Sky Ridge Spalding Rehabilitation Swedish The MC Aurora- Centennial The MC Aurora- North Campus The MC Aurora- South Campus (Main) Wesley MC Wesley Woodlawn
North Texas Division	**Gulf Coast Division**
Denton RMC Green Oaks Hospital Las Colinas MC MC of Lewisville MC of McKinney MC of McKinney - Wysong MC of Plano Medical City Alliance Medical City Arlington Medical City Dallas Hospital Medical City Fort Worth Medical City Frisco Medical City North Hills	Bayshore MC Bayshore MC - East Houston RMC Clear Lake RMC Clear Lake RMC - Heart and Vascular Clear Lake RMC - Mainland MC Conroe RMC Corpus Christi MC - Bay Area Corpus Christi MC - Bayview Behavioral Hospital Corpus Christi MC - Drs Reg. Corpus Christi MC - Heart Hos Corpus Christi MC - Northwest Regional Hospital Kingwood MC Pearland Rio Grande Regional Hospital Texas Orthopedic Hospital Valley RMC West Houston MC Woman's Hospital of Texas Cypress Fairbanks Houston Northwest Park Plaza Tomball

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MidAmerica Division	**TriStar Division**
Allen County Regional Hospital Belton Regional Medical Center Cass Regional Centerpoint MC Garden Park MC Lafayette Regional Health Center Lakeview RMC Lee's Summit Medical Center Menorah MC Overland Park RMC Rapides RMC Research MC Research MC - Brookside MC Research MC - Psychiatric Center The RMC of Acadiana - Women's and Children's Hospital Tulane - Lakeside Hospital Tulane University Hospital and Clinic	Cartersville MC Centennial MC Centennial MC at Ashland City Eastside MC Greenview Regional Hospital Hendersonville Hospital Horizon MC Parkridge East Hospital Parkridge MC Parkridge Valley Adult and Senior Parkridge Valley Child and Adolescent Redmond RMC Skyline MC Skyline MC - Madison Campus Southern Hills MC Stonecrest MC Summit MC
San Antonio Division	
Methodist Ambulatory Surgery Hospital Methodist Children’s Hospital Methodist Hospital and Heart Hospital Methodist Specialty and Transplant Methodist Stone Oak Hospital Methodist TexSAn Hospital Metropolitan Methodist Hospital Northeast Methodist Hospital Methodist Hospital South Methodist South Texas RMC	

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East Florida Division	**Capital Division**
Aventura Hospital and MC JFK MC JFK Medical Center North Campus Kendall MC Lawnwood RMC Mercy Hospital Northwest MC Palms West Hospital Plantation General Hospital Raulerson Hospital Sister Emmanuel Hospital St. Lucie MC University Hospital and MC Westside RMC	CJW MC - Chippenham Campus CJW MC - Johnston-Willis Campus Dominion Hospital Frankfort RMC Henrico Doctors' Hospital John Randolph MC Lewis-Gale Hospital - Alleghany Lewis-Gale Hospital - Montgomery Lewis-Gale Hospital – Pulaski Lewis-Gale MC Parham Doctors' Hospital Parkland MC Portsmouth Regional Hospital Reston Hospital Center Retreat Doctors' Hospital Spotsylvania RMC Stone Springs Hospital Center Terre Haute Regional Hospital
North Florida Division	**Far West Division**
Capital RMC Central Florida Regional Hospital Fort Walton Beach MC Gulf Coast RMC Lake City MC North Florida RMC Ocala RMC Ocala RMC - West Marion Community Hospital Osceola RMC Oviedo Medical Center Poinciana Medical Center Putnam Community Medical Center Twin Cities Hospital West Florida Hospital	Good Sam - Mission Oaks Hospital Good Samaritan Hospital Los Robles RMC MountainView Hospital Riverside Community Hospital RMC of San Jose Southern Hills Hospital and MC Sunrise Hospital and MC Thousand Oaks Surgical Hospital West Hills Hospital and MC

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West Florida Division	**Mountain Division**
Blake MC Brandon Regional Hospital Citrus Memorial Doctors Hospital of Sarasota Englewood Community Hospital Fawcett Memorial Hospital Largo MC Largo MC - Indian Rocks Campus Medical Center of Trinity Medical Center of Trinity – West Pasco Campus Memorial Hospital of Tampa Northside Hospital and Heart Institute Oak Hill Hospital Palms Of Pasadena RMC - Bayonet Point South Bay Hospital St. Petersburg General Hospital Tampa Community Hospital	Alaska Regional Hospital Brigham City Community Hospital Cache Valley Eastern Idaho RMC Lakeview Hospital Lone Peak Hospital Mountain View Hospital Ogden RMC St. Mark's Hospital Timpanogos Regional Hospital West Valley MC **South Atlantic Division** Coliseum MC Coliseum Northside Hospital Colleton MC Doctors Hospital of Augusta Fairview Park Hospital Grand Strand RMC Memorial Hospital of Jacksonville Orange Park MC Specialty Hospital Jacksonville Summerville Medical Center Trident MC Memorial Satilla Health

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GENERAL PROJECT GUIDELINES

1.1 The goal for all projects is to work efficiently and discover the most optimal design for long-term ownership. The design path therefore needs to be a creative process with a thoughtful, holistic approach across disciplines. This is necessary to realize efficiencies and to make better-informed design choices - for example, upgrading the building glass at a cost premium to downsize mechanical equipment for a net savings.

1.2 It is the responsibility of our design and construction partners to leave the facility with efficient, fully functional, and maintainable MEP systems within the scope of the project. However, the project boundary is not necessarily the limit of responsibility of the design team. All systems that serve areas within the project boundary also need to be investigated. For example, sanitary systems need to be assessed whether they are suitable to handle the load of the project – in reality, not just theory. This means the consultants must not only check existing drawings but must also speak with facility personnel about known condition of system.

1.3 Construction projects in existing facilities are also the means through which capital infrastructure needs may be identified and addressed. The designer is responsible to inform the FacilitiGroup Engineer of any infrastructure components observed that are in need of replacement or upgrade, even if they are considered outside the scope of the project.

1.4 It is the philosophy of HCA FacilitiGroup that we operate building to maximize equipment life and to, as much as practical, eliminate unplanned equipment outages. Unplanned shutdowns of equipment and systems are inconvenient and costly. Therefore, we place our highest emphasis (after safety and comfort) on our ability to rely on our infrastructure.

1.5 These Guidelines provide a roadmap for the overall design and creation of MEP systems serving HCA facilities. However, in all projects, it will be up to the design team to make informed decisions based on experience and specific project need. To help with these choices, please refer to the following hierarchy of goals, in order from highest priority to lowest:

A. Safety and health of patients, doctors, and staff

B. Comfort of patients, doctors, and staff

C. Durability and reliability

D. Maintainability

E. Low life cycle cost

F. Low first cost

G. Energy efficiency

H. Aesthetics

1.6 The Design Engineer shall visit the local AHJ enforcement department in person to determine the codes to be followed and to understand any special requirements such as fire damper requirements, smoke purge, water and sewer supply capabilities, etc. The Engineer shall ascertain which codes and standards apply to the project.

1.7 All equipment shall be U.L. listed and, where applicable, ARI certified.

1.8 Code required minimum air flows, pressure relationships, filtration, types and efficiencies, system selection, redundant capacity, etc., required by the various authorities having jurisdiction (AHJ) shall be researched by the engineer. It is understood the most stringent requirement of all the AHJ must be met.

1.9 In the case of an unreasonable interpretation of the code by the AHJ, HCA Design and Construction and HCA FacilitiGroup are to be consulted.

1.10 All HCA projects are to have proper onsite due diligence performed at the onset of the project to determine the availability of utilities, details of voltages, pressures, volumes, elevations available, and other details of any services, including water, gas, sewer, storm drainage, etc.,. Coordinate with the project's Civil Engineer for the building/site piping interface, usually five feet outside building line.

1.11 Coordinate with the architect and HCA Director of Architectural and Design Services for proper classification of spaces. For example, resist calling a space an emergency operating room when it is actually a treatment room.

1.12 Consideration shall also be given to disaster preparedness. Local susceptibility to hurricanes, tornadoes, ice storms, flooding, power reliability issues, etc., shall be researched. Appropriate modifications to the design, such as hardening exposed equipment to possible weather problems, placing a chiller(s) on the essential power system, or providing a portable generator quick connect to the main switchgear shall be considered and reviewed with HCA Corporate Engineering FacilitiGroup for direction. All state and local codes shall be researched and implemented. Consideration should also be given to preserving equipment exposed to a salt/air environment.

1.13 Equipment shall be reused when economically feasible. The condition and age of this equipment shall be evaluated. Notify the FacilitiGroup Engineer in writing of existing major equipment, chillers, cooling towers, boilers, generator sets, and variable frequency drives, that a project surpluses that is in a condition suitable for reuse.

1.14 The standard warranty period on systems and equipment shall be as specified in the HCA standard agreements with the architect and with the general contractor. Provide manufacturer's warranty for 18 months from date of shipment from the factory or 12 months from startup (which ever date is later).

1.15 The Contractor shall submit to HCA Corporate Construction Manager and Director of Facility Management (DFM) at the facility the beginning and ending dates of equipment warranty periods.

1.16 The project Test and Balance Firm shall be contracted directly with the General Contractor, not the mechanical subcontractor.

1.17 The partnership between the General Contractor and the Commissioning Agent will serve as the Owner's commissioning authority for the project.

1.18 General Contractor shall review the work required by Specification Section 01 91 13 and HCA Guideline Section 23 08 00 with the qualified mechanical, controls, and Test and Balance (TAB) subcontractors prior to awarding the work. Prior to the subcontractors submitting bids on the project, the General Contractor shall interview and brief the subcontractors on the requirements placed on them by the commissioning (Cx) specification to ensure that the subcontractors understand the scope of work required for all three phases of commissioning: pre-functional testing, functional performance testing, and owner verification. The General Contractor shall emphasize to the potential subcontractors the necessary schedule time, including troubleshooting and corrective action time, as well as the documentation deliverables required to be received by the owner and design consultant at least five days prior to the scheduled owner's verification visit. The project schedule should reflect HCA's stance that successful commissioning is a prerequisite to owner occupancy.

1.19 The design consultant shall review O&M manuals, as-built drawings, and equipment submittals prior to distribution to the hospital DFM. The design consultant shall verify that the sequence of operations in the record controls submittal has been updated to incorporate any changes made during construction and commissioning. The specifications will advise required areas and periods of training for maintenance personnel for specific equipment.

1.20 Design and construction teams are encouraged to suggest to HCA Design and Construction any possible energy saving alternatives, along with the estimated cost of the additional services required to perform the economic feasibility of infrequently used energy conservation measures.

1.21 The design consultants shall contact the utility companies prior to design to obtain information regarding rebates or other incentives applicable to energy efficient equipment or systems design. The design consultant shall review this information with HCA FacilitiGroup to determine if the project will qualify and apply for utility payment or credits.

1.22 Design supports and attachment methods for roof mounted equipment including duct and piping to withstand the wind pressures and forces specified in ANSI/ASCE 7-93 “Minimum Design Loads for Buildings and Other Structures” unless the local AHJ has other requirements.

1.23 At the completion of construction projects, a record set of all disciplines drawings, project manuals, and close-out documents shall be provided in PDF format to the facility. All this shall also be posted electronically to HCA’s online project management platform, e-Builder.

1.24 For renovation projects, equipment and materials to be taken out of service are to be demolished entirely, not abandoned in place. Major equipment to be demolished shall be turned over to the facility and protected.

1.25 Maintainability of equipment is a top concern and designs shall provide adequate clearance and accessibility to reasonably maintain system components. This means consideration of all aspects of maintenance including total removal of equipment. The locations, orientations, and arrangements of all MEP equipment installed above ceiling such as VAV boxes, fan coils, valves, and dampers are to be coordinated with the work of other trades to provide, not only the code minimum clearance, but also sufficient clearance for regular preventive maintenance duties. When inspections and regular maintenance are slowed due to the lack of accessibility, it will be costly throughout the life of the component.

1.26 Paint or coat work where exposed in equipment rooms, exposed in occupied spaces, and outside the conditioned building envelope. Refer to Division 9 in MEP Guidelines for more detailed information. It shall be the responsibility of the general contractor to coordinate this work to meet the intent of the design documents and the HCA MEP Guidelines.

1.27 For renovation and expansion projects, if system modifications affect greater than 10 percent of the system capacity, designers shall use pre-renovation water/air flow rate measurements to confirm sufficient capacity is available and that renovations have not adversely affected flow rates in non-renovated areas.

1.28 Contractor shall be familiar with working in operational healthcare facilities and be familiar with ICRA guidelines and installation methods.

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1.29 Specify that all infection prevention barriers used in construction are to have pressure monitors with digital readouts for ease of use.

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DESIGN DELIVERABLES

The following is a summary of proposed deliverables for MEP design documents:

Part 1 - General

1.1 Project Scoping and Assessment

A. Responsibilities

1. Gather appropriate as-builts and design documents
2. Above ceiling inspections – do not rely solely on drawings
3. Communication with facility staff to determine condition of existing infrastructure including:
    a. DFM and maintenance supervisor
    b. Key facility maintenance staff (identified by DFM)
    c. FacilitiGroup Engineering Manager

B. Other

1. Proper due diligence is the foundation for a successful project. There will be no excuses for not doing the front end work that our projects deserve including a lack of adequate time or information. Contact FacilitiGroup for guidance on design or for help with project schedule.
2. The scope of work in all projects must include demolition, rather than abandonment of de-commissioned MEP systems including low-voltage work.
3. Scope must also include remediation of known code issues within a project such as cabling on sprinkler pipe.
4. Scope must also include assessment of current condition and capacity of central energy plant including all services related to building heating and cooling, electrical (normal and emergency), plumbing, and fire protection systems.
5. Four components related to the current condition of every piece of existing equipment to be replaced or reused must be specifically listed in the narrative: age, capacity, condition, and known issues.
6. List any current issues that may hinder the successful completion and commissioning of this project. (3-way valves installed in a primary/secondary system, boiler sequencing issues, faulty control system sensors or actuators, electrical systems coordination, etc.) Separate what is required for the current project and what is out of the project scope but is a legitimate issue that needs to be fixed. These may need to be priced separately.
7. Identify possible utility rebate opportunities
8. Schematic Design (SD) Phase

a. High level energy model with at least three design options to determine most cost-effective design path
b. Establish communications with Cx Agent and establish appropriate review schedule
c. Provide more detailed information regarding rebate opportunities – requirements, amount, application process, etc.
d. Deliverables
    i. Narrative
        1. Existing conditions
            a. Describe existing chiller/boiler/generator/etc. system loads and serviced square footages.
            b. Include existing equipment information including capacity, year installed, condition, and if this will remain, be demolished, or replaced.
            c. Describe the chilled water and heating water system configuration (primary/secondary, variable primary, fixed primary, etc.). Note what the building chilled water and heating hot water delta T is.
            d. Describe the electrical systems to include normal and emergency power systems. Emergency descriptions are to include all pertinent information related to large scale power outages and disaster response operation (how the branches are broken out, number and type of transfer switches, paralleled generators, etc.)
            e. Describe the existing BAS/controls system and fire alarm system. Elaborate on current capabilities for expansion, deficiencies from current codes and standards (including HCA MEP Guidelines), and obsolete components.
            f. Provide greater detail regarding any current issues that may hinder the successful completion and commissioning of this project. Identify solutions and scope.
            g. Provide tables for existing equipment showing all pertinent information.
        2. New work
            a. For all systems, provide the new system load, subsequently designed redundancy, and serviced square footages.
            b. Describe changes to current system and system configuration (primary/secondary, variable primary, steam system to hot water, etc.)

c. Describe how the equipment was sized and any assumptions made in the selection. The engineer is to include any specific direction given by HCA to design or size equipment for future square footage.

d. Provide guideline specifications for equipment, piping, insulation, controllers, etc.

e. Provide tables for new equipment showing all pertinent information.

f. Coordinate with facility proper nomenclature for equipment. We do not want one naming convention on narratives and plans with the facility renaming the equipment during construction or after the project is completed. Start out with the correct names in the beginning to reduce confusion.

g. Chillers and other equipment need to be designed to operate within existing building parameters. For example do not design a chiller for a 18 degree delta T when the facility operates with a 10 degree delta T. Design air handling unit chilled water coils for a 2° F higher entering water temperature than the chiller leaving water temperature.

ii. Rough draft of specifications

iii. Drawings

3. For HVAC systems, provide schematic drawings depicting the pumping and general routing of each existing system (chilled water, heating hot water, condenser or tower water, etc.) including how and where the scope of the project will tie into these systems. Show all secondary loops if there is more than one loop.

4. For plumbing and fire sprinkler systems, provide schematic drawings depicting the pumping and general routing of each existing system (domestic cold, hot, hot water recirculating, fire pump, standpipes, irrigation connections) including how and where the scope of the project will tie into these systems. Show backflow prevention schematically on drawings or describe in narrative. Refer to Guidelines for design requirements for Legionella prevention program.

5. For electrical systems, provide a one-line diagram depicting the general layout the existing system including how and where the scope of the project will tie into these systems. This should include all branches of the emergency power systems as required to fully define the scope of work and locations of major equipment.

6. Schematic diagrams of every air handler, piping diagrams for chilled water, heating hot water, and domestic

C. Design Development (DD) Phase

1. Refine energy model to finalize equipment sizing and controls options
2. Refine design
    a. Minimum of three chiller and tower selections identified, submitted to FG engineers, and agreed upon by FG engineer and design engineer;
3. Formal selections for major equipment including options and accessories(even if subject to minor changes during CD phase)
4. Correspondence to FacilitiGroup Engineer describing other systems considered (minimum of two alternates)
5. Deliverables
    a. Drawings
        i. Schedules – 100% CD level of detail (even if subject to change)
        ii. Floor plans
            1. Enlarged equipment room plans showing equipment, piping, ductwork, panels, variable speed drives, and all required maintenance clearances
            2. Major trunk runs for ducts
            3. Piping mains and risers including all maintenance isolation valves
            4. Fully developed plans and RCPs for major areas for coordination
                a. Operating suite (only one typical operating room need be fully developed)
                b. ICUs
                c. Sterile processing suite
                d. Isolation rooms
                e. Typical L&D
                f. EDs
                g. Imaging
                h. Lobbies
                i. Typical patient room
        iii. Things to not show
            1. Duplicated spaces

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

2. RCPS other than in aesthetically key spaces (i.e., lobbies and typical patient room) and areas where coordination is critical (i.e. congested OR ceilings)
    a. Riser and schematic piping diagrams
- iv. Controls details – 100% CD level of detail
- v. Details – 50% CD level

b. Final draft of specifications

D. Construction Documents (CD) Phase

1. Complete design
2. Formal (submittal quality) equipment selections
3. Deliverables
    a. Bid, permit, and construction quality drawings – stamped. Including the following:
        - i. Table of required airflows and pressure relationships in critical zones
        - ii. Life safety plans in accordance with HCA standard
        - iii. Plumbing drawings in accordance with Design Guidelines requirements for Legionella controls
        - iv. BAS, fire alarm, and metering architecture and equipment
            1. Final specifications
                a. Section numbers aligned with HCA standards

E. Bidding

1. RFIs
    a. Engineer is to review and respond to all contractor requests for information.
2. Value engineering
    a. Engineer is to assess all value engineering options submitted by contractor and provide owner with recommendations. No VEs related to MEP systems are to be accepted without written permission from FG engineer. Approval of VEs from personnel other than FG engineer does not relieve the design engineer of responsibility for the VE.

F. Construction Administration

1. During need to communicate financial repercussions of owner-requests prior to doing any work.
2. Site inspections
    a. Inspections are to be as complete as possible

b. Engineer is to coordinate timing of visits with contractor to be able to observe systems installed above ceilings and within wall cavities prior to their being enclosed.

c. Engineer is to note all deficiencies in installations from industry accepted practice and deviations from owner requirements and design documents

3. Submittals

   a. Engineer is to review submittals and note corrections and comments for contractors. Engineer is to assume he is the last review before material procurement and is not to rely on owner review for quality control. Submittal with Engineer comments are to be sent to the owner for reference.

4. Deliverables

   a. Field reports

   b. Asset management

      i. Final submittals sorted by CSI

G. Commissioning

1. Deliverables

   a. Pre-functional checklists

   b. Functional checklists

   c. Field reports from Cx agent

H. Close Out and Continuing Responsibilities

1. Deliverables

   a. Final O&M manuals – one hard copy in binder for facility – electronic set uploaded to e-Builder

   b. Final submittals with all review comments – one hard copy included in owner's binder – electronic set uploaded to e-Builder (sorted by CSI number and by equipment tag for import into CMMS system)

   c. Test and balance report – one hard copy included in owner's binder– electronic set uploaded to e-Builder

   d. All commissioning reports – one hard copy included in owner's binder– electronic set uploaded to e-Builder

DIVISION 9: FINISHES

DESIGN GUIDELINES – FINISHES

It shall be the responsibility of the design team to clearly specify the painting and coating of MEP systems, at minimum and as applicable and appropriate, in accordance with the guidelines below.

PAINTING AND COATING OF MEP SYSTEMS

SECTION 09 90 00: PAINTING AND COATING

Part 1 - General
1.1 HCA is electing at this time not to provide guidelines.

Part 2-Products
2.1 HCA is electing at this time not to provide guidelines.

Part 3 - Execution
3.1 Paint the following work where exposed in equipment rooms and outside the conditioned building envelope:

A. equipment, including panelboards, switch gear, tanks, stands, and supports;
B. uninsulated metal piping;
C. uninsulated plastic piping;
D. pipe hangers and supports;
E. metal conduit;
F. plastic conduit;
G. tanks that do not have factory-applied final finishes;
H. duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material;
I. equipment, stands, supports, intake bonnets, flutes, and all factory-primed items to receive final paint that are exposed to view in equipment rooms, on the roof or outside the building.
J. Exposed galvanized sheetmetal installed outside of the conditioned building envelope, including in mechanical spaces that are heated only, is not required to be painted but shall be coated to prevent rust and corrosion.

3.2 Paint the following work where exposed in occupied spaces:

A. equipment, including panelboards;
B. uninsulated metal piping;
C. uninsulated plastic piping;

D. pipe hangers and supports;

E. metal conduit;

F. plastic conduit;

G. duct, equipment, and pipe insulation having cotton or canvas insulation coveri ng or other paintable jacket material;

H. other items as directed by Architect;

I. equipment, stands, supports, intake bonnets, flutes and all factory-primed items to receive final paint that are exposed to view in equipment roo ms, on the roof or outside the building.

3.3 Mechanical piping in mechanical rooms, boiler rooms, and powerhouses shall be color codes to indicate service. See HCA Piping Color Table below for recommended color scheme. For work in existing facilities, contractor is to match existing color scheme.

HCA Piping Color Table	
Piping	**Color Description**
Low Temp Supply	Dark Purple
Low Temp Return	Light Purple
Chilled Water Supply	Dark Blue
Chilled Water Return	Light Blue
Condenser Water Supply	Bright Green
Condenser Water Return	Dark Green
Hot Water Supply	Bright Red
Hot Water Return	Dark Red
Condensate	Dark Orange
Steam	Bright Orange
Natural Gas	Bright Yellow
Fuel Oil	Brown
Domestic Water	Blue

A. All piping, except for medical gas, shall be painted in exposed areas and in unconditioned areas such as loading docks, parking garages, canopies, and exterior soffits. Coordinate with architect to specify properly. Deletion of painting is not an allowable VE.

B. Use paint with stencils to neatly identify piping and flow direction. Steam piping shall also be labeled to indicate pressure. Piping shall be stenciled or labeled at 20-foot intervals and at least once in each separate space through which the pipe passes.

C. Color-coded plastic wrap-around labels are an acceptable alternative to painting on insulated pipe. Plastic labels shall only be applied in accordance with code-limitations for smoke developed and flame spread ratings. PVC labels shall only be applied by permission of AHJ.

D. Installing Contractor shall paint damaged and abraded finished on factory-coated MEP equipment and with touch-up paint matching factory finish.

DIVISION 21: FIRE SUPPRESSION

DESIGN GUIDELINES – FIRE SUPPRESSION

HCA is electing at this time not to provide guidelines.

EQUIPMENT AND SYSTEMS GUIDELINES - FIRE SUPPRESSION

SECTION 21 05 00: COMMON WORK RESULTS FOR FIRE SUPPRESSION

Part 1 - General

1.1 Facilities shall be 100% sprinkled and served by a hydraulically calculated system. Most states will allow sprinkler systems to be designed by the contractor, but several states require the Design Engineer to calculate and design the sprinkler system. If the engineer does not have the experience and expertise to design the sprinkler system, including hydraulic calculations, notify the HCA Corporate Construction Manager in order that a qualified engineer can be engaged.

1.2 Fire protection systems shall comply with the requirements and standards of the state and local plumbing code officials and with the requirements of the local water and sewer departments.

1.3 Fire protection piping shall be Schedule 10, rolled grooved standard steel for piping mains 2 ½" and above and Schedule 40 rolled grooved or threaded standard steel for branches and laterals 2" and below. Victaulic's 'Press-fit' sprinkler piping or threadable thin wall shall not be used on HCA projects.

1.4 UL/FM listed CPVC piping, similar to BlazeMaster, may be used where permitted by AHJ. Designer shall specify the required fire caulk material and systems to be used where CPVC passes through a rated partition or floor. Aquatherm Red Pipe systems are also an acceptable substitute where permitted by AHJ.

1.5 Flexible stainless steel hose connection between sprinkler heads and branch piping may be used on HCA projects where accepted by AHJ as an alternate, not the base bid. Great detail should be given to inspection of these heads by the engineering construction administration team during the construction process to assure that they are not bent past the recommended radius at any point during the construction process. Heads that are bent past the minimum radius shall be marked with paint and replaced. Specify requirements based on FlexHead Industries or equal.

1.6 Fire extinguishers shall be specified under Division 21 as required by local and state codes. Coordinate locations and cabinet sizes with the architect.

1.7 Provide quick response sprinkler heads throughout the facility or as required by code. Heads serving generator rooms and fuel storage rooms shall be specified with a minimum 11.2 k-factor.

1.8 Provide double-interlock preaction system for rooms housing MRI equipment.

1.9 Extended coverage heads shall not be permitted. Sprinkler heads in lobbies, elevator lobbies, waiting rooms, operating and delivery rooms, imaging, ICU/CCU, Cath Lab, Critical Care, Intensive Care, Special Procedure, Angio, central sterile clean rooms/clean processing and sterile compounding areas shall be concealed or shall match existing.

1.10 Sprinkler heads in fire/smoke compartments with patient sleeping shall be recessed, quick response type or shall match existing.

1.11 Sprinkler drawings shall be submitted to HCA's insuring agency, AIG, for review. Email plans to planreview.americas@aig.com and copy Anthony.Terrick@aig.com.

Anthony's alternate contact information is:

Anthony J. Terrick, PE
625 Liberty Avenue, Suite 1100, Pittsburgh, PA 15222
Tel +1 412 288 5310 | Cell +1 412 290 5622 | Fax +1 617 206 9301

1.12 Flow densities shall be as follow:

A. Light Hazard: 0.10 GPM/SF Over 1,500 SF

B. Ordinary Hazard I:

1. 0.12 GPM/SF Over 3,000 SF (Open Areas)
2. 0.14 GPM/SF Over 2,000 SF (Partitioned Areas)

C. Ordinary Hazard II: 0.17 GPM/SF Over 3,000 SF

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 21 13 13: FIRE PUMPS

Part 1 - General
1.1 Fire pump controller shall be U.L. and FM approved.

1.2 Fire pump starter shall be wye-delta, ~~closed~~ open transition.

1.3 Fire pump shall be provided with bypass loop for testing so water may be recirculated rather than being wasted to drain or grade.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 21 16 00: FIRE SUPPRESSION JOCKEY PUMPS

Part 1 - General
1.1 Jockey pump controller shall be U.L. and FM approved.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

DIVISION 22: PLUMBING

DESIGN GUIDELINES - PLUMBING

1.1 A front-end report documenting decisions with utilities and code officials is required during the conceptual stages of each project. The front-end report shall document routing and special requirements for water, sanitary, storm sewer, fire protection and natural gas services. State, local, fire, building, and health code officials shall be interviewed for any special or specific code requirements. Assumptions based on projects in other locations shall not be made. A copy of the front-end report shall be sent to HCA Design and Construction and FacilitiGroup.

1.2 All applicable codes including adopted editions and state and local modifications shall be determined by the architect and included in the front-end report and shall be incorporated into the design.

1.3 Plumbing and fire protection systems shall comply with the requirements and standards of the state and local plumbing code officials and with the requirements of the local water and sewer departments.

1.4 Obtain an analysis of the potable water supply in order to determine the need for water conditioning equipment for the project. If the water conditions are extreme, which may result in abnormal costs for the water conditioning equipment, notify the HCA FacilitiGroup Engineering Manager and HCA Construction Manager.

1.5 Coordinate plumbing systems with civil engineer.

1.6 Roof scuppers instead of secondary overflow drain piping shall only be used where climatic conditions or project budget considerations warrant. The design consultant shall recommend and obtain approval from HCA Design and Construction prior to using roof scuppers instead of overflow drain piping systems.

1.7 Specify check valves on the hot and cold water lines serving janitorial service sinks to prevent hot and cold water lines from being cross-connected through a mixing valve attached to a cleaning chemical source that uses the water for mixing/dilution.

1.8 Do not use combination swing-out toilets in lieu of fixed mounted toilets.

1.9 For laboratories, specify emergency deluge shower and eyewash stations with tempered water supply. Also specify these at any location where chemicals are mixed such as plant operations and housekeeping.

1.10 Water Supply: Provide potable and fire water storage as required by AHJ. Storage tanks shall be flow through/outdoor type.

1.11 Locate reduced pressure backflow preventers for easy access by maintenance staff. Install backflow preventers adjacent to floor drains and low on wall for quick and easy access. Do not locate above ceiling or over equipment.

1.12 Legionnaire's Disease Prevention and Facility Design: Legionella is an aerobic species of bacteria - oxygen is critical for this bacterial survival and growth. The points of Legionella infection are at the ends of plumbing system, not in the water heater (anaerobic condition). Storing domestic hot water at 140°F may not adequately control Legionella amplification because viable bacteria typically comes from the cold water stream. Proper system design, water treatment and good maintenance programs are essential for Legionnaire's disease prevention.

1.13 Designs shall not include aerators on sinks and lavatories. If AHJ requires hot water storage, store at 140°F and design for mixing valves to reduce water temperature to required temperatures. Use balanced mixing valves, such as 4-port valves, to insure proper temperature control at reduced flows during low demand periods. Designers should present research on current techniques such as chlorine-dioxide, copper silver ion exchange, ozone, chlorination, etc. to control and manage growth of Legionella.

1.14 Run the recirculation loop as close as practical to the point-of-use fixtures to minimize the amount of still water in the system. In expansion or renovation projects where existing domestic water piping is to be de-commissioned, always demolish piping back to the mains rather than abandoning in place. No "dead" plumbing legs shall be permitted where water may stagnate.

1.15 Design the plumbing system such that hot water is available at target temperature at every fixture within 3~~1~~0 seconds.

1.16 Consider all Legionella prevention measures in the design of new facilities and the expansion of existing facilities. In the preliminary design narrative, describe the design measures proposed to reduce Legionella risk. Review the Legionella prevention program with the HCA FacilitiGroup Director and the DFM of an existing facility prior to finalizing the design methods to reduce Legionella risk factor.

1.17 The Plumbing engineer shall develop water system flow diagrams that have sufficient detail to enable the identification, analysis, and management of the risk of Legionellosis throughout the building water systems. Process flow diagrams are to be representative of the systems as designed that identify and describe the potable and non-potable water systems within the building and on the building site, including at a minimum:

A. all water supply sources;

B. all water supply service entrances;

C. all water treatment systems and control measures, including disinfection and filtration;

D. all water processing steps, including but not limited to: receiving, conditioning, storing, heating, cooling, recirculating, and distributing;

E. all areas where hazardous conditions may contribute to the potential for Legionella amplification, including but not limited to:

   1. all clinical support areas, including dietary and central sterile;

   2. all patient care areas, including dialysis, respiratory therapy, and hydrotherapy;

F. all water use end points, including:

   1. cooling towers;

   2. open water features;

   3. spas and whirlpools;

   4. pools;

   5. ice machines;

G. any other critical control points determined by the plumbing engineer.

1.18 Drawings and documents of the actual installation shall be provided to both the DFM and FacilitiGroup Engineering Manager. It will be the responsibility of the facility to maintain a current set of and shall include the following:

A. the location of each piece of equipment associated with the building water systems;

B. a drawing of the water distribution piping system, including system materials, pipe sizes, design flow rates, design temperatures, temperature monitoring points necessary to confirm design temperatures throughout the system, fill provisions, blow down provisions, makeup provisions, sampling points, and drain provisions;

C. the location of all outside air intakes;

D. size and options for each piece of water system equipment;

E. applicable control system wiring diagrams, schematics, device locations, calibration information, and operational sequences;

F. material specifications for all building water system components;

G. material specifications for all water systems insulation;

H. safety Data Sheets (SDS) for applicable materials used for building water system treatment, cleaning, flushing, disinfecting, and sealing;

I. installation requirements of all equipment;

J. start-up requirements of all equipment;

K. operational requirements of all equipment and systems;

L. maintenance procedures for all equipment and water systems, including required actions, frequencies, and durations.

1.19 It shall be the responsibility of the engineer to update the current set of design documents described above and submit them to the facility.

1.20 In coastal areas (those areas within 60 miles of the ocean), projects that include a new Central Energy Plant or major expansion of an existing Central Energy Plant shall include a well to provide make-up water for cooling towers and boilers in the event normal utility services are lost. Coordinate with the electrical designer to assure the equipment necessary to operate the well is on emergency power.

1.21 Provide a 2” emergency domestic water connection with a valve and cap downstream of the house backflow preventer and upstream of the domestic booster pumps (if applicable).

1.22 Prior to specifying a water softener, check with the AHJ to determine if it is permissible to discharge the brine into the sanitary drain.

1.23 The temperature of the domestic hot water supply shall be monitored and alarmed by the Building Automation System. An automatic isolation valve shall be installed and controlled by the BAS and shall be programmed to close upon activation of the high water temperature alarm (125°F (adj.) for domestic and 145°F for dietary).

1.24 Provide flow meters for water entrances, gas service, domestic hot water irrigation systems, and makeup water as specified in the Appendix F - Energy and Resource Metering. Any substitution must be approved by the HCA FacilitiGroup.

1.25 Provide balancing valves on domestic hot water recirculation systems. These valves are to be shown on the plumbing plans in their proper locations. Proper balance of the hot water system is to be included the TAB firm scope of work.

1.26 Piping in mechanical rooms, boiler rooms, and powerhouses shall be painted for color coding in accordance with the HCA Piping Color Table. Refer to Section 09 90 00 – Painting and Coating.

EQUIPMENT AND SYSTEMS GUIDELINES – PLUMBING

SECTION 22 05 13: ELECTRIC MOTORS FOR PLUMBING

Part 1 - General

1.1 Work Included:

A. Specify premium efficiency motors for all motors three horsepower and larger.

B. Use inverter-duty motors where a VFD controls the motor. Inverter-duty motor shall include:

1. spike-proof design such that voltage spikes will not damage motor insulation;
2. no distance restrictions between any inverter and motor - no carrier frequency limitations;
3. Design that does not require inverter power conditioning equipment to protect motor;
4. 5-year warranty;
5. Shaft-grounding rings.

Part 2-Products

2.1 Acceptable Manufacturers: Lincoln, MagneTek/Century, Marathon, Gould, Toshiba, Baldor, Reliance, US Motors, and General Electric.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 22 05 23: GENERAL DUTY VALVES FOR PLUMBING PIPING

Part 1 - General

1.1 Work Included: Service shut-off valves shall be located at:

A. each piece of equipment;

B. the base of vertical risers;

C. each major section of piping, such as at branches to a floor and major wings or sections on each floor including the first floor of the facility;

D. each bathroom group including patient rooms.

Part 2-Products

Refer to Innovation Memo #7 for sole sourcing of Valves through Ferguson Enterprises.

2.1 Provide clamp lock hand lever operators on butterfly valves less than 8″. Provide hand wheel and closed housing worm gear on valves 8″ and larger. Specify wafer type butterfly valves where pipe removal next to the valve is desirable for maintenance of equipment, coils, etc.

2.2 Provide chain operators for all equipment room valves 4″ and larger which are located over 6′ 6″ above the finished floor that might operate on a regular schedule. Design Engineer shall designate which valves get chain operators.

2.3 Shut off valves for water piping 2″ and smaller shall be ball type and for 2½″ and larger shall be butterfly type. Specify sweated fittings on all valves without any threaded fittings.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 22 05 48: VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

Part 1 - General
1.1 Work Included:

A. Provide housekeeping pads under all floor mounted equipment.

B. Seismic isolation and protection shall be specified on a performance basis by the Design Engineer. All materials including equipment anchoring and pipe hangers shall be designed by a registered professional engineer in the State of the project. Isolation vendor shall include design costs with the equipment costs. Submittals shall include details on all isolators, anchorage, hangers, sway bracing, etc. for a complete system that is approved by State and local AHJ. Design Engineer shall include a performance specification and sufficient seismic details to convey scope of the seismic requirements to the contractor. The scope of work shall include a Certified Seismic Inspection Report prior to acceptance of the work.

Part 2-Products
2.1 Acceptable Manufacturers: Mason Industries, Kinetics Noise Control, Vibration Eliminator Co., Vibration Mountings & Controls, Inc., Korfund Co., Amber Booth, Vibro-Acoustics, or Hyspan.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 22 07 00: PLUMBING INSULATION

Part 1 - General
1.1 Work Included: All insulation, mastics, and coverings shall meet 25/50 flame spread and smoke developed ratings.

Part 2-Products
2.1 Pipe Insulation:

A. Insulate domestic hot water and hot water recirculation piping with fiberglass pipe insulation with ASJ jacket. Thicknesses shall comply with the more stringent requirements of the latest edition of ASHRAE 90.1 or the locally adopted/enforced energy code.

B. Insulate domestic cold water piping with ½″ fiberglass pipe insulation with ASJ jacket to prevent condensation. As VE item, insulation may be omitted on cold water piping in chases behind fixtures and wall cavities, except this shall not apply to piping in any exterior wall cavity. For locations such as south Florida where condensation is not likely, omit insulation on cold water piping.

C. Fittings on pipe sized up to 2″ shall be mitered. Molded fittings shall be used for 2½″ and larger. All indoor fitting insulation shall be covered with a tight fitting PVC jacket.

D. For horizontal rainwater leaders, insulate with 1″ thick, flexible, fiberglass duct insulation in areas where condensation is likely to occur.

E. Under rainwater leaders, insulate with minimum 2″ thick, flexible, fiberglass duct insulation in areas where condensation is likely to occur.

F. For outdoor domestic water piping, insulate with Foamglas with aluminum jacket on pipe and fittings.

Part 3 - Execution

3.1 Provide piping design that prevents pipe from freezing. Outside piping shall be insulated and heat traced in climates with ASHRAE winter design temperatures of 32°◦F and lower. Coordinate with Division 26.

SECTION 22 11 16: PIPE AND PIPE FITTINGS FOR PLUMBING

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

Refer to Innovation Memo #7 for sole sourcing of piping through Ferguson Enterprises.

2.1 Domestic hot and cold water piping shall be Type L copper. Use Type K with Sil-Fos joint for piping under slab.

A. Type K – ½″ = 0.049″ wall thickness

B. Type L – ½″ = 0.040″ wall thickness

C. Type M – ½″ = 0.028″ wall thickness

2.2 T-Drill fittings and Victaulic's PressFit couplings are not allowed on HCA projects.

2.3 Domestic cold water piping 4″ and larger is to be brazed, designer option to use rolled grooved copper (Victaulic or Anvil) in lieu of brazing where welding is an issue but only in accessible spaces. Also grooved piping is acceptable in mechanical rooms when the engineer deems it appropriate.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

2.4 Use PVC below slab for sanitary waste and storm water. The PVC pipe shall extend through the floor slab only enough (1″ to 2″) to allow the transition to cast iron with a Fernco coupling. Protect PVC by wrapping with felt paper to minimize damage during pouring of the floor slab. Verify with AHJ that it is acceptable to turn-up PVC pipe above floor slab. If not, install Fernco fittings underground in the vertical and transition to cast iron before turning-up through floor slab.

2.5 In central plants, central sterile, and kitchens where waste above 140°F is frequently discharged into the sanitary system, use cast iron pipe for underground sanitary piping in lieu of PVC. Extend the cast pipe for 30′ to 40′ to allow mixing with colder waste streams to dilute the temperature of the sanitary waste.

2.6 No-hub couplings shall be ProFlo MD Series for sanitary waste and vent and storm water piping.

2.7 Aquatherm Green Pipe systems are an acceptable substitute for domestic cold water piping systems. Aquatherm Faser Green Pipe systems are an acceptable substitute for domestic hot water and domestic hot water recirculation piping. Aquatherm Lilac Pipe systems are an acceptable substitute for rainwater, reclaimed water, or grey water systems except where installed near patient-occupied spaces unless adequate steps are taken to mitigate sound transmission from running water through pipes. Verify acceptance with AHJ and insulate as needed with consideration given to pipe R-value. Pipe exposed outdoors should be Aquatherm UV piping with with an outer coating of black polyethylene.

2.8 ProPress piping systems by Viega is an acceptable VE for the following piping systems: fire domestic hot water, domestic cold water and domestic hot water recirculation piping. The VE must accompany a 50 year parts warranty from the manufacturer. The cost and time savings must be evaluated to determine if this will be accepted.

Part 3 - Execution

3.1 At end of construction and prior to turnover of building to owner, contractor is to run a camera through all sanitary mains (4″ and above) included within the scope of the project to the greatest extent of: 1) 10 feet beyond the point of connection of the renovation or construction work; 2) the next pipe size increase; 3) 10 feet outside the building. Where project includes a connection to sanitary utility, the camera needs to record to that connection point. This recording is to be properly labeled to indicate the position of the camera at various points for reference. This recording is to be turned over to owner at completion of construction but immediately prior to turnover of building.

3.2 All piping systems are to be installed with strict adherence to the most current version of the manufacturer instructions and recommended best practices. All personnel installing ProPress must have attended a Viega ProPress training class and must be able to produce documentation of that fact.

3.3 When installing ProPress, contractor is to cut pipe ends at right angles. Tube ends are to be reamed and chamfered, and all grease, oil, and dirt removed with a clean rag. Fitting sealing ring is to be inspected prior to installation to assure it is free of damage and is properly seated.

3.4 Contractor is to "dry fit' the assembly and to mark the pipe with a felt tip pen at the edge of the fitting prior to final installation. Contractor is to remove the fitting and check the distance between the mark and the end of the pipe conforms to manufacturer tolerances. During the final fit, the end of the fitting must align again with that mark.

3.5 Contractor shall test piping systems with dry air or nitrogen under pressure to identify any leaking joints.

SECTION 22 11 23: DOMESTIC WATER PUMPS

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Equipment: Domestic water booster pumps.

2.2 Acceptable Manufacturers: Taco, Systecon, Bell & Gossett, SyncroFlo, Canariis or Grundfos.

2.3 Units shall contain the following:

A. hydro accumulator tank for use in facilities with low night flow. (Not required on larger projects.);

B. variable speed, closed-coupled, end suction type pumps;

C. NEMA rated pump motors that do not overload at any point on pump-head curve;

D. low suction cut off;

E. suction strainers;

F. pressure reducing valves;

G. check valves;

H. shut-off valves;

I. gauges at suction and discharge;

J. copper pump headers.

2.4 Hot Water Recirculation Pumps:

A. Acceptable manufacturers: Taco, Paco/Grundfos, and Bell & Gossett

B. Pumps shall be of all bronze construction with:

1. flexible coupled motor;
2. manual motor starter;
3. thermal overload protection.

Part 3 - Execution

3.1 Verify location and clearance requirements.

3.2 Install per manufacturer's recommendations.

SECTION 22 13 29: SANITARY SEWERAGE PUMPS

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Sump Pumps:

A. Acceptable manufacturers: ~~Weil~~Wilo, ~~Chicago, Worthington, Federal, Goulds, Zoeller, and Swaby~~Zoeller, and Liberty.

B. Pumps shall be all bronze, 115 volt, grounded cord plug in type. Pumps in elevator shafts shall comply with the latest ANSI code requirements.

2.2 Sanitary Waste Pump, Submersible Type:

A. Acceptable manufacturers: ~~Weil~~Wilo, ~~Chicago, Gould, Zoeller, and Swaby~~Zoeller, and Liberty.

B. Pumps shall be non-clog, close coupled, bronze or coated impeller, totally submersible type, and water proof.

C. Controls to include float type switches (non-mercury type), control panel, high water alarm, disconnects, and starters.

Part 3 - Execution

3.1 Verify location and clearance requirements.

3.2 Install per manufacturer's recommendations.

SECTION 22 31 16: COMMERCIAL DOMESTIC WATER SOFTENERS

Part 1 - General

1.1 Work Included:

A. Provide complete softener unit(s) as listed in the equipment schedule for each project.

B. Unit shall soften water to zero grains hardness, as determined by an accepted test method.

C. Separate duplex units are to be provided for boiler make-up water and domestic hot/cold water systems.

D. Softeners serving domestic water systems are to have an auto (proportional) blending valve pipe arrangement to set softener output to building system at 3 to 5 grains hard water.

E. Domestic water units shall contain sampling ports before the softener, between the softener and blending valve arrangement, and after the blending valve arrangement.

1.2 Quality Control: Softeners shall be sized on the following basis (Industry Standards):

A. Steam boiler softener - Soften all water above zero grains hardness with separate softener unit to zero grains.

B. Domestic Water - The following shall apply when selecting a whole building softener:

1. 0 to 5 grains incoming hardness - no softener required.
2. 5 to 10 grains incoming hardness - soften all domestic hot water prior to supplying water heaters to 3 to 5 grains.
3. 10 grains and above - soften all water prior to supplying hospital and equipment. Provide blending valve arrangement set at 3 to 5 grains with means for manual testing.

Part 2-Products

2.1 Acceptable Manufacturers: Culligan, Anderson Chemical, R.A. Bruner, Hydromax, Stay-Rite, Wigen Water Technologies or Marlo

2.2 Equipment Requirements:

A. Provide manway access openings for tanks over 30″ diameter.

B. Provide hand holes for tanks under 30″ diameter.

C. Tanks shall be ASME rated for 125 psig w.p.

D. Tanks shall be epoxy coated inside.

E. Tanks shall be of seismic resistant construction where applicable.

F. Use automatic regeneration control based on water meter readings. On small systems, use time clock method to initiate regeneration based on water meter readings.

G. Operational controls shall be automatic type.

H. Provide testing kit for each softener unit.

Part 3 - Execution

3.1 Startup shall be performed by a factory representative.

SECTION 22 33 33: STORAGE ELECTRIC WATER HEATERS

Part 1 - General

1.1 HCA's preference is to use steam semi-instantaneous heaters. Use electric water heater only if steam is not available and storage is required by AHJ. Consult with DFM if storage is required.

Part 2-Products

2.1 Acceptable Manufacturers: Hesco, Inc., Ruud, State Industries, Bradford White, A.O. Smith, PVI, or Lochinvar.

2.2 Equipment:

A. Tanks to be constructed to ASME code, 300 psig tested and 150 psig working pressure, and contain the ASME stamp.

B. Acceptable interior linings: Vitreous Glass, Polymerized Epoxy.

C. Provide 12″ x 16″ manway on heaters larger than 125 gallons.

D. Controls shall consist of internal fusing for control and load circuits, insulated sheath elements, T&P ASME relief valve, pressure gauge, UL listing, thermostatic or solid state element controls, and anode rods.

E. Each heater shall include fused or current breaker protected control circuit.

Part 3 - Execution

3.1 Installation:

A. Unit shall fit properly into the space provided with adequate room for all maintenance tasks.

B. Installation shall be in accordance with manufacturers recommendations.

C. Provide electrical coordination with Division 26.

3.2 Startup:

A. All connections shall be secured and operational prior to startup of unit.

B. Startup and adjustments shall be performed by a factory representative.

C. The warranty shall be ten years total; five years non-prorated and five years prorated.

SECTION 22 34 36: STORAGE NATURAL GAS WATER HEATERS

Part 1 - General

1.1 HCA's preference is to use steam semi-instantaneous heaters. Use gas fired boiler with storage tank type of heater only if steam is not available and storage is required by AHJ. Consult with HCA FacilitiGroup and Facilities Management Services if storage is required.

1.2 Elevate stored water temperature to at least 140°F and use balanced mixing valves.

Part 2-Products

2.1 Acceptable Manufacturers: Aerco Inc., Hesco Inc., Bradford White, Patterson Kelly, Teledyne Laars, A.O. Smith, or PVI.

2.2 Equipment:

A. Water containing section to be copper with bronze heads. Heat exchanger to have five year limited warranty against failure, caused by defective workmanship or materials.

B. Each unit shall contain the following:

1. UL, AGA listing
2. ASME stamped for 150 psig w.p.
3. Approved for indoor/outdoor installation
4. Standard controls
5. Auto ignition
6. High limit switch
7. Auto main gas valve
8. Gas main regulator with capability of 14″ w.c. pressure
9. Pilot light - auto type
10. Factory wired system controls
11. Recirculation pump - bronze type

C. Storage Tank shall be ASME constructed for 150 psig w.p., contain 12″ x 16″ manway on tanks 30″ diameter and larger, piped drain, and ASME relief valve

Part 3 - Execution

3.1 Installation and Startup:

A. Installation shall be per manufacturer's recommendations.

B. Coordinate electrical requirements with Division 26.

C. All connected systems shall be up and running prior to startup of unit.

D. Startup shall be performed by a factory representative.

3.2 The warranty to be ten year total; five year non-prorated, and five year prorated.

SECTION 22 35 13 13: HEATING-FLUID-IN-COIL INSTANTANEOUS

Part 1 - General
HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Acceptable Manufacturers: Aerco Inc., Hesco Inc., Patterson Kelley, or Armstrong

2.2 Equipment:

A. Shell: Carbon steel with stainless steel tube sheet and stainless steel mixing chamber, constructed to Section VIII ASME unfired pressure vessels code, stamped with appropriate symbol (U) for 150 psig working pressure.

B. Unit to be insulated and protected by a Painted steel jacket.

C. Units to be single wall heating coils unless code requires double wall construction. Unit may be constructed of copper, stainless steel, or copper helically wound coils.

D. Single wall coil thickness to be 0.049″ minimum, with a ¾″ I.D. pipe size.

E. Provide heaters with floor mounted skid frame, control valve, ASME T&P relief valve, temperature, steam pressure gauges mounted in a console, steam trap, steam inlet strainer, double safety solenoid temperature limiting system and bronze re-circulating pump and associated piping.

F. Secondary steam valve shall be controlled separately by BAS to limit domestic water temperature in the event of a failure of the water heater controllers.

Part 3 - Execution

3.1 Installation:

A. Water heaters shall include standard equipment as shown on manufacturer's specification sheets. Unit shall fit properly into space provided.

B. Installation to be in accordance with manufacturer's recommendations.

SECTION 22 43 00: HEALTHCARE PLUMBING FIXTURES

Part 1 - General
HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Refer to Innovation Memo #6 for sole sourcing of plumbing fixture through Ferguson Enterprises Installation:

A. Fixtures are to be installed per manufacturer's guidelines.

B. All barrier free fixtures shall be installed in accordance with the ADA rules and regulations.

C. Shower valves shall be pressure balanced type unless noted otherwise.

D. Tub and showers shall have non-slip walking surface.

E. Note: Use of combination fixtures on HCA projects requires HCA Design and Construction's approval for use in ICU/CCU suites.

2.2 Materials:

A. Wall hung lavatories shall be furnished with wall bracket or chair carriers. This depends upon which state the facility is located. Consult state and local requirements. Florida requires all fixtures wall hung to have carriers.

B. All fixtures except polished stainless shall be white.

C. All faucets/flush valves shall contain stop-check supplies. Specify that only non-threaded fittings shall be used inside the wall-cavity in order to avoid inside the wall leaks from over tightening any in wall fittings.

D. All fixtures shall be caulked with white General Electric silicon sanitary sealant or equal.

E. Provide metal or treated wood backing for all wall hung fixtures. Consult local/state codes.

F. Provide shower and floor drain water proofing membrane for non-prefabricated showers and floor drains located above slab on grade. Use Chloraloy 240 branch non-plasticized chlorinated polyethylene concealed water proofing membrane 0.040" thick.

G. Water closets shall be floor mounted bottom outlet type except for public restrooms which shall be wall hung. Exceptions to this standard must be coordinated with HCA Design and Construction.

H. Emergency department decontamination showers interior (preferable) and exterior if code required, shall have holding tanks serving shower drains. Consult state/local codes for double containment requirements, usually not required. If not required to be double wall type, provide a minimum of 300 gallon holding capacity (septic tank type). Tank to have manhole access. No outfall line is required. Effluent discharge from shower to be held in holding tank for proper removal and treatment. Locate holding tank outside of building with service vehicle access. Shower valves shall consist of two mixing valve arrangements, one with a hand held shower wand and the other with a ¾″ hose bibb connection. Locate the ¾″ hose bibb mixing valve near exterior door for Hazmat unit use. Both shower valves to contain thermometers.

Part 3 - Execution

3.1 Coordinate installation dimensions for minimum fixture clearance with state and local plumbing codes and other divisions of this document.

3.2 Provide deep seal traps serving floor drains in walk in coolers/ freezers, and storage rooms, or for any floor drain subject to drying out.

3.3 Staff and Patient: Lavatory/sink faucets shall contain plain end outlets, no aerators are allowed.

3.4 Flush valves handles shall be installed on wide side of water closet as required for ADA accessibility.

SECTION 22 60 13: MEDICAL GAS STARTUP AND CERTIFICATION PROCEDURE

Part 1 - General

1.1 Work Included:

A. Testing, certification, and startup of medical gas systems shall comply with NFPA 99, current edition.

B. Certification of medical gas systems must be performed by a certified, competent, and experienced medical gas pipeline tester.

C. The certifier, if also a manufacturer, manufacturer's representative or a supplier of medical gas systems components, shall not furnish, sell or in any other way supply products for installation on part of the systems being certified.

D. The certifier shall be licensed to ASSE 6000 series, and P.I.P.E. 6030, Level M4 or equivalent.

E. Certifier to be member of M.G.P.H.O. organization of medical gas verifiers.

F. Existing piping systems being cut into shall be certified for cleanliness prior to any new connections to existing piping systems.

G. Certification/verification applies to any existing, renovated, new addition, or new construction of medical gas systems.

H. Bulk oxygen parks shall be certified prior to use and/or connection to a medical gas piping system.

I. New or renovated systems shall meet the following criteria:

1. Purity test,
2. Cross connection,
3. Operating pressures,
4. Alarm monitoring,
5. Labeling of system components,

6. Equipment function and operation,
7. All findings shall be presented in a written report to the Director of Facilities Management (DFM), Architect, and Design Engineer.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 22 61 13: MEDICAL COMPRESSED AIR PIPING

Part 1 - General
1.1 Work Included:

A. Furnish medical compressed air systems per the latest edition of NFPA 99.
B. Furnish the following system components:
   1. Outlets, Zone Valve Boxes (Z.V.B.), valves, alarms, pressure gauges, switches, and miscellaneous accessories for a complete system.
   2. Wiring for line voltage by Division 26. Alarm wiring by Division 22.
   3. Manifolds.

1.2 Code Compliance/Quality Assurance:

A. System to be designed and installed per NFPA 99, the latest edition.
B. Employ only qualified journeymen. Provide brazers performance qualification test records for each brazer used on installation.
C. All brazers shall be qualified per NITC/ASSE 6000 series certification, 37 minimum hours training course and possess a valid certification card at all times while brazing a medical gas system.
D. System verification to be performed by an independent certifier.
E. Installation to comply with all applicable state/local codes.

Part 2-Products
~~2.1 Refer to Tab 17 for sole sourcing of Valves through Ferguson Enterprises.~~

~~2.2~~2.1 Manufacturer assemblies to comply with NFPA 99.

~~2.3~~2.2 Piping Materials and Installation:

A. Shall comply with NFPA 99

~~2.4~~2.3 High Pressure Cylinder Manifolds:

A. Nitrous oxide and carbon dioxide manifold locations to be in a conditioned space and not subject to temperatures below 20°F or above 130°F.

~~2.5~~2.4 Medical Gas Outlets:

A. Quick connect recessed wall outlets.
   1. Consult local facility when remodeling or adding additions to the facility. Not all facilities use this type outlet.

B. Ceiling mounted hose drops to be Diameter Index Safety System (D.I.S.S.) type individual outlets with hoses and hose retractors.

C. Surgical columns, if approved by HCA Design and Construction for the project, are to be retractable type or fixed, depending upon application.

~~2.6~~2.5 Medical Gas Valving: Valving shall be per NFPA 99, rated for oxygen service.

~~2.7~~2.6 Medical Gas Alarms – M.A.P.

A. Master alarms to be provided per NFPA 99. Locations to include Maintenance Engineers Shop (primary) and PBX locations (secondary) at minimum.

B. LPA line pressure alarms (area) to be installed in required areas per NFPA 99.

C. Alarms are to be provided with a contact closure and tied back to BAS for monitoring.

Part 3 - Execution

3.1 Identification: Medical gas piping shall be identified by means of metal tags, stenciling, stamping or with adhesive markers, in a manner that is not readily removable. Label piping at intervals of not more than 20’, and at least once in each room and each story, traversed by the piping system. There is no requirement to paint medical gas piping.

3.2 Installation:

A. Medical gas piping to be purged at any time brazing is to take place.

B. Recommended practices during construction: The system while under construction should remain capped with appropriate plugs or electrical tape during non-construction times. System should be left with a slight nitrogen purge in piping.

C. Purge gas to be medical grade nitrogen (NF) only.

SECTION 22 61 19: MEDICAL COMPRESSED-AIR EQUIPMENT

Part 1 - General

1.1 Work Included: Source equipment for medical air system

1.2 Code compliance/Quality assurance:

A. Installation to be per NFPA 99.
B. Conform to all local, state and federal guidelines.
C. Employ competent, qualified system mechanic/foreman who has satisfactorily completed at least five other similar installations.
D. Verify equipment will fit into space proposed.
E. Coordinate with other trades for a timely installation.

Part 2-Products

2.1 Acceptable Manufacturers: Beacon/Medeas Products, Allied Chemetron, Amico Products, or Powerex

2.2 Manufacturer to have had a minimum of five years' experience in manufacturing medical air compressors.

2.3 Service and parts to be available within 200 miles of installation location during normal working hours.

2.4 Medical Air Compressor Acceptable Types: Base mounted/tank mounted, oil-less, scroll type, rated for continuous duty, permanently lubricated sealed bearings.

2.5 Medical Air Compressor Components: Each air compressor system to include the following:

A. Duplex desiccant type driers,
B. After coolers, if applicable,
C. Dew point and CO monitors (provide a calibration kit),
D. Local alarm in control panel that may be separate from unit,
E. Duplex final filters (0.01 micron rated) with element change indictors,
F. Duplex final line regulators,
G. Duplex safety relief valves,
H. Control panel with disconnect and hour meters,
I. Receiver with corrosion resistant interior,
J. 30 month warranty from startup and shall not exceed 6000 hours of operating.

Part 3 - Execution

3.1 Installation:

A. Coordinate location with other trades.
B. Unit to be housed in a conditioned space not to exceed 80◦F.

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C. Startup to be performed by a factory representative and shall be coordinated with the medical gas/vacuum system certifier.

3.2 Locate equipment to allow recommended clearances in order to properly service the equipment. Design service clearance around medical air compressor to comply with manufacturer's recommendations.

SECTION 22 62 13: MEDICAL VACUUM PIPING

Part 1 - General

1.1 Work Included:

A. Furnish medical vacuum systems per the latest edition of NFPA 99.

B. Furnish the following system components:

1. Outlets, Zone Valve Boxes (Z.V.B.), valves, alarms, pressure gauges, vacuum switches, and miscellaneous accessories for a complete system.
2. Wiring for line voltage by Division 26. Alarm wiring by Division 22.
3. Manifolds.

1.2 Code Compliance/Quality Assurance:

A. System to be designed and installed per NFPA 99, the latest edition.

B. Employ only qualified journeymen. Provide brazers performance qualification test records for each brazer used on installation.

C. All brazers shall be qualified per NITC/ASSE 6000 series certification, 37 minimum hours training course and possess a valid certification card at all times while brazing a medical gas system.

D. System verification to be performed by an independent certifier.

E. Installation to comply with all applicable state/local codes.

Part 2-Products

~~2.1 Refer to Tab 17 for sole sourcing of Valves through Ferguson Enterprises.~~

~~2.2~~2.1 Manufacturer assemblies to comply with NFPA 99.

~~2.3~~2.2 Piping Materials and Installation:

A. Shall comply with NFPA 99

~~2.4~~2.3 Medical Gas Outlets:

A. Quick connect recessed wall outlets.

1. Consult local facility when remodeling or adding additions to the facility. Not all facilities use this type outlet.

B. Ceiling mounted hose drops to be Diameter Index Safety System (D.I.S.S.) type individual outlets with hoses and hose retractors.

C. Surgical columns, if approved by HCA Design and Construction for the project, are to be retractable type or fixed, depending upon application.

~~2.5~~2.4 Anesthesia Evacuation:

A. Low velocity exhaust ductwork systems are preferred and should be used for Waste Anesthetic Gas Disposal (W.A.G.D.) systems if permitted by the authority having jurisdiction. If exhaust ductwork W.A.G.D. systems are not permitted, use individual evac wall/hose type outlets. The evac piping is to be connected to the medical vacuum system after the NFPA 99 required separate piping distances have been maintained. This is required to provide maximum dilution of the anesthesia waste gases prior to induction to the medical vacuum pumps.

B. Where combined medical vacuum and anesthesia evacuation systems are used and adequate dilution of the W.A.G.D. cannot be provided, an oxygen compatible vacuum pump shall be used.

~~2.6~~2.5 Medical Gas Valving: Valving shall be per NFPA 99, rated for oxygen service.

~~2.7~~2.6 Medical Gas Alarms – M.A.P.

A. Master alarms to be provided per NFPA 99. Locations to include Maintenance Engineers Shop (primary) and PBX locations (secondary) at minimum.

B. LPA line pressure alarms (area) to be installed in required areas per NFPA 99.

C. Alarms are to be provided with a contact closure and tied back to BAS for monitoring.

Part 3 - Execution

3.3 Identification: Medical gas piping shall be identified by means of metal tags, stenciling, stamping or with adhesive markers, in a manner that is not readily removable. Label piping at intervals of not more than 20’, and at least once in each room and each story, traversed by the piping system. There is no requirement to paint medical gas piping.

3.4 Installation:

A. Medical gas piping to be purged at any time brazing is to take place.

B. Recommended practices during construction: The system while under construction should remain capped with appropriate plugs or electrical tape during non-construction times. System should be left with a slight nitrogen purge in piping.

C. Purge gas to be medical grade nitrogen (NF) only.

SECTION 22 62 19: MEDICAL VACUUM EQUIPMENT

Part 1 - General

1.1 Work Included: Source equipment for medical vacuum.

1.2 Code compliance/Quality assurance:

A. Installation to be per NFPA 99.

B. Conform to all local, state, and federal guidelines.

C. Employ competent, qualified system mechanic/foreman who has satisfactorily completed at least five other similar installations.

D. Verify equipment will fit into space proposed.

E. Coordinate with other trades for a timely installation.

Part 2-Products

2.1 Acceptable Manufacturers: Beacon/Medeas Products, Allied Chemetron, Amico Products, Becker or Powerex

2.2 Manufacturer to have had a minimum of five years' experience in manufacturing medical vacuum pumps.

2.3 Service and parts to be available within 200 miles of installation location during normal working hours.

2.4 Medical Vacuum Pumps, Acceptable Pump Types:

A. Oil-less rotary vane - continuous duty.

B. Design Claw pumps with variable frequency drives.

2.5 Anesthesia Evacuation Pump: Liquid ring only, continuous duty type.

Part 3 - Execution

3.1 Startup to be performed by a manufacturer's representative and shall be coordinated with the medical gas/vacuum system certifier.

3.3 Unit to be located in a conditioned space not to exceed 80°F.

3.4 Locate equipment to allow recommended clearances in order to properly service the equipment. Design service clearance around vacuum pumps to comply with manufacturer's recommendations.

SECTION 22 63 13: MEDICAL GAS PIPING

Part 1 - General

1.1 Work Included:

A. Furnish the following medical gas systems per the latest edition of NFPA 99: Oxygen (O2), Nitrous Oxide (N2O), Nitrogen (N2), Evac (EV), Carbon Dioxide (CO2).

B. Furnish the following system components:

1. Outlets, Zone Valve Boxes (Z.V.B.), valves, alarms, pressure gauges, switches, and miscellaneous accessories for a complete system.
2. Reserve oxygen manifold.
3. Emergency Oxygen Supply Connection (EOSC) Concrete approach pad for supply vehicle required
4. Wiring for line voltage by Division 26. Alarm wiring by Division 22.
5. Manifolds.

C. Items Furnished by Owner: Bulk oxygen storage vessel with reserve backup supply.

1. Small facilities provide cryogenic gaseous manifolds.
2. Larger facilities to contain bulk system with reserve.
3. Oxygen park to contain the following:
    a. Concrete approach pad for supply vehicle.
    b. No drainage system to be provided within 8′ - 0′ of supply location or oxygen park pad. Oxygen pad shall not slope towards asphalt pavement.
    c. Concrete bulk pad with secured chain link fence and access gate. Secure location.
    d. Vehicle approach pads to oxygen park shall not slope towards asphalt pavement.

1.2 Code Compliance/Quality Assurance:

A. System to be designed and installed per NFPA 99, the latest edition.

B. Bulk oxygen system per NFPA 50.

C. Employ only qualified journeymen. Provide brazers performance qualification test records for each brazer used on installation.

D. All brazers shall be qualified per NITC/ASSE 6000 series certification, 37 minimum hours training course and possess a valid certification card at all times while brazing a medical gas system.

E. System verification to be performed by an independent certifier.

F. Installation to comply with all applicable state/local codes.

Part 2-Products

~~2.1 Refer to Tab 17 for sole sourcing of Valves through Ferguson Enterprises.~~

~~2.2~~2.1 Manufacturer assemblies to comply with NFPA 99.

~~2.3~~2.2 Piping Materials and Installation:

A. Shall comply with NFPA 99

~~2.4~~2.3 High Pressure Cylinder Manifolds:

A. Nitrous oxide and carbon dioxide manifold locations to be in a conditioned space and not subject to temperatures below 20°F or above 130°F.

~~2.5~~2.4 Medical Gas Outlets:

A. Quick connect recessed wall outlets.
   1. Consult local facility when remodeling or adding additions to the facility. Not all facilities use this type outlet.
   2. Nitrogen control cabinets are to be provided in all operating and delivery rooms with the use of this gas.
B. Ceiling mounted hose drops to be Diameter Index Safety System (D.I.S.S.) type individual outlets with hoses and hose retractors.
C. Surgical columns, if approved by HCA Design and Construction for the project, are to be retractable type or fixed, depending upon application.

~~2.6~~2.5 Medical Gas Valving: Valving shall be per NFPA 99, rated for oxygen service.

~~2.7~~2.6 Medical Gas Alarms – M.A.P.

A. Master alarms to be provided per NFPA 99. Locations to include Maintenance Engineers Shop (primary) and PBX locations (secondary) at minimum.
B. LPA line pressure alarms (area) to be installed in required areas per NFPA 99.
C. Alarms are to be provided with a contact closure and tied back to BAS for monitoring.

Part 3 - Execution

3.1 Identification: Medical gas piping shall be identified by means of metal tags, stenciling, stamping or with adhesive markers, in a manner that is not readily removable. Label piping at intervals of not more than 20′, and at least once in each room and each story, traversed by the piping system. There is no requirement to paint medical gas piping.

3.2 Installation:

A. Medical gas piping to be purged at any time brazing is to take place.

B. Recommended practices during construction: The system while under construction should remain capped with appropriate plugs or electrical tape during non-construction times. System should be left with a slight nitrogen purge in piping.

C. Purge gas to be nitrogen (N) only.

3.3 Emergency Oxygen Supply Connection (EOSC): Provide on building served by cryogenic oxygen supply source. Not required on small systems with gaseous manifold oxygen supply sources.

SECTION 22 66 00: CHEMICAL WASTE SYSTEMS

Part 1 - General

1.1 Work Included:

A. Laboratories require acid neutralization basin to be located outside building in serviceable non traffic area.

B. Provide an acid dilution tank, 5 gallon minimum capacity, for each Dark Room/Day Light Processor location. Two or more processors may be served by one dilution tank if in close proximity. Provide aluminum frame and cover with lifting handle for access to dilution basin to facilitate refilling of basin. Dilution basin to be located in Dark Room/Day Light Processor area with access for maintenance. All piping from drains serving Dark Room/Day Light Processor equipment to be polypropylene pipe and fittings meeting ASTM D635/D43 for self-extinguishing characteristics. Joints above floor to be mechanical coupling type. Joints below slab piping to be fusion type.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 22 67 00: MEDICAL PROCESSED WATER SYSTEMS

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Acceptable Manufacturers: Enfield, Orion, GSR

2.2 Pipe: High purity PVDF, schedule 40, iron pipe dimensions from un-pigmented PVDF resin meeting ASTM D3222.flame-retardant, PVDF high purity material with socket fusion welded joints.

2.3 Fittings: Socket Fusion PVDF, schedule 80 wall thickness from virgin, un-pigmented PVDF Resin meeting ASTM D3222. Fittings shall be joined using the socket fusion method, conforming to ASTM D2657. Each fitting shall be individually packaged and sealed.

2.4 Ball Valves and Check Valves: PVDF, fully compatible with PVDF pipe and fittings; tested to 150 psi at 73°F. Use ball type check valves for vertical or horizontal installation. Each valve shall be individually packaged and sealed.

2.5 Provide reduced pressure backflow preventer in piping serving equipment producing distilled or de-ionized water.

2.6 De-ionized water system equipment shall consist of a four tank in series header system. (Three deionizer tanks and one activated carbon filter). System shall be designed to produce 18 mega ohm water, less than 0.5 ppm as calcium carbonate. Tank construction to be corrosion resistant and rated for 100 psig working pressure. System to include the following:

2.7 Water quality indicator light calibrated to indicate when tanks are exhausted and need replacing.

2.8 Ultra violet light with thermistor switch.

2.9 ¾″ Sample port with valve.

2.10 20 Micron filter at discharge to system from header.

2.11 5 Micron pre-filter with bypass on incoming water entrance to deionizer header.

2.12 Re-circulation pumps to be stainless steel and arranged to maintain water quality through the carbon filter, deionizer, micro-filter and monitor. Provide on/off switch for pump to disable during periods of no use.

Part 3 - Execution

3.1 Pipe Installation

A. Install piping per manufacturers recommend-actions.

B. Connect equipment furnished by others in accordance with Division 22.

3.2 Sterilization of Systems

A. Sterilize system as indicated or in accordance with AWWA C601.

B. Flush system thoroughly prior to testing.

C. Do not put system into service until satisfactory tests are reviewed by owner’s representative, architect, and Design Engineer.

DIVISION 23: MECHANICAL

DESIGN GUIDELINES - MECHANICAL

SECTION I: MECHANICAL GENERAL

1.1 In-door & Outdoor Design Conditions:

A. Use the latest published edition of the ASHRAE Fundamentals Climatic Design Information for the location nearest the project site as the outdoor design conditions.

A. Winter Heating: Winter dry bulb (DB) 99% less 10°F (except for locations in Florida from Orlando south).

B. Summer Cooling: DB from the 0.4% Design DB: Wet bulb (WB) from the 0.4% Design WB. These conditions may be exceeded if your experience or judgment for any locale indicates higher temperatures should be used for sizing equipment, especially cooling towers in very humid climates.

C. Altitude: Deviations from ASHRAE standard outdoor design conditions shall be presented to HCA FacilitiGroup for approval.

D. Indoor: Meet AHJ required conditions. Use latest edition of FGI Guidelines for space temperatures and humidity for non-AHJ specified occupied areas if not otherwise mentioned herein. Also, see specific use areas described herein.

E. HVAC system produced noise shall not exceed the following levels: Patient rooms, nurses stations, offices, conference rooms, LDRs, nursery, exam rooms, therapy rooms, diagnostic rooms, waiting rooms, and treatment rooms shall not exceed a NC 37; Operating rooms, C-section rooms, lobbies, cafeteria, toilets, laboratories, and utility rooms shall not exceed a NC 42. NICU shall not exceed NC 35 (This criteria includes HVAC and other equipment generated noise)

1.2 Consideration shall be given to aesthetic issues, such as the appearance of equipment located outside. Coordinate screening of chillers, cooling towers, above ground fuel tanks, etc., with architect. Screening of rooftop equipment may in some cases approach the cost of a full penthouse enclosure, which would be the preferred choice. Provide the HCA Corporate Construction Manager with the cost differential for consideration and direction.

1.3 Design Engineers shall specify the boiler gas trains and automatic sprinkler systems to meet standards required by the HCA insurance underwriter and shall follow these in the design process.

1.4 Pre-Design Testing:

A. When existing systems are to be tied into to serve portions of a new project, or if existing systems are likely to be affected by the new project, testing shall be conducted to establish the current performance and operating capacity of the existing systems. The test should be designed such that a similar test if necessary can be performed after construction to verify that air supplies to spaces or cooling/heating supplies to existing equipment have not been adversely affected. Pre-design testing is also appropriate to fully understand a pre-existing condition or deficiency rather than making assumptions that can later result in significant redesign, increased construction costs, and occupancy delays. If pre-design testing is required, submit a proposal and obtain approval for this testing from the HCA FacilitiGroup Engineering Manager. This work will be coordinated through the Design Engineer as an additional service.

B. This procedure for pre-design testing should not be confused with construction test and balance. The construction test and balance specifications shall be prepared by the mechanical Design Engineer and the engineer shall be responsible for responding to the contractor's technical questions and reviewing his work even though the test and balance contractor shall be contracted directly with the GC. HCA Design and Construction shall be copied on all test and balance deficiencies and final reports.

C. Pre-Design Test Report

1. Submit test report of results of pre-design testing to the Design Engineer and HCA Design and Construction.
2. Include static pressure profiles of all systems designated by Design Engineer. Set terminal boxes to full cooling prior to recording and documenting static pressure profiles. Include diagram of system with measurements indicated on diagram.
3. Assess performance of existing air systems by comparing the measured airflow values to scheduled design total airflows.
4. When chilled water plant modifications are anticipated, compare the chilled water system actual delta T to the existing design delta T. Note the condition and type of all AHU chilled water control valves as well as the system differential pressure being maintained.

1.5 Design /Consulting Engineer shall consider the effect of the addition of a facility A/C system on the remainder of the facility, and vice versa, regarding pressurization and load capacity of the facility. The engineer shall evaluate alternatives for systems expansions for facility additions.

1.6 Direct Expansion (DX) vs. Chilled Water:

A. Chilled water is the preferred cooling medium for new facilities and existing facilities that have chilled water available. Equipment selections for DX, electric driven chiller, engine driven chiller, absorption chiller, screw chiller, reciprocating chiller and air and water cooled variations shall be based on life cycle cost, system flexibility, and capability of the system to meet project design criteria. The use of DX shall be avoided whenever possible. A DX system does not dehumidify well and does not provide operational flexibility. If utilized, DX shall not be oversized. DX system efficiency shall be based on seasonal energy efficiency ratio. Level of redundancy shall be determined by HCA FacilitiGroup, but generally the "70% rule" discussed under chillers would be applied. Systems currently operated as variable primary systems should continue to operate as such. In facilities with fixed primary pumping, serious consideration must be given to reconfiguring the system to variable speed pumping if considerable HVAC work is part of the project scope. Roof-mounted DX systems shall be avoided when possible.

B. Use DX systems for small additions if chilled water capacity is unavailable or installation cost for chilled water becomes prohibitive. Use DX to cool critical equipment needed for the hospital to function during commercial power outages if there are no chillers on the essential system. Discuss options with HCA Design and Construction.

C. Use chilled water and/or chilled propylene glycol/water mixture for ORs and other areas where humidity control is critical.

D. Determine the temperature differential across the chilled water coils of existing AHUs in cases where a secondary chilled water system is to be expanded or existing AHUs are to be added to a new secondary chilled water system. Use this information to estimate the temperature differential of the completed secondary chilled water system and the loading of the chilled water plant. If valve or coil changes to an existing AHU are required to achieve the secondary loop temperature differential necessary to match the chiller selections, notify HCA Design and Construction and include the changes in the project's narrative design and CDs. Select chillers with a temperature differential of 1 degree less than the anticipated building differential at a minimum.

1.7 All design and equipment selections shall be coordinated with HCA corporate equipment replacement programs. For example, when contemplating a chiller change-out due to equipment age, capacity limitations, or regulatory considerations, Design Engineer shall check with HCA Design and Construction to verify if an existing replacement program with HCA is available for consideration.

1.8 Use only reverse return piping design on complex layouts, such as the first (main) floor of a facility. Provide balancing valves for various branches of non-reverse return.

1.9 Design Engineer shall consider and report the cost and benefits of over-sizing the utility distribution system (domestic cold and hot water, steam and condensate) if facility is designed for future expansion.

1.10 Design Engineer is encouraged to suggest to HCA FacilitiGroup any possible energy saving alternatives, along with the estimated cost of the additional services required to perform the economic feasibility of infrequently used energy conservation measures. Some of these measures include, but are not limited to:

A. Plate and frame heat exchanger for waterside economization

B. Refrigerant free cooling

1.11 Ceiling return/exhaust air plenums shall be avoided.

1.12 Do not locate exhaust or return fans in the ceiling above occupied spaces. Floor mounted centrifugal return fans are preferred compared to in-line fans.

1.13 To avoid operating large chillers when free cooling is available, use DX/propylene glycol systems to cool critical equipment not served by air handling units (AHU's).

1.14 Avoid the use of face and bypass dampers in AHU coils.

1.15 Mechanical Drawings:

A. The drawings shall detail the required minimum lengths of undisturbed air or water flow upstream/downstream of flow rate measurement devices used by Building Automation System (BAS) or by the Test and Balance contractor. (Refer to Appendix D ~~Tab 12~~ – Standard Drawing Details)

B. Include within the drawings or submit to HCA FacilitiGroup with the check set/final construction drawings the following for each AHU: the total supply CFM and return CFM based on the sum of the supply diffusers and return grilles, the diversified supply CFM and return CFM based on load calculations, the supply fan CFM and return fan CFM to be used as test and balance criteria, the sum of the exhaust grilles for the spaces served by the AHU, and the minimum amount of outside air CFM to be maintained at the AHU. Separately for exhaust fans, show the sum of all the exhaust grilles and the test and balance criteria for each exhaust fan.

C. Show for VAV/CAV terminal boxes the required minimum length of rigid straight duct connected to the box's inlet. The diameter shall be the same as the box inlet diameter and the minimum length shall not be less than 1.5 times the inlet diameter. Box selection and the use of flexible duct downstream of the box shall take into consideration space noise criteria. (Refer to Appendix D ~~Tab 12~~ – Standard Drawing Details)

D. Lay out the CAV/VAV terminal units to facilitate access for maintenance. Avoid locating these units over such areas as bulkheads around nurse stations and corridors. Also avoid locating these above the ceilings of patient sleeping rooms and patient treatment spaces to the extent possible. Never locate them above OR's, C-section rooms or any other room that is regularly occupied.

E. Where practical, locate terminal boxes in corridors, in such a position that normal ladder maintenance will not obstruct doorways or openings.

F. Diffusers providing air to corridors shall not be on terminal boxes serving rooms. Corridor diffusers are to be supplied from a box~~es~~ dedicated to corridors.

G. Each CAV/VAV terminal unit shown on the drawing shall be identified with a unique reference ID. Include AHU number as part of the terminal unit ID.

H. A schematic of the chilled water system, condenser water system and heating water system piping shall be provided (flow diagram).

I. A schedule sheet shall list the capacity and other pertinent requirements of the equipment listed, including the RPM selection for all fans and the design AHU discharge air temperature set point (or this can be included in the sequence of operation narrative).

J. Include on drawings a comprehensive control schematic and points list for each system showing all points for control and monitoring. Each point shall be labeled with a name (such Discharge Air Temp Sensor) and the point type (such as DI, DO, AI or AO). With schematic include the necessary electrical ladder diagrams for VFDs, starters, etc. to convey start/stop points, safeties, and other required interlocks. Preferably, control sequences and points list shall be placed on drawings with the control schematics.

K. PT (pressure and temperature) test plugs shall be shown at the facility piping connections to all coils, heat exchangers, chillers, hot water boilers, etc. A PT plug shall be located adjacent to each hydronic temperature sensor to facilitate the calibration of the sensors. (Refer to ~~Tab~~ Appendix D~~12~~ – Standard Drawing Details) The installation of PT test plugs is essential to the completion of the HCA commissioning process.

L. A PT test kit with thermometers and pressure gages of the proper range shall be turned over to the facility maintenance staff by the mechanical subcontractor at the end of the construction project.

M. All equipment rooms/central plant shall be drawn to ¼″ = 1′ 0″ scale and all equipment rooms shall have a section drawn to show clearances and access spaces around and under equipment, piping, ductwork, etc. These sections shall clearly show the discharge duct routing from AHU's, the configuration and the spatial relationship among the outside air louvers, the outside air dampers, the return air dampers, air blenders and the outside air and return air entrances into the mixed air plenum. Show all AHU access doors. Indicate the AHU compartment lighting.

N. On pumps show a single pressure gauge connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable. (Refer to ~~Tab~~ Appendix D~~12~~ – Standard Drawing Details).

O. For all return, relief, and outside dampers: show on drawings damper size, free area, pressure drop and velocity at design CFM.

P. Include on the equipment schedule sheet in the drawings the outside air design dry bulb and wet bulb temperatures.

Q. Schedule each piece of equipment individually with an exclusive tag. I.E. provide a line on the schedule for each VAV box do not group similar boxes.

R. On the schedule sheets show total combined CFM of all VAV boxes and exhaust fans associated with each individual air handling unit.

1.16 Pharmacies shall be designed to meet USP Chapter 800, Compounding Regulations.

1.17 All medication rooms shall have a dedicated thermostat / air terminal box.

1.18 Design engineer must refer manufacturers and installers to the entirety of Appendix F - Energy and Resource Metering to obtain full scope of work. Omissions will not be at the owner's expense.

1.19 It is the responsibility of the Design Engineer to properly coordinate, select, and apply metering equipment in accordance with the manufacturer requirements and HCA Guidelines to fulfil the owner requirements. The design documents must clearly show the locations of components. Additionally, design documents must clearly show scopes of work between all trades, including commissioning, and purchased equipment to avoid overlap or gaps in scope.

1.20 Hot water reheat systems to be designed for 140° supply temperature.

1.21 Avoid use of electric duct heaters.

1.22 When a pressure relationship (positive or negative) is required between two spaces, either by code or owner preference, design shall be for a minimum of 75 cfm differential per leaf of door connecting the two spaces.

SECTION II: GUIDELINES FOR HVAC CONTROLS

1.1 The most important component of the HVAC system is the Building Automation System. (BAS). This is truly the heart of the system. Without a properly designed, installed and commissioned BAS, the entire HVAC system will consume excessive energy, cause patient and healthcare worker complaints, create an uncomfortable environment for occupants of the building, and cause maintenance workers needless hours of trouble shooting. The importance of the design, installation, testing and commissioning of the BAS cannot be over emphasized in the implementation of the HVAC system for the facility.

A. All third party integrations shall communicate to the BAS via BACnet MS/TP or BACnet IP. IP is only allowed where manufacturer is preapproved and has an accepted ISA on file with Corporate HCA IT&S.

B. ONLY electrical metering integrations to the BAS can be via MODBUS RTU or MODBUS IP. IP is only allowed where manufacturer is preapproved and has an accepted ISA on file with Corporate HCA IT&S.

C. Communications via LON or any other proprietary protocol are not acceptable.

1.2 Specify all conduit is to be color-coded in accordance with HCA Conduit Color Table in Section 26 05 33.

1.3 The sequences of operations described herein are desired; however, it is recognized that in addition and renovation projects it may not be practical to exactly duplicate these sequences. To the extent possible these features should be implemented:

A. Controlling the AHU discharge air temperature at a set point that is not dependent on operating state, e.g. economizer, mechanical cooling, etc.,

B. Preventing two separate control loops from attempting to control the AHU discharge air temperature or any other variable simultaneously,

C. Primary and secondary means of protecting coils from freezing,

D. Staging chillers on and off automatically.

E. Incorporating the efficiencies of operations through programming. Examples include but are not limited to:

1. Chilled water systems controlled as a whole with reference to CHWV positions and resetting the operating differential set point of the loop as required to minimize energy consumption based upon demand of the system.
2. Hot water systems controlled as a whole with reference to HWV positions and resetting the operating differential set point of the loop as required to minimize energy consumption based upon demand of the system.
3. Air handling systems controlled as a whole with reference to VAV damper positions and resetting the operating static pressure set point and supply air temperature set point of the system as required to minimize energy consumption based upon demand of the system.
4. VAV terminal units controlled in a sequence to prevent movement of the damper and valve simultaneously using a dual PID methodology separately for space temperature and discharge air temperature control.

1.4 The system descriptions and features described in this section of the Design Guidelines should be used as a checklist during design of the HVAC system. The control section of these guidelines is placed immediately after the initial mechanical guidelines to emphasis the importance of the controls even during the initial design of the HVAC system. The controls should not be the last part of the system that the designer thinks of; rather, the functional performance of the controls should be preeminent in the designer's mind during the conceptual design of the HVAC system.

1.5 The following lists are general guidelines. Specific guidelines for various HVAC systems follow the discussion of the general guidelines:

A. Do not change (rotate) equipment based on run time. This causes problems if it occurs when equipment is running or has been taken out of service. Track and display run time, but the lead / lag staging shall be user defined and easily changed.

B. Specify a UPS for each building and field level DDC controller to ensure power is maintained at controllers during transfer to standby power. This should include all controllers except terminal units that do not serve critical spaces. Care to incorporate supporting devices for network communications during power transition should be included.

C. Require signal filtering on all fluid (water & air volume) flow measurement devices; these output signals have high frequency variations due to turbulence, and all controls manufacturers have a method of filtering or dampening these effects.

D. Provide engineered selection and placement of fluid (air and water volume) flow measurement with proper installation clearances as defined by the manufacturers recommendations on the engineered drawings.

E. If variable speed secondary chilled water pumps are designed for parallel operation, the following control sequence is recommended. Start the lead secondary pump when any chiller is required. Modulate to maintain adjustable differential pressure. When VFD speed is greater than 95% (adj.) for 10 minutes, start the second pump and command both with same required speed. When VFD speed is less than 60% (adj.) for 15 minutes, stop the second pump. If multiple pumps with VFDs are staged for reheat/preheat systems, use a similar method of pump control.

F. On secondary loop systems with VFDs, all the AHU chilled water valve positions shall be monitored every 10 minutes when mechanical cooling is in use. The BAS shall use this information to determine the secondary loop differential pressure set point. If any AHU chilled water valve exceeds an adjustable high percent open position, for example 70% (adj.) open, increase the differential pressure set point by ½ psi. When all AHU chilled water valves are below an adjustable low percent open position, for example 20% (adj.) open, lower the differential pressure set point by ½ psi. This optimization process shall require the user to specify the upper and lower differential pressure limits that the process adjustable range shall not violate.

This purpose of this process is to maintain a high return water temperature, avoid forcing chilled water through the valves on units closest to the secondary pumps and save on chilled water pumping hp.

G. On primary/secondary chilled water systems, the bypass line shall not be smaller than the primary loop common line. The pressure drop through the bypass line shall be less than 1.5′ of water at the design evaporator flow of the largest chiller. The bypass line shall be physically connected to the primary loop common discharge line before any secondary line takeoff. A temperature sensor shall be installed in the bypass line.

H. In order to mix primary bypass and building return water and insure each chiller is supplied with the same temperature water, 10 pipe diameters shall be maintained between the supply water take off to the first chiller and the nearest upstream pipe fitting where bypassed primary chilled water and building return water join.

I. Specify flow meters of the type designed to be installed and removed from the pipe without draining the system, e.g. the hot tap type. Any tool required for removal or insertion shall be furnished with the meter. Flow meter locations shall be shown on the construction documents. The manufacturer’s recommended minimum lengths of straight pipe from fittings, valves, temperature sensing wells, etc. shall be dimensioned on each side of the meter; however, if practical, design for more than the minimum required straight lengths. See Section 23 09 13 for detailed requirements. Selected flow meters shall be a type that does not have moving parts.

   1. When it is not possible to use an insertion type flow meter due to lack of sufficient length of “straight pipe” to meet manufacturer’s recommendations, then a full bore magnetic meter may be used in lieu of the insertion type meters without a bypass assembly.

J. Differential pressure switches, instead of flow switches, shall be specified to prove chiller flow. The switches shall be installed across the evaporator and condenser bundles. The operating differential pressure with the chiller running shall be mid-range of the specified differential pressure switch.

K. CAV/VAV Boxes:

   1. Terminal box controls shall be DDC.
   2. Electrical Contractor shall run 120V power to each DDC box controller. The unique box ID served by each breaker shall be identified in the panel directory. Coordinate with electrical engineer to insure circuits are shown on electrical drawings. Boxes serving critical spaces shall be on emergency power.
   3. Each box shall be furnished with 24V control circuit transformer. Transformer and DDC controller shall be factory mounted, wired and calibrated at box manufacturer’s plant.

4. Specify a discharge air temperature sensor after the reheat coil. Connect sensor to box controller.
5. DDC boxes that close the damper to automatically calibrate the transducer shall have a method of disabling the automatic feature, manually commanding a calibration and adjusting the time between automatic re-calibration of the box. Boxes serving operating and C-section rooms shall undergo auto-zero calibration without closing the terminal box's damper.
6. All points in DDC box controller shall be available to operator via operator workstation for commissioning, monitoring, troubleshooting, and set point adjustments. This includes, but not limited to, CFM set points, zone temperature, zone temperature set point, damper position, damper commanded position, leaving air temperature, and hot water valve position. Refer to the commissioning checklists for complete requirements.
7. Small marker shall be clipped to the ceiling grid as a means of marking access to each terminal box.

L. Averaging temperature sensors shall be specified with an accuracy of +/- 0.3°F over their full range. Averaging sensors shall be used for mixed air and preheat air sensors. These sensors shall have a coil coverage ratio of 1 foot of sensor capillary for every 1 square foot of coil surface area.

M. Probe type temperature sensors shall be specified with an accuracy of +/- 0.3°F over their full range.

N. Centrifugal fan air flow measurement systems shall be of the piezometer rings types that measure the difference of the static pressure entering the fan inlet ring and the static pressure at the throat or minimum area of the inlet ring. The Paragon Controls Incorporate MicroTrans EQ transducer/ transmitter or the Air Monitor Veltron model with local readout and temperature correction capability shall be used to measure the differential pressure, perform the square root extraction, signal filtering, and transmit a cubic feet per minute air flow output signal to the DDC controller. The overall accuracy of the flow measurement shall be within 3.0% over a range of 80 to 110 % of AHU/fan design CFM.

O. Centrifugal fans are preferred; however, if in-line fans must be used, specify piezometer ring air flow measurement systems. If unavailable, only the Paragon Controls, Incorporated fan inlet probe type system may be used. If Paragon Controls probes are used, the transducer/transmitter shall be the MicroTrans or the Air Monitor Veltron and the specifications shall require that the AHU/fan supplier include in the submittal, the fan's smallest diameter/area in the inlet bell and the diameter/area of any object, i.e. fan shaft, bearing, etc., that penetrates the plane of smallest diameter of the inlet bell. Require in the specifications that the installing contractor along with the air flow sensing system representative provide full verified documentation of the dimensions/areas.

P. A detail shall be shown for duct installed humidifiers showing the straight length of duct required between the humidifier dispersion tube and duct fittings, the controlling limit humidity sensor, any filter located downstream and the high limit humidistat.

Q. The design consultant, rather than the controls subcontractor or AHU supplier, shall specify the size of the return, relief, and outside air dampers. Return, relief, and outside dampers for each AHU shall be listed in a schedule showing the required damper free area, velocity at the design flow full open position, and the type of blades, opposed or parallel. The objective should be minimal fan speed change required as the economizer dampers operate over their full range, and good mixing of return and outside air in the mixing plenum. Dimension the required damper separation distance from facing louvers.

R. The BAS shall include a trend viewing utility that shall have access to all data base points. It shall be possible to display trend data in histogram (X-Y plots) format without exporting the data to another application.

S. Integrator cards shall be specified for all VFDs that make all the VFD parameters available to the BAS. All VFD parameters shall be mapped into the BAS. Minimum control speeds shall be set for each VFD at the speed recommended by the driven motor manufacturer. Critical equipment speeds shall be identified and programmed to skip over to prevent operation of equipment at these points.

T. VFD’s shall be controlled with physical I/O to/from the BAS and not through the communications trunk. The minimum points of physical I/O for each VFD are as follows:

   1. Command On/Off
   2. Command Speed
   3. Speed reference
   4. VFD Alarm
   5. VFD Status

U. The AHU outside air CFM shall be a calculated software point that can be displayed and alarmed.

V. The BAS graphics shall have an AHU summary display (See Example in the Appendix) that lists for each, the AHU discharge air temperature and set point, chilled water valve position, outside air CFM and outside air set point, mixed air temperature, the economizer damper position, the preheat valve position, and preheat coil leaving air temperature. The outdoor temperature, chilled water supply temperature and AHU current operating mode/state shall also appear on this page(s). Parameters outside the user specified control tolerance shall change colors and flash (Refer to ~~Tab~~ Appendix B-8~~7~~ – BAS Summary Graphics). Total terminal box airflow for each AHU to be shown as a separate point in the BAS graphics in addition to the AHU supply cfm point. ~~See Appendix B-7 for further details.~~

W. The outdoor air temperature shall be displayed on every HVAC BAS graphics page.

X. Ensure that there is a link to a PDF showing the sequences of operations to graphics page of each mechanical system.

1.6 VAV Air Handling Units

A. VAV air handling units shall be designed to operate with a return fan.

B. VFDs shall be furnished for both the supply and return fans. A data interface between the VFD processor and the BAS shall be specified to enable the BAS to obtain VFD data.

C. Whenever a unit is commanded off by operator command, all outside air dampers and relief dampers shall close, the return dampers shall open, the chilled water valve shall close, the preheat process shall stay under control of its input sensor, the humidifier steam valve shall close and the supply, return and interlocked exhaust fans shall shutdown.

D. Whenever the unit is commanded on by operator command, minimum outside air dampers, return damper, and fire/smoke dampers shall open. After the fire/smoke dampers are open, the supply fan shall start. When the supply fan has started, the return fan and interlocked exhaust fans shall start.

E. For both the supply and return fans, fans adaptable to using piezometer rings type air flow measuring systems are preferred.

F. The supply duct static pressure shall be maintained above the minimum specified by the manufacturer of the terminal reheat boxes. A static pressure sensor in the supply duct at the location shown on the construction documents shall be used to control the supply fan VFD to maintain the supply duct static pressure set point (adj.) as determined by the T&B subcontractor. A high limit static pressure sensor shall be installed between the supply fan discharge and the first downstream damper to prevent over pressurization of the supply duct. If the high limit sensor reaches its high limit set point (not user adj.), the BAS shall shut off the supply fan, initiate an alarm, and require a local manual reset in order to restart the fan. Additionally, provide a similar low limit static pressure sensor upstream of the supply fan or return fan to avoid damaging the low pressure duct due to a damper failing closed.

G. The design minimum outside air quantity shall be achieved by modulating the return fan VFD to maintain a fixed differential (adj.) between the measured supply fan and return fan flows. The BAS shall control the differential to within 2% of the set point. The controlled variable input shall be filtered by the BAS controller in order to smooth out the noise always present in differential velocity pressure measurements.

1.7 Constant Volume Air Handling Units

A. Constant Volume Air Handling Units with economizers shall have return fans. In medium pressure and high pressure systems, VFDs and flow measuring instrumentation shall be furnished for both the supply and return fans, if a return fan is used. The outside air shall be controlled by varying the speed of the return fan to maintain the desired differential between the supply and return flows as described above.

B. The supply duct static pressure shall be maintained at the minimum set point as determined by the T&B subcontractor in order to achieve design flow at all boxes. A static pressure sensor in the supply duct at the location shown in the contract documents shall be used to control the supply fan VFD to maintain the supply duct static pressure set point (adj.). The BAS System will have a high/low limit control similar to the VAV AHU described above. Both the normal static pressure and high limit controls will be used on both medium and high pressure systems.

C. Unit startup and shutdown by operator command shall be similar to the method above described for the VAV AHU.

1.8 Humidification

A. The humidification mode and control/ monitoring mode shall be enabled anytime the supply fan is operating. As the sensed space controlling relative humidity rises to its adjustable set point, the humidifier steam valve shall modulate closed. As the sensed space controlling relative humidity decreases, the humidifier steam valve shall modulate open. If the relative humidity in the duct downstream of the humidifier rises to the controlling high limit set point, 80% (adj.), the humidifier steam valve shall modulate toward closed and control the duct relative humidity to the controlling high limit set point. The controlling high limit set point only overrides the proportional signal from the space humidistat whenever the relative humidity in the duct is at or above the controlling high limit set point. If the relative humidity in the duct downstream of the humidifier rises to the alarm high limit set point, 95% (adj.) (always set higher than controlling limit), the controller shall disable the humidifier by closing the steam valve, and an alarm shall be sent to the BAS System. The alarm high limit condition shall require operator acknowledgement and reset in order to enable the humidification mode.

1.9 Air Handling Unit Control

A. The operating states of chilled water air handling units are defined as Mechanical Cooling (mechanical cooling with minimum outside air), Economizer Operation (100% outside air supplemented by mechanical cooling), Free Cooling (cooling by mixing outside and return air), and Preheat (using minimum outside air and adding heat to meet the AHU discharge air temperature set point). Each individual operating state to have an individual PID control loop for that state.

B. A global outdoor air temperature sensor unaffected by any building wall or roof heating shall index the AHU's to either the Mechanical Cooling or Economizer Operation states. The location of the sensor should be on the North exposure, shielded from sunshine and distant from cooling tower exhaust air and AHU relief air

C. In Economizer Operation, the economizer dampers shall be full open and the chilled water valve shall be modulated to supplement the cooling provided by the outside air. If necessary in order to ensure minimum flow or load is available for the chilled water plant, a minimum number of AHUs shall be programmed to never enter into Economizer Operation. These AHUs shall transition from Mechanical Cooling to Free Cooling when there is no longer the need for chiller operation. These selected AHUs shall transition from Free Cooling to Mechanical Cooling when the first AHU transfers out of Free Cooling.

D. The AHU shall transition from Economizer Operation to the Free Cooling state when the chilled water valve has been modulated closed for 5 minutes (adj.). In the Free Cooling state, the outside, relief, and return dampers shall modulate to maintain a discharge air temperature within 0.5% of set point. The chilled water valve is maintained in the closed position to prevent it and the economizer dampers from simultaneously modulating to control the discharge air temperature.

E. An averaging mixed air temperature sensor shall be installed on the entering side of the first coil. The sensor(s) shall be serpentined across the face of the coil. The specifications shall require 1 linear foot of sensor element per square foot of coil surface area.

F. For all AHUs ~~with no preheat coil~~, at a mixed air temperature of 40°F (adj.) the BAS shall alarm, disable/close the economizer dampers reverting to minimum outside air operation (if applicable), fully open the chilled water valve, open the chiller's chilled water isolation valve, and start the appropriate chilled water pump(s) to move chilled water through the coil. If the chilled water pump is controlled by a VFD, the pump(s) shall be operated to maintain the differential pressure set point. Software reset by the maintenance staff shall be required to return to normal operation.

G. Adequate mixing of return and outside air is required for stable and nuisance free operation of air side economizer systems. The design team shall coordinate and apply the optimal spatial relationship between outside air louvers/dampers and return air dampers, use air blenders, turning vanes, plenum baffles, and other techniques as needed to ensure adequate mixing.

H. If preheat is required, the preheat coil hot water control valve shall maintain the average air temperature leaving the coil at set point whenever the outdoor temperature falls below the temperature at which the economizer dampers are able to maintain the set point. The averaging temperature sensor(s) shall be serpentined and be a length as described for the mixed air sensor above. Transition from Free Cooling to Preheat occurs after the economizer dampers have been modulated closed for 5 minutes (adj.). The economizer dampers remain closed in the Preheat State. Transition from Preheat back to Free Cooling occurs when the preheat valve has been modulated closed for 5 minutes (adj.). In the Free Cooling state, the preheat valve is modulated closed unless the preheat low limit control loop, described below, takes control. A local preheat coil hot water circulating pump installed at the coil shall operate at outdoor temperatures below 40°F. The pump shall be designed to preclude localized tube freezing by maintaining a minimum velocity of 3′ per second through the individual tubes. A differential pressure switch across the preheat coil circulating pump shall be used by the BAS to determine the preheat coil circulating pump status.

I. A preheat coil low limit control loop shall be available at all times to limit the temperature of the air leaving the preheat coil to a minimum set point of 42°F (adj.). Should the preheat coil be unsuccessful in limiting the temperature at set point, a preheat coil low limit temperature alarm shall be activated at a preheat coil leaving air temperature equal to 38°F. The preheat low limit alarm shall disable/close the economizer dampers reverting to minimum outside air operation, fully open the chilled water valve, and start the appropriate chilled water pump(s) to move chilled water through the coil. If the chilled water pump is controlled by a VFD, the pump(s) shall be operated to maintain the differential pressure set point. Software reset by the maintenance staff shall be required to return to normal operation.

J. Do not use face/bypass or clamshell preheat coils without the approval of HCA Corporate Engineering FacilitiGroup.

K. The operation of all chillers should terminate when all the AHUs have transferred from Economizer operation to Free Cooling. If any AHUs were selected to skip the Economizer mode for reasons described above, these AHUs shall transition to Free Cooling when all the other AHU have transitioned from Economizer Operation to Free Cooling DX equipment should be used to handle any loads not able to be served with Free Cooling.

L. The lead chiller shall start when the first AHU switches out of Free Cooling and is in need of chilled water in order to make the discharge air temperature set point.

M. When the lead chiller start sequence is initiated, all of the AHUs that were selected to skip Economizer Operation shall switch directly from Free Cooling to Mechanical Cooling.

N. The chilled water valve shall modulate to maintain the discharge air temperature within ½ºF of the set point.

1.10 AHUs that are dedicated to areas that are unoccupied for long periods of time should be provided with an energy conservation control sequence. For example volume reduction for OR AHUs and night setback for Dietary, Outpatient, etc. The control sequence used should maintain appropriate pressure relationships.

A. Specify a leaving water temperature sensor on all cooling and heating AHU coils.

1.11 Freeze Protection

A. A manual reset freeze-stat on the leaving side of the chilled water coil shall stop the AHU fans, command the chilled water valve to a full open position, and start the appropriate chilled water pump anytime the temperature of the air leaving the coil drops below the set point, 36F (adj.). The minimum and economizer outside air dampers and the relief damper shall close. The interlocked exhaust and return fans shall also stop. This BAS shall initiate a separate identifiable alarm for this condition. The freeze-stat shall be serpentined across the face of the chilled water coil at the rate of 1 linear foot of element per sq. ft. of face area.

1.12 Fire Alarm System Shutdown of the AHU

A. The fire alarm shutdown operation of the AHU shall be designed such that, insofar as possible, the BAS and its components are not required to be UL 864 / UUKL listed.

~~A.~~B. Upon a signal from the fire alarm system the supply, the return and all interlocked exhaust fans shall stop. All outside air and relief dampers shall close. All fire/smoke and smoke dampers shall also close. The chilled water valve shall close and the preheat/hot water valve shall remain under control.

~~B.~~C. An AHU serving an OR suite and areas outside the OR suite shall use this sequence only if the device first initiating the alarm is outside the OR suite. If the alarmed device is a smoke detector in the return duct, an outside air smoke detector, a smoke detector in an OR, or any detector in the OR suite, activate the applicable OR AHU smoke vent cycle below.

1.13 Smoke Vent Cycle for OR AHU (example only, based on TDH Standard)

A. Unless AHJ has its unique requirement, upon an alarm first initiated from the return duct smoke detector or any smoke detector located in the spaces served by the unit, the freezestats shall be disabled, the outside air and supply duct smoke detectors shall be timed out for 30 seconds, and:

1. The supply fan VFD shall be indexed to operate at 100% design speed
2. The return fan and exhaust fan(s) shall operate at 100% of design

3. All smoke dampers shall remain open
4. The DDC terminal boxes shall be indexed to the maximum setting
5. The CHW valve shall be 100% open and chilled water pump shall start.
6. The preheat is under control
7. All outside air and relief dampers shall open fully
8. The return damper shall close fully. Should the mixed air temperature fall below 38°F during the above smoke vent operation, the appropriate chilled water pump shall start. Should the outside air smoke detector alarm after the 30 second timeout, the supply fan shall stop, the minimum and economizer outside air dampers shall close, and the return damper shall remain closed.

B. Unless the AHJ has its unique requirement, upon an alarm first initiated from the outside air smoke detector:
   1. The supply fan VFD shall be indexed to operate at 100% design speed
   2. The return fan and exhaust fan(s) shall operate at 100% of design
   3. All smoke dampers shall remain open
   4. The DDC terminal boxes shall be indexed to the maximum setting
   5. The preheat is under control
   6. All outside air and relief dampers shall close fully
   7. The return damper shall remain open
   8. If subsequently a smoke detector within the OR suite or the supply air smoke detector alarms:
   9. The supply fan shall stop
   10. The return dampers shall close fully
   11. The relief dampers shall open fully
   12. The return fan and exhaust fans shall continue to run
   13. The supply duct fire/smoke and smoke dampers shall remain open whenever the supply fan is running and shall close whenever the supply fan is off.
   14. Return duct fire/smoke and smoke dampers shall remain open whenever the return fan is commanded to run and shall close whenever the return is off. Exhaust duct fire/smoke and smoke dampers shall remain open whenever the exhaust fan is commanded to run and shall close whenever the exhaust fan is off.
   15. The DDC terminal boxes shall be indexed to the maximum CFM setting any time the supply fan is running in the smoke vent cycle.

1.14 Chiller Lead/Lag Control (Systems Using Secondary Loop)

A. The lag chiller(s) shall be started/stopped based on a comparison of the primary and secondary loop flow rates. The primary loop flow shall be assumed to equal the sum of the design flow for the chiller evaporators on line. Calculate and display the building tonnage using the measured total secondary loop flow rate and secondary loop supply and return temperatures.

B. The BAS shall accommodate user input data that defines the design cooling capacity and design chilled water flow rate for each chiller. The BAS shall use this information to control the lag chillers.

C. Use the following procedure to start and stop the lag chillers:

1. A comparison of the primary and secondary chilled water flow shall be the preferred method of deciding when to start an additional chiller. (The secondary loop flow shall be a BAS analog point. The design flow or TAB adjusted flow for each chiller can be used for the primary loop chilled water flow.) Start an additional chiller when the secondary loop flow exceeds 95% (adj.) of the primary loop flow continuously for a period of 10 minutes (adj.). A backup method shall be used to start an additional chiller in case the first method fails to generate a start command, i.e. the secondary loop flow meter data goes unreliable, etc. The backup method shall start an additional chiller whenever reverse flow is sensed by the temperature sensor in the bypass/common line. If the backup method is invoked, the BAS shall alarm and print a statement notifying the user that a lag chiller was started using a backup method and that the cause needs to be investigated. Anytime a lag chiller is started or stopped, the system shall print out:

D. The actual temperature difference across the secondary loop,

E. The design temperature difference across the secondary loop,

F. The calculated building load from the measured secondary flow and temperature difference,

G. The total chiller capacity on line before the lag chiller was started.

1. Stop the lag chiller most recently started when:

H. The primary loop flow minus the design flow of the most recently started chiller exceeds the secondary loop flow by 25% (adj.) continuously for a 10 (adj.) minute period. A backup method shall be used to drop a lag chiller in case this method fails to appropriately drop a lag chiller. The backup method shall drop the most recently started chiller when the temperature drop across the primary loop indicates the building load can be carried without this chiller. If the backup method is invoked, the BAS shall alarm and print a statement notifying the user that a lag chiller was dropped off line using the backup method and that the cause for this action needs to be investigated.

1. The BAS shall be programmed to stage chillers of different capacities and accommodate user assignment of the order in which multiple chillers are to be staged. The system shall also be programmed to permit the user to designate any chiller as being "Out of Service" without affecting the system's ability to stage the remaining chillers automatically based on secondary loop load.
2. The automatic chiller staging process shall not attempt to start any chiller the user has designated "Out of Service", but shall start the next chiller in the user defined lead/ lag sequence of operation.

I. The BAS shall start the next chiller in the user defined sequence in the event a required chiller fails.

J. Specify an interface device between BAS and chiller control panel that maximizes the amount of control and data available to the BAS.

K. When there are multiple chillers of the same capacity to be sequenced then the lead chiller in the sequence shall also rotate based upon user defined parameters that are not run time based.

1.15 Chiller Lead/Lag Control (Systems with Constant or Variable Flow Primary Loop Only)

A. The lag chiller(s) shall be started / stopped based on the building return temperature or measured total flow, as applicable. The building load shall be calculated similar to the method above for primary/secondary loop systems.

1.16 Cooling Tower Control

A. The preferred design is to have a common condenser supply/return lines to the cooling towers. Any time a chiller is dropped off line, a cooling tower shall be isolated at the inlet. This is preferred to prevent mineral deposits from accumulating on the fill when cells are operating at much less than design flow. Using automatic isolation valves to isolate the outlet basins of the inoperative cells is unnecessary provided the sumps' equalization connection is of sufficient capacity to preclude: air entrainment due to severe vortexes, the occurrence of common sump level draw down, excessive water makeup and subsequent overflow when some cells are isolated at the inlet.

B. The common condenser supply temperature to the chillers shall be used to control the cooling tower VFD fans. The temperature set point shall be 70°F (adj.) corresponding to the minimum acceptable condenser supply temperature to the chillers. When multiple towers sharing a common return line are operating, the fan VFDs shall be controlled to the same speed. The fan speed shall be controlled above a minimum value (adj.) to prevent overheating of the motor windings.

C. If a closed piped condenser water bypass is used, the location of the condenser water supply line's connection to the bypass valve, the location of the bypass valve's connection to the common condenser water return line, and the head delivered by a single condenser pump shall be taken into account in order to avoid air entrainment into the condenser water lines. The length of piping between the bypass valve and the temperature sensor in the common condenser return line shall be limited in order to facilitate control of the bypass valve during startup of the lead chiller in cold weather.

D. The condenser water pumps shall be located indoors unless an alternate location is approved by HCA FacilitiGroup.

E. The condenser water return piping shall not be elevated above the cooling tower sump, prior to entering the condenser water pumps.

F. The BAS shall be programmed to accommodate user assignment of the order that the cooling towers are to be staged. The system shall be programmed to permit the user to designate any tower as being "Out of Service" without affecting the system's ability to stage the next tower in sequence.

1.17 Heating Systems

A. Each boiler shall be controlled by its unit mounted microprocessor based control system. The boilers shall be monitored by the BAS via the appropriate interface device. The use of technology and communications via BACnet MS/TP is the preferred method for monitoring of these systems. Any controlling points are to be hardwired.

B. Each boiler water level controller shall be interlocked with its respective boiler feed water pump to provide boiler feed water and maintain acceptable boiler water level. Feed water shall have full modulating control using a modulating feed water control valve.

C. The deaerator shall be controlled by its self-contained control system. The deaerator alarms are to be monitored by the BAS. The use of technology and communications via BACnet MS/TP is the preferred method for monitoring of these systems.

D. Converter/heat exchanger control valves are modulated in sequence by the BAS to maintain leaving hot water temperature as sensed by the leaving water temperature sensor. The converter/heat exchanger control valve shall not open unless the hot water pump is energized. The leaving water temperature set point shall be reset using a reset schedule based on outside air temperature.

E. Hot water is preferred for preheat. Consideration shall be given to using appropriate methods (air blenders, dedicated preheat coil circulating pumps, etc.) to preclude water freezing in the preheat coil in climates where extremely cold air is encountered.

F. Combustion air shall be heated to maintain the room air temperature adjacent to equipment and water piping above 50°F.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

SECTION III: PATIENT ROOMS

1.1 Air conditioning system choices for patient rooms, by order of preference are:

A. Medium pressure, variable air volume with reheat where allowed by the AHJ and pressure relationships are maintained. Variable volume terminal units shall be pressure independent type.

B. Medium pressure, constant volume, terminal reheat. Terminal boxes shall be pressure independent type.

1.2 Patient room return air grilles for ducted systems shall be located in the ceiling at the outside wall. All air systems shall be designed to return as much air as possible, 70% minimum target.

1.3 Toilet rooms shall be exhausted.

1.4 HVAC system produced sound levels shall not exceed the NC specified in Section I.

SECTION IV: SURGERY (ORs)

1.1 For any new construction project or renovation to an operating room, the design engineer is to consult FacilitiGroup prior to establishing the initial scope and budget.

1.2 Operating Rooms (ORs) should be served by a dedicated air handling system(s). This requirement applies for new construction projects and major renovations involving significant replacement of ductwork, as practical. If the design team determines a separate air handler serving the ORs is not practical, the FacilitiGroup Engineer needs to be contacted for guidance.

1.3 In OR suites with dedicated AHUs, provide supply and return tracking pair medium pressure air valves with reheat in supply valve to serve ORs. Valves to be to be Phoenix Theris, Siemens Venturi, Price VVA, or Triatek. Use direct digital controls (DDC) on terminal boxes for OR and recovery areas. Where permitted by AHJ, use DDC controls on terminal boxes to reduce airflow during unoccupied periods (refer to Section 23 09 13).

1.4 Where air valves are provided on the supply and return systems, all terminal boxes shall be venturi-type air valves. No grilles shall be connected directly to the trunk without an air valve between. This applies to all miscellaneous rooms and corridors served by the common air system.

~~1.5~~ In OR suites without a dedicated AHU, provide VAV boxes in lieu of air valves on the supply duct to maintain a constant airflow during occupied operational mode. Where permitted by the AHJ, use DDC controls to reduce airflow during unoccupied periods (refer to Section 23 09 13). To maintain a positive pressure relationship between the operating room and the corridor with reduced supply airflow, the preferred

Formatted: +bodytext, No bullets or numbering method is to use a single modulating damper (2-position) in the return duct. The damper is to be located in the ceiling of the sterile corridor outside the operating room for ease of maintenance access and as close to the main trunk for sound attenuation.

~~1.6~~1.5 Where allowed by the AHJ, each OR should be designed such that, during unoccupied mode, the total room airflow is reduced as much as possible while maintaining the code-required minimum ventilation and positive pressure relationship with the sterile corridor. Care must be taken to spell out in the design documents and to confirm during commissioning that the ORs maintain positive pressure, even during transition from one mode to the next. That means closing off the return air damper or air valve before the supply terminal turns down and opening up the supply VAV or air valve before the return opens up.

~~1.7~~1.6 It is also the preference that during unoccupied mode, the OR temperature be allowed to float within the limits allowed by code, while humidity stays in check. The design engineer should take care to limit reheat during unoccupied mode except as required to maintain space minimum temperature or for humidity control. Provide BAS temperature and humidity sensors in each OR and recovery room for monitoring of space temperature and humidity via DDC system. For air valves with stand-alone control systems, the preferred method for control is for the BAS to monitor space temperature and humidity and to modulate the hot water reheat coil valve accordingly. The BAS is also to pass the airflow volume setpoint to the valve control system and to monitor the actual airflow returned from the control system.

~~1.8~~1.7 HVAC system produced sound levels shall not exceed the NC specified in Section I.

~~1.9~~1.8 Design ORs to operate down to 62°F at 50% RH. Use a minimum of 25 air changes per hour (ACH) for all ORs. If the number of ORs involved in a project is limited and/or the difficulty and expense involved in attaining a 62°F/50% RH OR are excessive, review these conditions with HCA Design and Construction to determine required OR design temperatures.

~~1.10~~1.9 Apply low temp chillers (preferred method), DX coils, desiccant wheels, or 100% outside air pre-treatment units as appropriate to minimize energy being consumed to produce the 62°F/50% RH OR environment. To minimize the quantity of low temperature air being produced to condition ORs, use separate air handling equipment (not the AHU(s) serving the ORs) for conditioning support areas around ORs (e.g. sterile corridors, sub-sterile areas, sterile storage and the like). Utilize control strategies to minimize the operation of desiccant wheels and low temp chillers so they only operate when required to maintain humidity levels below 60% RH. When using low temperature chillers the preferred method is to only use the low temp coil in the outside air stream. When utilizing a desiccant technology with AHUs, specify an air measuring device in the outside air stream. Where allowed by applicable code, eliminate airside economizer.

~~1.11~~1.10 OR air supply diffusers shall be with 24″ x 48″ laminar flowdiffusers, Titus, Anemostat, Price or Precision Air, at a maximum of 200 CFM per diffuser, located as near to the center of the room as possible. When codes require supply air to be filtered via HEPA filters prior to entering the OR, locate 90% (Merv 14) efficient filters at air handling unit discharge and utilize HEPA filter grilles in only those ORs requiring HEPA filtration.

~~1.12~~1.11 Do not locate terminal boxes or control dampers above OR ceilings. Where possible, boxes and other maintenance items should be in the corridors.

~~1.13~~1.12 Use either a dedicated exhaust system or a SWAG (Scavenging Waste Anesthesia Gas) system for anesthesia evacuation.

~~1.14~~1.13 Provide smoke evacuation system per NFPA 99, unless the AHJ does not require it (such as in Florida).

~~1.15~~1.14 To facilitate the rapid warming of OR’s after certain procedures, design for a minimum 95°F discharge temperature off the reheat coil at the design air handler discharge air temperature and the minimum reset heating hot water temperature. A separate heat exchanger system is preferred for OR suites so the remainder of the facility can reset the heating hot water temperature without effecting the OR suite.

~~1.16~~1.15 Specify differential pressure monitors on OR rooms. The differential pressure switches shall be inter-locked with the door switches to only alarm if it is less than .01″w.c. positive pressure with all OR doors closed. When an alarm condition exists a red light shall be displays and a signal shall activate an alarm in the BAS.

SECTION V: CENTRAL SUPPLY

1.1 Provide steam piping of the pressure required by HCA-furnished equipment. Size steam piping for the instantaneous peak rather than the average usage.

1.2 Locate aluminum exhaust (or return) grilles above sterilizer doors to capture the steam plume generated when sterilizer doors are opened.

1.3 Ventilate ethylene oxide sterilizers with a dedicated exhaust fan on emergency power.

1.4 A central instrument air system will be required for most hospitals. Provide compressed air where required for sterilizer equipment by connecting to the instrument air system.

1.5 Ventilate the sterilizer equipment room with outside air to maintain space temperature control in non-coastal areas and where exterior walls and roof are in close proximity. Where these conditions do not exist, conditioned air may be used to maintain space temperature and humidity at reasonable levels.

1.6 Return condensate from equipment in central sterile areas provided the condensate is recommended as suitable by the equipment manufacturer for return, and the condensate return piping is readily accessible, or the cost to extend the condensate return system is not excessive. The intent is to reduce operational costs associated with boiler make-up water, boiler chemicals, and sewage costs associated with cooling down and wasting condensate to drain. Coordinate with central sterile equipment provider which items of equipment are to be equipped with the condensate return option.

SECTION VI: ISOLATION ROOMS

1.1 HVAC system produced sound levels shall not exceed the NC specified in Section I.

1.2 Ceiling exhaust grille over head of bed is preferred standard where allowed by AHJ. In this case, air valves are NOT required to maintain pressure relationship.

1.3 If required by AHJ, use low wall exhaust that draws across the patient and away from the door and worker. Use perforated diffusers because of the relatively high airflows.

1.4 Where low wall exhaust is required, terminal units are required. Terminal units are to be tracking pair medium pressure terminal units with reheat to be Phoenix Theris, Siemens Venturi, Price VVA, or Triatek. Air valves to be controlled by manufacturer control system that reports all inputs and output to BAS. If there is only one room served by the exhaust fan the exhaust valve can be eliminated.

1.5 Dedicated exhaust fans are to be labeled biohazard and be placed on emergency power. The fans shall use an up-blast discharge at 10′ above the roof. Locate exhaust fans to avoid re-entrainment of exhaust air back into the facility.

1.6 Provide differential pressure monitors/alarms with contacts and door switches that are monitored by the BAS to indicate an alarm condition in the event pressure rises above set point (-0.01″ w.c. minimum) when the door is closed. Provide a short delay to avoid nuisance alarms while room pressure adjusts upon door closure.

1.7 Coordinate with the architect room enclosure sealing methods such as specifying non-vented light fixtures, sealing electric back boxes and custom seals between the leafs and the bottom of the sliding doors. For hinged doors, guillotine type sweeps are required to pull contaminants into the room rather than pushing out.

1.8 At each room, provide local visual and audible indication of differential pressure and an alarm with readout display of actual differential pressure.

SECTION VII: ENDOSCOPY AND BRONCHOSCOPY ROOMS

1.1 HVAC system produced sound levels shall not exceed the NC specified in Section I.

1.2 If required by AHJ, use low wall exhaust that draws across the patient and away from the door and worker. Use perforated diffusers because of the relatively high airflows.

1.3 Terminal units are to be tracking pair medium pressure terminal units with reheat to be Phoenix Theris, Siemens Venturi, Price VVA, or Triatek. Air valves to be controlled by manufacturer control system that reports all inputs and output to BAS. If there is only one room served by the exhaust fan the exhaust valve can be eliminated. Bronchoscopy rooms and Endoscopy rooms used shall have 12 ACH minimum and shall be under negative pressure relationship where permitted by AHJ.

1.4 Dedicated exhaust fans are to be labeled biohazard and be placed on emergency power. The fans shall use an up-blast discharge at 10′ above the roof. Locate exhaust fans to avoid re-entrainment of exhaust air back into the facility.

1.5 Provide differential pressure monitors/alarms with contacts and door switches that are monitored by the BAS to indicate an alarm condition in the event pressure rises above set point (-0.01″ w.c. minimum) when the door is closed. Provide a short delay to avoid nuisance alarms while room pressure adjusts upon door closure.

1.6 Coordinate with the architect room enclosure sealing methods such as specifying non-vented light fixtures, sealing electric back boxes and custom seals between the leafs and the bottom of the sliding doors. For hinged doors, guillotine type sweeps are required to pull contaminants into the room rather than pushing out.

1.7 At each room, provide local visual and audible indication of differential pressure and an alarm with readout display of actual differential pressure.

SECTION VIII: RADIOLOGY

1.1 HVAC system produced sound levels shall not exceed the NC specified in Section I.

1.2 Using emergency power for cooling of Imaging Room is generally not necessary. Consult HCA FacilitiGroup for special cases (E.R. imaging).

SECTION IX: OB, DELIVERY, LDRPS

1.1 HVAC system produced sound levels shall not exceed the NC specified in Section I.

1.2 LDRPs shall be designed with not less than the minimum ACH required by the AHJ.

1.3 C-Section rooms shall be designed similar to operating rooms without dedicated AHUs using a minimum of 25 ACH. The preferred design is for VAV type boxes on the supply and modulating dampers on the return. Tracking pair air valves are not required. Unoccupied airflow set back similar to OR's shall be implemented where permitted by the AHJ.

1.4 C-Section rooms shall be designed to maintain 62 degrees and 50% RH. Duct-mounted sub-cooling coils are acceptable to condition these rooms independently of the other spaces on the system.

SECTION X: LABORATORY

1.1 Laboratory areas served by dedicated AHU system: It may be acceptable to return air to a dedicated laboratory AHU system. Verify requirements with laboratory director and local AHJ. Identify specific areas requiring exhaust with laboratory director and local AHJ. Exhaust area per FGI Guidelines.

1.2 Laboratories served by AHU system which also serves other areas: Laboratory air, from air handling systems which serve areas other than laboratories, shall be 100% exhausted. As required by NFPA 99, do not return air from any portion of the lab.

1.3 HVAC system produced sound levels shall not exceed the NC specified in Section I.

1.4 Locate exhausts over blood banks or refrigerators to reduce heat input to the space.

SECTION XI: PHYSICAL THERAPY & HYDROTHERAPY

1.1 Provide exhaust at whole body therapy tubs.

1.2 HVAC system produced sound levels shall not exceed the NC specified in Section I.

SECTION XII: EQUIPMENT ROOMS

1.1 Electrical switchgear rooms shall be air conditioned to 80°F. Telephone equipment rooms, data/com, and elevator equipment rooms shall be air conditioned to 75°F. VAV or dedicated fan coil units are acceptable. Cooling must be available year round with the preferred system being chilled water with economizer. DX is acceptable if chilled water is unavailable. Cooling of telephone rooms shall be on emergency power. If elevator equipment is served by emergency power, then the cooling or ventilating systems serving those rooms shall also be on emergency power.

1.2 For new construction, provide a separate room to house the clinical air compressor and vacuum pump. Air condition the room in accordance with manufacturer's standards. For existing/renovation project, provide air-conditioned rooms with vacuum pumps and medical air compressors if equipment can be practically separated from other equipment. A/C equipment shall be on emergency power.

1.3 Equipment rooms shall be designed to allow sufficient space for maintenance of equipment. Rooms shall be sufficiently sized to permit return air fans to operate without the addition of air baffles as well as allow for the installation of air blender sections in necessary to avoid freeze stat shutdowns on AHU's. Minimum head room for service access aisles shall be 6′ 6″

1.4 Provide sufficient clearances for equipment access and maintenance. Provide for tube and coil pull areas for:

A. Chiller condensers and evaporators.

B. Shell and tube heat exchangers.

C. AHU coils.

D. Boilers.

1.5 Maintain NEC required service areas for electrical equipment.

1.6 Provide any code required or service required clearances over equipment.

1.7 Do not ventilate AHU equipment rooms using untreated outside air. Use conditioned supply air.

1.8 In accordance with ASHRAE 15 and current model building codes, locate chillers and associated pumps in a separate room from other equipment such as boilers, heat exchangers, and plumbing equipment. Provide for emergency ventilation of the chiller room in accordance with ASHRAE 15. When determining the required cooling capacity, consider heat gains from open drive chiller motors, VFDs, pump motor inefficiencies, walls and roofs.

1.9 Particular attention shall be paid to noise and vibration control. The extent of sound and vibration control efforts shall be a function of the sensitivity of spaces adjacent to the equipment rooms, whether above, below, or on the same level. For critical applications, AHU's and return fans shall have a maximum noise control (NC) level specified for both breakout sound level and for sound radiated to the space.

1.10 Limit duct velocities to minimize duct noise.

1.11 The following sound and vibration control items shall be considered:

A. Using substantial equipment room walls, i.e., block construction with filled cavities.
B. Using double walls for equipment rooms.
C. Thickening up floor slabs under and/or over equipment rooms.
D. Sound treatment of the equipment room walls and/or ceiling or the ceiling below.
E. Using discharge air plenums on AHU's where the sound design criteria for adjacent spaces is NC 30-35 or lower.
F. Lagging the plenum (especially on rooftop units) with drywall or limp mass materials to reduce breakout noise.
G. Specifying sound attenuation in either or both supply and return ductwork (attenuators shall be AHJ approved).
H. Specifying a "quiet," NC AHU supply and/or return fan.
I. Use of more or better vibration isolators.
J. Relocation of the room or of the critical adjacent space.
K. Location of medium pressure mains or large trunk elbows away from areas sensitive to noise.
L. Use of fan wall or fan array technology AHU's. (If possible do not exceed 25 hp per motor). Provide a minimum of 2 VFDs per fan array (evaluate if a VFD per fan is a cost effective alternative.)

1.12 Equipment rooms shall not be used as AHU return, relief, or fresh air plenums.

1.13 Utilities that serve other areas shall not pass through electrical rooms.

1.14 Do not use drywall as an air plenum or chase enclosure. Drywall construction cannot be adequately sealed as an air conveying duct. Use sheet metal in all plenums and chases.

1.15 Coordinate closely with the facility's IT person as well as the HCA Corporate IT&S personnel to determine Data/Com room equipment cooling loads. Also, coordinate with corporate IT to determine if Data/Com room's cooling needs to be on emergency power.

1.16 In areas where design temperatures are below freezing when possible recirculate generator radiator exhaust to maintain room temperature by modulating a damper in the exhaust plenum.

EQUIPMENT AND SYSTEMS GUIDELINES - MECHANICAL

NOTE: Where CSI MF04 sections are not listed, HCA is electing at this time not to provide guidelines.

SECTION 23 05 00: COMMON WORK RESULTS FOR HVAC

Part 1 - General

1.1 Work Included:

A. Follow the shop drawing submittal procedure outlined in HCA's standard contracts with the architect and with the contractor.

B. The mechanical contractor is responsible to the general contractor for the shop drawing layout of the following rooms and details. Prior to construction, contractor shall submit shop drawings of the following to Design Engineer for review.

1. Concrete pads and foundations.
2. Equipment room layouts with actual equipment, piping and duct.
3. Roof layouts.
4. Trench locations and sizes.
5. Dimensioned floor drain locations.
6. Congested areas (i.e. above ceilings adjacent to powerhouse or equipment rooms, etc.).

C. Engineering Drawing Standards: Single-line drawings of duct and piping systems are satisfactory except for the following, which shall be double-lined:

1. All mechanical equipment rooms,
2. Main duct runs to and from air handling equipment rooms,
3. Ductwork and piping in congested areas,
4. Ductwork with widths 36″ and greater.

D. All equipment rooms shall be drawn to ¼″ = 1′ 0″ scale and all equipment rooms shall have a section drawn to show clearances, access spaces, relative heights of piping, main duct and outside air and relief louvers.

E. Record drawings shall be specified per the HCA standard contract with the architect and with the general contractor. The contractor shall maintain record drawings during course of project and give to Engineer for recording on CADD.

F. Design Engineer shall periodically monitor status of record drawings to ensure contractor is consistently annotating drawings as construction progresses.

G. Structural steel used for supporting equipment in fan plenums or outside shall be galvanized.

H. The mechanical contractor shall furnish wall and ceiling access panels to the general contractor for installation. Show final locations of panels on record drawings.

I. Valve tags are required for all emergency shutoff valves and all manual valves 1″ and larger. These shall be engraved brass tags hung from valves with minimum 1″ high lettering. Submit valve tag directory in close-out documents. Mark ceiling grid with colored marker indicating valve locations above the ceiling. Emergency shutoff valves shall include all valves 2″ and larger for the following services: domestic hot and cold water, chilled water, heating hot water, steam and steam condensate and natural gas

J. Refer to Section 09 90 00 in the Guidelines for painting and coating requirements.

K. Piping shall be stenciled or labeled at 20-foot intervals and at least once in each separate space through which the pipe passes.

L. Duct floor penetrations and plenum floor penetrations in mechanical equipment rooms shall have a minimum of 2″ curb.

M. CAV/VAV terminal units concealed above lay-in ceilings shall be marked by a marker clipped to the grid.

1.2 Sleeves:

A. Provide sleeves for piping passing through: Masonry walls and floors,

B. Penetration assemblies shall be provided to comply with the U.L. Fire Resistance Directory requirements for through wall penetrations. Designers shall specify penetration methods that meet the fire and temperature rating required by the building code. Fire barrier products shall be specified under Division 7. Penetration details shall be shown on the architectural drawings and shall be coordinated by the Design Engineer. Contractor shall submit details for approval under Division 7.

C. Floor sleeves in wet areas, including all mechanical equipment rooms, shall extend a minimum of 1″ above the floor to prevent water entrance to the sleeved hole. Vertical pipe supports must be extended to and be supported by the floor rather than the sleeve.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Where Trane chillers are to be demolished, the contractor shall document the model, serial number, tonnage, etc. of the chiller prior to demolition. The contractor shall document the model and serial number and all pertinent information of the chiller control panel and transmit that information to FacilitiGroup. The control panel shall be wrapped, boxed, and turned over to the facility.

3.2 Specify that the Controls Subcontractor shall be an active participant in the commissioning process as required by Section 01 91 13.

SECTION 23 05 13: ELECTRIC MOTORS FOR HVAC

Part 1 - General

1.1 Work Included:

A. Specify premium efficiency motors for all sizes from one horsepower and larger.

B. Use VFD-duty motors where a VFD controls the motor. Inverter-duty motor design shall include:

1. Spike-proof inverter motor such that voltage spikes will not damage motor insulation.
2. No distance restrictions between any inverter and motor - no carrier frequency limitations.
3. Motor design shall not require inverter power conditioning equipment to protect motor. Grounding rings on driven end of shaft are required on all motors with VFDs.
4. Motor must meet NEMA MG-1, Part 31, part H.
5. Provide inverter-duty motors with a 5-year warranty.

Part 2-Products

2.1 Acceptable Manufacturers: MagneTek/ Century, Lincoln, Marathon, Gould, Toshiba, Baldor, Reliance, US Motors, General Electric.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 05 23: GENERAL-DUTY VALVES FOR HVAC PIPING

Part 1 - General

1.1 Work Included: Service shut-off valves shall be located on supplies and returns at:

A. Each piece of equipment.

B. The base of vertical risers.

C. Each major section of piping, such as branches to a floor and major wings or sections on each floor including the first floor of the facility.

Part 2-Products

2.1 Acceptable Manufacturers:

A. Iron body valves: Kitz, Nibco, Crane, Grinnell, or Milwaukee.

B. Bronze body valves: Kitz, Nibco, Grinnell, Milwaukee, or Kennedy.

C. Butterfly valves: Kitz, Nibco, Crane, Centerline, Grinnell, Keystone or Hammond.

D. Ball valves: Kitz, Nibco, Apollo, Watts, Milwaukee, or Hammond.

E. In systems and locations where the uses of Victaulic fittings are allowed, the appropriate Victaulic valves are also permitted.

2.2 Provide clamp lock hand lever operators on valves less than 8″ . Provide hand wheel and closed housing worm gear on valves 8″ and larger.

2.3 Provide chain operators for all equipment room valves 4″ and larger which are located over 6′ 6″ above the finished floor that might operate on a regular schedule. Design Engineer shall designate which valves.

2.4 Shut off valves for water (HVAC and plumbing) piping 2″ and smaller shall be ball type and for 2½″ and larger shall be butterfly type.

2.5 Shut off valves for steam and condensate systems using valves 2″ and smaller shall be all bronze body ball valves and for 2½″ and up shall be iron body, bronze mounted (IBBM) gate valves. Valves 2½″ and larger for steam service shall be rated for minimum 150 psig steam. Steam bypass valves shall be globe type, bronze for 2″ and smaller and IBBM for 2½″ and larger.

Part 3 - Execution

3.1 All valves shall be installed to be accessible by maintenance personnel.

SECTION 23 05 48: VIBRATION AND SEISMIC CONTROLS FOR HVAC

Part 1 - General

1.1 Work Included:

A. Housekeeping pads shall be provided under all floor mounted mechanical equipment. Roof curbs and pads for AHUs shall be high enough (6″ to 10″ may be required) to allow sufficient height for the condensate drain trap.

B. Seismic isolation and protection shall be specified via performance basis by the Design Engineer. All materials including anchoring, pipe and duct hangers shall be engineered by a registered professional engineer in the State of the project. Isolation vendor shall include design costs with the equipment costs. Submittals shall include details on all isolators, anchorage, hangers, sway bracing, etc. for a complete system that is approved by State and local AHJ. Design Engineer shall include a performance specification and sufficient seismic details to convey scope of the seismic requirements to the contractor. The scope of work shall include a Certified Seismic Inspection Report prior to acceptance of the work.

Part 2-Products

2.1 Acceptable Manufacturers: Mason Industries, Kinetics Noise Control, Vibration Eliminator Co., Vibration Mountings & Controls, Inc., Korfund Co., Amber Booth, Vibro-Acoustics, or Hyspan.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 05 93: HVAC SYSTEMS TEST AND BALANCE

Part 1 - General

1.1 The TAB Contractor shall be a sub-contractor to the General Contractor and be financially independent from all other sub-contractors associated with the project.

1.2 The Mechanical Contractor shall coordinate his work with the TAB Contractor and correct any system deficiency identified in the General Contractor's and TAB Contractor's inspection.

1.3 Specify that TAB Contractor shall be an active participate in the commissioning process as specified in Section 01 91 13.

1.4 Balance air flows to following tolerances:

A. Supply diffuser: 0 to +10% of design

B. Return: +/- 5% of design

C. Exhaust: 0 to -10% of design

D. In all cases, maintain intended room pressurization with regard to adjacent spaces.

1.5 Balance water flows to following tolerances:

A. Pumps: 0 to +10% of design

B. Equipment (coils, heat exchangers, chillers, boilers): 0 to +5% of design

1.6 The TAB contractor shall compare the sum of the CAV/VAV box diffuser readings with the flow indicated by the box's controller prior to calibrating the box's controller. If the two readings agree within +/- 5%, the factory calibration factors shall not be changed. If the readings are not within +/-5%, a documented trouble shooting procedure consisting of checking and resolving the following shall be conducted prior to calibrating the controller to verify: (Refer to Tab 3 - Functional Performance Test Procedures)

A. Box size is per the approved submittal,

B. Manufacturer's gain/flow factor has been correctly entered into the controller,

C. Low pressure duct/connections are tight,

D. Velocity pressure connections at the box inlet and controller are tight and undamaged,

E. Static pressure at the box's inlet exceeds the minimum required, and

F. Box flow measuring device is undamaged.

1.7 This procedure and results for carrying out steps A-F above are to be retained by the Mechanical Contractor for delivery to the Owner/Design Engineer on request.

1.8 TAB contractor shall compile an Excel spreadsheet for all terminal boxes, listing each box by its unique identification number, the inlet flow area established by the box manufacturer, the manufacturer's gain factor for the box, final TAB calibrated gain factor for the box if field calibrated, and the ratio of the calibrated gain factor to the manufacturer's gain factor.

1.9 Require the TAB contractor to measure and include in the report the AHU supply and return fans' flow, rpm, hp, and sensed duct static pressure at the dirty differential pressure drop across both the pre-filter and final filter.

1.10 The test and balance specification shall require contractor to measure system performance with the pressure drop across filters at the value specified for dirty filters.

1.11 TAB shall show in their report all the individual velocity measurements from duct or AHU traverses in grid format.

1.12 The TAB report shall include a static profile of each AHU with the supply fan controlling to the minimum sensed duct static pressure necessary for the system terminal units to achieve maximum cooling design flow simultaneously. This static pressure shall be documented in the report and shall become the duct static pressure set point.

1.13 The TAB report shall record the VFD speed for all supply and return fan measurements included in the report.

1.14 The TAB Contractor shall measure the HVAC background noise level in all the spaces specified in Division 23: Mechanical, Section I: Mechanical General, 1.01F. The sound level shall be measured at the patient head location in patient in patient sleeping and therapy rooms. In all other rooms the sound level is to be measured at the approximate center of the room 48″ above floor level. The TAB report shall document the measure NC level for each space. The TAB report shall also include an NC curve for any space that exceeds the specified NC limit.

1.15 Where AHUs share a common outside air duct, relief duct, or louver, specify that the TAB contractor test those AHUs simultaneously in the 100% economizer mode with all boxes at 100% cooling to verify the supply duct static set point and the design supply/return air volume differential are maintained.

1.16 The TAB contractor shall verify building and space pressure relationships in all modes of operation.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 07 00: MECHANICAL SYSTEMS INSULATION

Part 1 - General
1.1 Work Included: All insulation, mastics and coverings shall meet 25/50 flame spread and smoke developed ratings.

Part 2-Products
2.1 Pipe Insulation:

A. Insulation thicknesses shall comply with the more stringent requirements of the latest edition of ASHRAE 90.1 or the locally adopted/enforced energy code.

B. For indoor chilled water piping, specify only closed-cell type insulation including cellular glass, phenolic, or flexible elastomeric. Use all service jacket (ASJ) in equipment rooms. Foam glass concealed above ceilings and within shafts does not need to be covered. Do not use factory pre-applied ASJ on foam glass. The pre-applied jacket prevents application of mastic on the longitudinal and circumferential joints.

C. For hot water, steam and steam condensate piping shall be insulated with molded fiberglass pipe insulation having ASJ finish. Do not use calcium silicate insulation. On piping larger than 2″ diameter support piping with high density insulation inserts (specifically manufactured for supporting piping) to prevent crushing of insulation. Do not allow wood blocks to be used as piping supports due to microbial growth risk. Length of piping support inserts, spacing between supports and the lengths and gauge of shields shall be per insulation insert manufacturer’s installation instructions.

D. Fittings on fiberglass pipe insulation shall be mitered insulation up to 2″ diameter and molded fittings for 2½″ and larger. All indoor fitting insulation shall be covered with a tight fitting PVC jacket.

E. Use foam glass on all outdoor piping with aluminum jacket on pipe and fittings.

F. Fittings on foam glass insulation shall be made up of mitered sections of foam glass.

G. Phenolic insulation as produced by Resolco, Inc. is an acceptable substitute for all pipe insulation.

2.2 Duct Insulation:

A. Duct insulation shall be flexible fiberglass blanket type with aluminum foil facing, where ductwork is installed in concealed locations (e.g. within shafts and above ceilings). The insulation is to be secured using outward clinching staples on ductwork up to 36″ wide and stick pins above 36″ wide. Seal staples and pins with mastic, not self-sealed tape.

B. Within building envelope, return ductwork within the facility is not to be insulated, except where specifically required by AHJ (such as S. Florida); however, it may be used for sound attenuation. Certain local modifications to the model building codes require all return ductwork to be insulated. For certain climate conditions, return ductwork located above ceiling directly below roof may need to be insulated to prevent excessive heat gain and to prevent condensation on ductwork.

C. Internal lining of ductwork is unacceptable.

Part 3 - Execution

3.1 Provide piping design that prevents pipe from freezing. Outside piping shall be heat traced in climates with ASHRAE winter design temperatures of 32°F and lower. Cooling tower and condenser piping 6″ and larger need only be insulated and heat traced where ASHRAE winter conditions are 25°F and below. Coordinate with Division 26.

3.2 Insulation on steam control valves, pressure reducing valves, calibrated balance valves and triple duty valves shall be provided with a manufactured removable insulation cover. Insulated covers shall be heavy canvas type, filled with insulating material and leather laces or straps to secure cover around valve or fitting.

3.3 Design and install insulation on pump casings and suction diffusers to be removable and replaceable without damaging insulation.

3.4 Design and install insulation on heat exchangers to be removable to allow access to the tubes and flanges.

SECTION 23 08 00: COMMISSIONING

Part 1 - General

1.1 Scope of Work:

A. Mechanical Contractor shall be an active participant in the commissioning process as specified in Section 01 91 13. (Refer to Appendix A - Commissioning Specifications to be included on all projects). The specification shall list the equipment/systems to be commissioned and include the Pre-functional Checklists and Functional Performance Tests to be used in the commissioning process. The PFCs and FPTs included in the tabs are example forms. The forms included in the project manual need to be modified to reflect the equipment that is to be installed and the sequence of operations in the construction documents.

B. Include Functional Performance Tests and Functional Performance Verification Tests in the overall project construction schedule.

C. General Contractor shall have reviewed the work required by this Section with the Controls and TAB subcontractors prior to awarding the work.

D. CX agent to verify with HCA Corporate FacilitiGroup Energy Service Center full BAS communication between the facility and ESC.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 09 13: BUILDING AUTOMATION SYSTEM AND DIRECT DIGITAL CONTROL

Part 1 - General

1.1 The BAS/DDC shall use BACNet/IP protocol capable of communicating over an Ethernet system. It shall be capable of residing on the HCA Enterprise WAN/LAN by having an assigned IP address. BAS/DDC systems are required to permit a remote user with password access, monitor points and issue basic commands over the HCA WAN/LAN using a PC type terminal without the need for proprietary BAS/DDC software. The system database shall reside on an owner-furnished server, not a PC. The user interface is to be installed on an owner-furnished workstation. Controls contractor to coordinate and verify with HCA Corporate FacilitiGroup Energy Service Center full BAS communication between the facility and ESC.

1.2 For renovations or expansions in facilities where pneumatic controls are existing, regardless of extent, new controls are never to be pneumatic without the express written consent of FacilitiGroup.

1.3 Locations of humidity sensors and pressure monitors for critical spaces shall be in accordance with HCA Critical Space Sensor Requirements Table below:

HCA Critical Space Sensor Requirements Table		
Room Type	**Humidity Sensor**	**Pressure Monitors**
Operating Rooms	X	X
C-Section Rooms	X	X
Isolation Rooms		X
Bronc/Endo Rooms		X
Cath Labs	X	X
Central Sterile - Decontamination		X
Central Sterile - Clean Workroom	X	X
Central Sterile - Sterile Supply	X	X
Newborne ICU	X	X
Positive Protective Environmental Rooms		X
Nuclear Medicine		X
Laboratory Suite Boundaries		X
Pharmacy Suite Boundaries		X
USP 797 Compounding Areas	X	X

Part 2-Products

2.1 Work Included:

A. Specify that the Controls Subcontractor shall furnish the test and balance Contractor with the appropriate DDC system software available to assist in the test and balance process.

B. Require that the Controls Subcontractor provide a technician for 8 hours to assist/train the TAB technician in the coordination/ interface of the BAS with the TAB activities.

C. During submittal process, Architect / Design Engineer shall submit a copy of the complete BAS/DDC submittal including design team comments to HCA Engineering FacilitiGroup, 6100 Tower Circle, Suite 400, Franklin, TN 37067.

D. Specify that the Controls Subcontractor shall be an active participant in the commissioning process as required by Section 01 91 13.

E. Section II: Guidelines for HVAC Controls shall be consulted in specifying the BAS equipment and sequences of operation.

F. Include air flow measurement on all AHU systems even if air flow is not directly used for AHU control. Specify Piezometer ring air measurement systems for AHUs and return air fans. Alternate means of air flow measurement systems shall not be used without specific project approval by HCA FacilitiGroup.

G. Design Engineer shall show the location of all duct mounted static pressure probes on the mechanical construction drawings for all VAV & CAV systems.

H. Operating Rooms & C-Section Rooms:

1. Each operating and C-section room shall have a temperature and humidity transmitter connected to the BAS for continuous readout of room temperature and humidity and set to alarm below 30% RH (adj.) and above 60% RH (adj.).
2. Provide differential pressure monitor with display between each OR and C-section Room and the adjacent corridor so staff can verify proper space pressurization. Pressure transmitter shall send an alarm to the BAS in the event OR pressure becomes negative or excessively positive.
3. Where AHJ permits, design OR and C-Section DDC box controls with sequences to reduce air flow to 25% - 30% of maximum (based on heat load requirements) to space during unoccupied periods. Provide design to maintain a minimum airflow and positive space pressurization during unoccupied mode and transitions between modes.
4. Air valves are to be controlled by manufacturer control system that reports all inputs and outputs to BAS. The preferred method for control is for the BAS to monitor space temperature and humidity and to modulate the hot water reheat coil valve accordingly. The BAS is also to pass the airflow volume setpoint to the valve control system and to monitor the actual airflow returned from the control system.
5. The unoccupied mode periods for the weekend and week days are to be User defined in the BAS. Provide an unoccupied mode override with 3-hour timer at the Nurse Station. For OR and C-Section spaces served by two terminal units, use the controller signal output of a single terminal unit to control both of the terminal units' reheat coils. This is to prevent the terminal units from separately heating and cooling simultaneously.

I. Specify a BAS paging and email feature with the capability to telephone/email selected facility maintenance personnel to notify them of critical BAS alarms.

J. For large spaces with multiple terminal boxes, use a single thermostat to control the boxes.

K. Differential pressure switches shall be installed across all filters and connected to the BAS.

L. Specify that all CAV/VAV Terminal Box Controller parameters be mapped to the front end.

M. Coordinate with HCA IT&S and specify that the BAS utilize the facility's Ethernet LAN to the extent possible to avoid duplicating LAN wiring.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

N. Specify that the BAS shall be connected to the facility LAN and shall permit an unlimited number of simultaneous users to access the system over the LAN, and to (based on password level) monitor parameters, change set points, set up trends, or start/stop controlled equipment.

   1. A remote user shall have this capability without having the system database loaded on his/her remote computer.
   2. Connection by remote Energy Management system shall be accommodated by allowing polling of BAS parameters over BACnet IP.

O. Specify characterized ball type valves for the reheat coil control valves. These valves shall have fully modulating electronic actuators. Actuators shall be proportional and accept a 0 – 10 vdc or 0 – 20 mA control signal. Do not use pulse or tri-mode controllers/actuators. Experience has shown it is impossible to properly span the ball valve with a pulsed controller/actuator. The controller's output to the actuator shall be capable of being spanned to compensate for the two stem travel ranges, 0 – 20% open and 85 – 100% open, where the typical ball valves exhibits no change in flow with stem travel. The preferred method for controlling the zone temperature is by implementing two PID loops, one with the zone temperature as the input and the second one with the box DAT as input (similar to the JCI VMA1620 box controller dual PID loop control). It is recommended that reheat systems are tuned such that steady state control of the space temperature at set point shall occur with a variation of less than 20°F in the temperature of the air supplied to the space.

P. Spaces with one thermostat serving multiple terminal reheat boxes shall have all reheat valves controlled by a master box's controller.

Q. Design for a discharge air temperature sensor on each terminal unit. (Do not accept deletion of sensors as a value engineering option.)

R. Specify a UPS with 15 minutes backup for all building level and field equipment level controllers except controllers on terminal units not serving critical spaces

S. Main electrical feed, emergency generators, ATSs, and chillers shall be furnished with metering as described in Appendix F - Energy and Resource Metering.

2.2 Acceptable Manufacturers: Johnson Controls (JCI) Metasys (Facility Explorer is not acceptable), Siemens Apogee, or Schneider Electric StruxureWare Platform as follows. ~~.~~(Refer to latest revision of Innovation Memo #13 for further details.):

A. Johnson Controls shall be used on all projects on which the existing BAS is a Johnson Control System and on all new construction in which the new building is not associated with an acute care hospital that has either a Siemens or Schneider Electric (or associated legacy brand, see below) installed.

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B. Siemens shall be used on all projects on which the existing BAS is a Siemens System and on all new construction in which the new building is associated with an acute care hospital that has a Siemens system installed.

C. Schneider Electric shall be used on all projects on which the existing BAS is a Schneider, Andover Infinity, Andover Continuum, Inet, Invensys, or TAC system and on all new construction in which the new building is associated with an acute care hospital that has a Schneider system installed. In the case of new construction being associated with a Schneider Electric legacy system please contact HCA FacilitiGroup for guidance.

~~2.2~~

~~A.~~D. Alternates: A different vendor on existing hospitals may be considered for continuity and shall require HCA FacilitiGroup approval.

2.3 Input Devices

A. Outside air temperature and humidity transmitters

1. Humidity Measurement:

   a. Accuracy [relative humidity range (5 -95%), temperature range (0-180°F)]: +/-2%
   b. Repeatability: +/-0.5% RH
   c. Operating Pressure: Ambient +/- 20″ w.c.
   d. Operating Environment (Electronics): -20°F to 160°F
   e. Operating Environment (Probe): -20°F to 180°F
   f. Stability: +/-1% RH at 50% RH in 5 years

2. Temperature Measurement:

   a. Sensing element: 1000 Ohm platinum RTD, 2-wire.
   b. Accuracy: +/-0.3°F
   c. Sensor Stability: <0.1°F in 5 years

B. Duct mounted temperature and humidity transmitters

1. Humidity Measurement:

   a. Accuracy [relative humidity range (5% -95%), temperature range 59°F - 95°F)]: +/- 3%
   b. Repeatability: +/-0.5% RH
   c. Operating Pressure: Ambient
   d. Operating Environment: 32°F - 122°F and 0-95% RH (non-condensing)
   e. Stability: +/-1% RH at 50% RH in 5 years

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2. Temperature Measurement:
   a. Sensing element: 1000 Ohm platinum RTD, 2-wire.
   b. Accuracy: +/-0.3°F
   c. Sensor Stability: <0.1°F in 5 years
3. Averaging Temperature Measurement (Mixed Air, leaving preheat coil, and discharge air temperature):
   a. Sensing element: capillary tube
   b. Accuracy: +/-0.3°F
   c. Required length for mixed air temperature: 1 linear foot of element per sq. ft. of cross-section area. Specify a single element of sufficient length to provide the required coverage.

C. Freeze-stat (Low Limit Binary): Length shall be 1 linear foot of element per sq. ft. of coil face area.

D. Duct Static Pressure Measurement
1. Duct mounted static pressure probes
   a. Acceptable Manufacturers: Setra, Air Monitor Corp, Paragon Controls (PE-5000).
   b. Materials: 6063-T5 Anodized Aluminum
   c. Accuracy (Velocity>600 FPM): <2%
   d. Temperature Range: 350°F Continuous
   e. Humidity Range: 0-100% RH Continuous
2. Differential Pressure Transducer – VAV/ CAV Box
   a. Acceptable Manufacturers: JCI, Setra
   b. Pressure Range: 0 to 1.5″ w.c.
   c. Overpressure Limit: 1 psi
   d. Full Scale Accuracy:
      i. Linearity: +/- 0.008″ w.c. maximum for pressures equal to or less than 1.0″ w.c.
      ii. Repeatability/Hysteresis:
3. +/-0.00075″ w.c. maximum
      i. Stability (one year): Zero shift +/-0.01″ w.c. , Span shift +/-0.01″ w.c., both maximum
      ii. Temperature Effects: Zero +/-0.0004″ w.c., Span +/-0.0004″ w.c., both max. per °F

iii. Position Effects: Zero Shift +/-0.1 VDC, max., Span Shift: +/-0.05 VDC max.

E. Airflow measurement:

1. Fan Inlet, Piezometer sensing rings are preferred for fan air flow measurement.

a. Probes (use probes only as a last resort):

i. Acceptable Manufacturers:

1. Paragon Controls Incorporated

ii. Materials: 6063-T5 Anodized Aluminum. Use 316 SS in 100% outside air systems in coastal areas (up to 60 miles from the coast).

iii. Accuracy (Velocity>600 FPM): <2%

iv. Temperature Range: 350°F Continuous

v. Humidity Range: 0-100% RH Continuous

b. Transducer/Transmitter for piezometer ring and fan inlet probes:

i. Acceptable Manufacturers: Paragon Controls Incorporated MicroTrans model, Air Monitor Inc Veltron model.

ii. For arrays having four fans or more: Paragon Controls Incorporated FAATS-1000 with one transducer per array.

iii. Full Scale Accuracy Data @ 70°F:

1. Accuracy: +/- 0.25% Full Scale

2. Terminal point non-linearity: +/-0.2%

3. Hysteresis: +/-0.02%

4. Non-repeatability: +/-0.03%

5. Temperature effect: +/- 0.15% Full Scale/°F

iv. The transmitter shall locally display the measured air velocity/volume in FPM & CFM.

v. The transmitter shall accept local user input and shall display the flow area, calibration factor and the temperature used to determine the air density.

F. Room Differential Pressure Monitors

1. Acceptable Manufacturers: TSI PresSura, Accutrol, Siemens, Setra.

2. Range: -0.2000″ to +0.2000″ w.c.

3. Resolution: 5% of reading.

4. Accuracy: +/- 10% of reading +/-0.0000″ w.c.
5. Display update: 0.5 seconds
6. Alarm contacts: Contacts close in alarm conditions.
7. Analog Output: 0-10 VDC or 4-20 mA
8. Ability to accept pressure measurement from two rooms.
9. RS-485 communication capability for interface with Facility Management System.

G. Current Sensing Relays

1. Acceptable Manufacturer: Hawkeye Model 908 or approved equivalent
2. Current sensor shall be induce powered from the monitored load and shall have an adjustable operating range from 2.5 - 135 A. Visual indicators (LED's) shall indicate output status and sensor power. Adjustable trip set point to +/- 1%. Current sensor output shall be N.O., solid state, 0.1A @ 30 VAC/DC. Note: Current sensing relays must be sensitive enough to detect and alarm when a fan motor is operating without a belt or a pump motor is operating without flow: otherwise, differential pressure transducers/switches should be specified to monitor equipment status.

H. Water Flow Meters

1. As specified in the Appendix F - Energy and Resource Metering.

I. BTU Meter

1. As specified in the Appendix F - Energy and Resource Metering.

2.4 Output Devices

A. Control Valves

1. Contractor shall submit valve schedule including but not limited to the following information:
   a. Line size
   b. Valve inlet size
   c. Design flow
   d. Cv
   e. Pressure drop through coil
   f. Valve authority

SECTION 23 10 00: FACILITY FUEL SYSTEMS

Part 1 - General

1.1 Work Included: Size fuel oil tank(s) for at least 48 hours fuel supply at 80% full load for each emergency generator and boiler, excluding standby boiler. Confirm required fuel oil capacity with the AHJ. Requirements for coastal areas (up to 60 miles from the coast) and seismic zones may require more capacity. In certain locations, the supply tank piping serving the boilers must be arranged in a manner that precludes the boilers from using the fuel required to satisfy the emergency generator's requirement. Above ground tanks are preferred unless it is not possible due to site limitations.

Part 2-Products

2.1 Underground fuel oil tanks: Acceptable Manufacturers: Xerxes, Owens Corning

2.2 Tank Trim: Acceptable Manufacturers: OPW, Universal

2.3 Underground fuel oil piping: Smith Fiberglass, Centron Corp., Ameron-Bonds

2.4 Fuel Monitoring Systems: Refer to section 28.34.00 for requirements related to fuel oil detection and alarm system.

2.5 Fuel Oil Pumps: Acceptable Manufacturers: Roper, Viking, Webster.

2.6 Above-ground storage tank (AST):

A. Above-ground Storage Tanks: Convault, Ecovault, Park Equipment Super Vault.

B. Primary tank shall be continuously welded (interior and exterior) steel. An exterior, 6″ thick, continuous, homogeneous, 4000 psi, monolithic reinforced concrete vault shall totally enclose the secondary containment and tank system, except for penetrating appurtenances for the tank at the top, and shall have no cold joints or heat sinks on bottom and sides

C. Tank shall be a UL listed 142 primary steel tank and shall have a UL listed overfill containment system integral with the tank system. Overfill containment reservoir shall have a normally closed UL listed drain port into the primary tank. Minimum overfill storage volume shall be 7 US gallons.

Part 3 - Execution

3.1 Refer to section 28.34.00 for requirements related to fuel oil detection and alarm system. Contact local propane supplier for propane tank and fill system requirements.

3.2 Install propane systems in accordance with all State and local code requirements. The propane supply to the boiler pilot light shall be permanently piped to propane tank storage location.

SECTION 23 20 00: HVAC PIPING

Part 1 - General

1.1 Submittals: Pipe and fittings of foreign manufacture may be used, but the Design Engineer shall require certification that they meet ASTM/ANSI standards.

Part 2-Products

2.1 Above-ground Piping Systems:

A. Chilled water and heating hot water may be all standard weight black steel or a mixture of Type L hard copper for piping 1″ and less, steel or copper pipe from 1-1/4″ to 2″, and steel for piping 2-1/2″ and larger. Condenser water shall be standard weight black steel.

B. Steam piping shall be standard weight black steel. Steam condensate and pumped condensate return piping shall be schedule 80 black steel. Piping for steam and steam condensate shall be seamless; other piping may be electric-resistance welded.

C. Type L soft copper may be used for run-outs to room terminals.

D. Chemical feed lines shall be Schedule 80 PVC for cooling towers and Schedule 10 stainless steel for boilers.

E. Dielectric fittings shall be used between steel and copper piping.

F. Weld-o-lets and Thread-o-lets are acceptable. Stab-in welded piping is not. T-drill branch tee connections shall not be allowed for HVAC piping.

G. Cooling tower bleed and sump drain connections shall be shown, sized and detailed. Towers shall be isolated to permit shutdown and cleaning where mechanical cooling is required all twelve months. (Refer to Tab 12 – Standard Drawing Details).

H. For chilled water, heating hot water and condenser water piping, specify only welded steel piping. Victaulic's "Pressfit" shall not be used for any HVAC piping. The use of grooved fittings, in lieu of welded, on HVAC piping may be considered in renovation projects to reduce hazard from welding in occupied areas, except grooved fittings may not be used on hot water heating piping. When used, grooved piping shall be rolled grooved with zero flex couplings. The use of Victaulic couplings shall not be used for piping in new areas where welding can occur without impacting the hospital or patient care environment. Victaulic couplings are acceptable in mechanical rooms where engineer deems it acceptable. A Victaulic factory trained employee shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.

2.2 Gasket Materials:

A. Steam service: Flexitallic Style CG, TEADIT Style 913, Garlock Flexseal Style RW, Lamons SpiraSeal Style WR, or Leader Style LG-13.

B. Chilled water, condenser water, steam condensate, and heating hot water: Style IFG 5507 as manufactured by Garlock or approved equivalent.

C. Refrigerants: Style IFG 5500 as manufactured by Garlock or approved equivalent.

2.3 Underground piping systems, where required, shall be analyzed considering first cost, life expectancy, dampness of the soil and accessibility. The decision shall be made by HCA Design and Construction.

2.4 Aquatherm Faser Blue Pipe systems are an acceptable substitute for chilled water, heating hot water, and condenser water piping. Verify acceptance with AHJ and insulate as needed with consideration given to pipe R-value. Pipe exposed outdoors should be Aquatherm UV piping with an outer coating of black polyethylene.

2.5 ProPress piping systems by Viega are an acceptable VE for chilled water, heating hot water, and condenser water piping. The VE must accompany a 50 year parts warranty, and 5 year labor and consequential damages from the contractor and manufacturer. The cost savings will be evaluated to determine if this will be accepted.

Part 3 - Execution

3.1 Prior to hanging, welding or soldering of piping systems, clean and clear each individual section of pipe of all mud, dirt, shavings, fillings, debris, paper, leaves and other foreign material.

3.2 After installation, piping shall be flushed and tested as specified in Section 23 25 00 – Chemical Water Treatment.

SECTION 23 21 16: HYDRONIC PIPING SPECIALTIES

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Bladder type expansion tanks are preferred. Size and pipe per manufacturer's recommendations.

2.2 Air separators are required on hot water systems and on chilled water systems. Where possible air separators shall be full flow.

2.3 Each end-suction pump shall have a suction diffuser at its intake (except condenser water pumps). Suction diffusers shall be sized by the Design Engineer by pressure drop, and the design maximum pressure drop shall be scheduled. If cooling tower is located on the ground, strainers for condenser water pumps should be located on discharge side at pump.

2.4 Pressure gauges in central plants (chiller rooms) shall be glycerin-filled, ½% accuracy. Other gauges shall be 2% accuracy. Provide gauges across chillers (cooler and condenser), pumps, and AHU coils.

2.5 Avoid mercury or other liquid filled glass tube thermometers.

2.6 Thermometers shall be solar digital vari-angle with separable well. Specify thermometers only by Weiss Instruments, Inc. Locate thermometers across chiller coolers and condensers, entering and leaving heat exchangers, hot water boilers and AHU coils. Thermometers installed outside are to be provided with outdoor waterproof cover.

2.7 On constant volume pumping system, each pumped system shall have a means of balancing the flow. Avoid the use of automatic flow regulating devices. Butterfly valves shall not be used for balancing. Balancing valves shall be specifically manufactured for flow balancing and shall be equipped with pressure measurement taps and shall be provided with flow vs. pressure drop chart. Insure balancing valves are installed with manufacturer's recommended straight lengths of pipe, usually 1.5 to 2 pipe diameters.

2.8 On variable flow systems, i.e. pumps with VFDs, use a separate check and isolation valve. Balancing or combination valve is not required.

2.9 Provide inlet strainer, PT plugs, and air vent in piping connection to each coil. Balancing valves are required at each air handler coil but not ~~required~~ at individual terminal box reheat coils. Ball shut-off valves on reheat coils shall be provided with memory stops. (Refer to Appendix D~~tab 12~~ – Standard Drawing Details)

2.10 For AHU's with multiple coils, provide only a single balancing valve to serve the multiple coils. Show details at coils with recommended straight pipe lengths before and after balancing valves.

2.11 Design piping system for balancing valves at major branches of piping system including at each floor and at major wings or sections.

Part 3 - Execution

3.1 Use manual air vents throughout the chilled and hot water heating systems. Avoid use of automatic air vents except where recommended at bladder type expansion tanks.

3.2 PT test plugs shall be located at each hydronic BAS temperature sensor and at the entering and leaving connections of coils, chillers, hot water boilers and heat exchangers. (Refer to tab 12 – Standard Drawing Details)

3.3 Specify Contractor to provide facility with a PT measurement kit with thermometers and gages chosen to indicate system pressures and temperatures at mid-scale.

3.4 Flushing details shall be shown on details. This will likely include temporary flushing loops and valves at AHU coils and terminal boxes to prevent flushing through coils and control valves.

SECTION 23 21 23: HYDRONIC PUMPS

Part 1 - General

1.1 Work Included:

A. Provide one condenser water and one chilled water pump per chiller. Provide one backup pump for each system. Header pumps to allow flexible operation. Ensure chiller automatic isolation valves open when starting a chiller/pump.

B. On hot water heating systems, provide two primary pumps, each sized for 100% of load. Only one pump will operate with the second pump serving as a standby.

Part 2-Products

2.1 Acceptable Manufacturers: Peerless, Armstrong, Bell & Gossett, Aurora, Paco, Taco, Weinman, and Grundfos.

2.2 Close coupled end suction pumps may be used for design flow rates to 100 GPM.

2.3 Vertical inline pumps are preferred for hydronic applications and where multiple vendors have an appropriate product to submit. Provide adequate clearance for maintenance including pump or motor replacement. Provide rail above pumps on which to attach a lift for motor pull. Provide adequate floor space below lift in which to roll the cart for motor removal.

2.4 End suction, base mounted, coupled pumps may be used where selection provides an efficiency of not less than 80%. Use flexible type center drop out spacer coupling with EPDM coupling sleeve, solid foot mounted volute, and specify pump removal without piping disassembly.

2.5 Use double suction, horizontal or vertical, split-case pumps when maintenance is of greater concern. Design Engineer shall use experience to select optimum pump type.

2.6 Where possible, do not specify pumps with impellers exceeding 90% of the impeller diameter range for the pump casing.

2.7 Pumps are to have mechanical type seals.

2.8 Both entering and leaving flanges on pumps and suction diffusers are to be drilled and tapped for gauge connections.

2.9 Concentric reducers are not permitted at pump inlets. To avoid air pockets, use eccentric reducers with flat side on top where transitions are required.

2.10 Drip lip bases are not required. Furnish coupled pumps with manufacturer's standard steel base.

2.11 Pumps are to be selected for maximum efficiency but never less than 80%. Coupling guards must meet ANSI/OSHA requirements.

2.12 Pump impellers shall be trimmed when outside 10-15% of scheduled duty.

Part 3 - Execution

3.1 Provide and arrange piping and valves so that a single pressure gauge may be used to read both pump suction and discharge pressures and suction strainer. Provide ball valves at all three gauge taps. (Refer to tab 12 – Standard Drawings Details)

SECTION 23 22 16: STEAM AND CONDENSATE PIPING SPECIALTIES

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Acceptable Manufacturers: Hoffman, Muesco, Spirax Sarco, Watson McDaniel

2.2 Steam traps shall be F&T type except inverted bucket type may be used on end-of-main drip stations. Traps shall be sized for twice the design steam rate. All traps shall be accessible and maintainable.

2.3 Steam condensate pumps shall be duplex. Use condensate pump units with below-the-floor receivers if necessary to obtain gravity drainage of steam condensate.

2.4 Condensate receivers shall be cast iron.

2.5 Use parallel traps at heat exchangers, AHU steam coils and domestic water heater.

Part 3 - Execution

3.1 Provide vacuum breakers on modulated steam heating coils.

3.2 Condensate shall not be lifted from trap discharges on modulating steam valve equipment.

SECTION 23 23 00: REFRIGERATION PIPING SYSTEM

Part 1 - General

1.1 Work Included:

A. The preferred systems of HCA do not involve field erected refrigerant piping. However, if such is required on a project, engineered drawings shall indicate size and routing of refrigerant piping including the need for oil traps, double suction risers, and pipe sloping for oil return. The specifications shall include standards for dehydration, charging and testing.

B. The HCA standard for walk-in-cooler refrigerant piping shall be designed and installed by the kitchen equipment supplier. It is not shown on the engineering drawings.

C. The preferred location of condensing units is on the ground, provided:

1. Location is aesthetically acceptable,
2. Refrigerant piping lengths are not excessive resulting in large pressure drops,
3. Relocation of units will not be required with proposed future facility expansions.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 25 00: HVAC WATER TREATMENT

Part 1 - General

1.1 Work Included:

A. Water Softening: Design Engineer shall consult with water management engineer regarding scale/corrosion tendencies of the local water source. (Coordinate requirements with Water Softener specification in the Plumbing Division.) This will serve as the basis for deciding whether or not to soften the domestic water. Design Engineer shall submit recommendations to HCA Design and Construction for approval.

B. Water Treatment Chemicals: HCA regionally contracts with preferred chemical treatment vendors. The Design Engineer shall coordinate the design of the chemical treatment feed and monitoring process with the chemical treatment engineer whose name and phone number may be obtained from the HCA Design and Construction for green field projects, or the Director of Facility Management (DFM) for projects at an existing facility.

C. Domestic Water Treatment: If a facility has secondary treatment for Legionella in place, this system will need to be extended to include new construction. Any time Legionella treatment is encountered the design engineer shall contact the Director of FacilitiGroup to discuss the appropriate approach.

D. Water Treatment Equipment: Specify the water treatment equipment such that the mechanical contractor may competitively bid the equipment among water treatment vendors.

E. Steam Boilers:

   1. All makeup water going to the boiler shall be softened to a hardness of 0 ppm.

   2. The contract documents shall show the electrical power connections, location of chemical tanks and equipment, and piping components necessary to introduce the oxygen scavenger, condensate neutralizing amine, and boiler water treatment (phosphate, alkalinity builder, and polymer sludge dispersant) into each boiler.

F. Open Re-circulating Cooling Condenser Water:

   1. The contract documents shall specify and show the necessary electrical power, piping, and equipment required for the automatic feed of micro biocides, dispersants, and other necessary chemicals as specified by the chemical supplier's representative. The documents shall also show where chemicals are introduced into the system as well as the location of the conductivity probe.

G. Acid Feed: Depending on water quality and system tonnage, the determination of the need for acid feed should be investigated. All avenues for alternate treatment methods should be investigated before acid feed is approved. Report options to provide alternative treatment to HCA Design and Construction.

H. System Startup Chemicals: Mechanical contractor shall purchase startup chemicals from HCA's designated supplier, and utilize the supplier's representative to operationally treat the systems until such time as this responsibility is formally accepted by HCA. Weekly testing of the efficacy of the chemical treatment of the cooling towers and boilers shall be conducted and the results immediately copied to the hospital's DFM.

1.2 Closed Re-circulating Comfort Heating and Cooling Water:

A. Before startup of new chilled water or heating systems the specifications shall specify cleaning, flushing and draining procedures designed to clean and verify by testing that the systems are clean prior to circulating through new clean components, control valves, coils, pumps, etc. or connecting the new system to an existing system. Utilize flushing connections at AHU coils, chillers, and at end-of-mains for hot water piping. Close valves at coils and chillers and flush systems through equipment/coil bypass connections. Drawings shall show flushing bypass connections and valves at all coils and equipment. Show flushing connections in hot water piping at end of piping run(s) on each floor and at major branches on the ancillary floors. After flushing systems, close flushing valves, cut bypass connections and cap piping at end of flushing valves. On VAV boxes, open valves to boxes and flush through hose bib connection at each box y-strainer. (Refer to Tab 12 – Standard Drawing details).

B. Cleanness of the system shall be determined by water sampling performed by the water management chemical engineer and witnessed and approved in writing by the General Contractor's quality control representative.

C. Permanent facility pumps should not be used for circulating the cleaning water. However if it is impractical to use temporary pumps, the permanent facility pump may be used provided that the pump is unconditionally warranted for two years, parts and labor, after the date of substantial completion by the mechanical contractor.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Boilers

A. Contractor shall be responsible for "boil-out" or pre-cleaning before boiler is placed into operation. The alkaline boil-out program shall be the responsibility of the mechanical contractor in conjunction with the water management chemical engineer. Cleanness of the system shall be determined by water sampling by the water management chemical engineer.

B. Each steam boiler shall have an automatic surface blowdown controller/sampler in order to control conductivity.

C. Cooling coil/sample cooler shall be installed on all boilers.

D. Each chemical injection pump shall be interlocked to operate parallel with the respective feed water pump for each boiler.

E. Liquid neutralizing amine product shall be piped to either the steam header or the discharge side of the boiler feed pump. Specify FDA approved amines. All other chemicals shall be fed into the deaerator tank.

F. Boiler makeup water shall be metered. Meter shall be specified and located to enable the facility to receive credit on facility's sewer bill for water evaporated.

G. If the Contractor is responsible for water treatment between startup and turnover to the Owner, the Contractor shall maintain records showing the target and actual chemical concentrations. At turnover, these records shall be given to the Owner and the boiler and deaerator water surfaces shall be inspected for evidence of scaling and corrosion. Include findings in the closeout manual.

3.2 Point of Use Boilers or Steam Generators: Makeup water shall be treated by means of a replaceable cartridge conditioner, or small softener, if softened water is unavailable. Automatic blowdown shall be provided.

3.3 Open Re-circulating Cooling Condenser Water:

A. Remove all loose debris followed by chemical cleaning, sequestration, and passivation of all contact surfaces. This work shall be conducted under the direction of a representative of the water treatment vendor.

B. Makeup water shall be metered. It shall be specified and located as described above, under Boiler Makeup Water. The meter shall have dry electrical contacts interlocked with the chemical feed equipment. ~~Blow down water shall be metered.~~

C. If the Contractor is responsible for water treatment between startup and turnover to the Owner, the Contractor shall maintain records showing the target and actual chemical concentrations. At turnover, these records shall be given to the Owner and the chillers and boilers shall be inspected for evidence of scaling and corrosion. If the cooling load will not permit a chiller to be inspected, the cleanliness will be determined by documenting that the measured leaving condenser water and condenser refrigerant temperature difference is within the specified design limit. Include findings in the closeout manual.

D. Each cooling tower shall have an automatic blowdown controller/sampler in order to control conductivity.

SECTION 23.25.16.13: CONDENSER WATER BASIN CLEANING AND FILTRATION SYSTEM

Part 1 - General

1.1 Provide cooling towers with a basin cleaning and particle separation/filtration system for the condenser water in each cooling tower basin.

1.2 Equip cooling tower basin with a factory installed sweeper eductor system to ensure that separable particles of 40 microns and larger are removed.

Part 2-Products

2.1 Select Lakos TC Series or approved equal with pumping rate based on the following calculation and the filtration system manufacturer's recommendations:

A. For Basin Depths 8″ to 3′ : Filter Flow Rate [gpm] = Basin Length [ft] X Basin Width [ft] X 1.0

B. For Basin Depths greater than 3′ : Filter Flow Rate [gpm] = Basin Length [ft] X Basin Width [ft] X 1.5

2.2 The completely factory assembled skid mounted separator package shall include all required wiring and piping and be suitable for outdoor mounting. The package assembly shall include at least the following components:

A. Centrifugal separator.

B. End suction single stage pump and TEFC motor.

C. Pump suction basket strainer and isolation valve.

D. Solids collection vessel with internal corrosion protection, ¼″ mesh stainless steel basket, 25 micron fiber felt bag and automatic motorized purge ball valve and controls for automatic operation.

E. Indicator package with pressure differential indicator, isolation ball valves, flow control orifice and dry contact to signal the BAS when the solids collection system needs servicing.

F. Electrical control panel (NEMA 4X enclosure) with starter, overloads, HOA selection switch, UL listed and control transformer suitable for 120V control voltage. Provide binary general alarm point to be monitored by BAS.

2.3 The entire separation/filtration assembly shall be rated for 125 psig at 100ºF.

Part 3 - Execution

3.1 Tie general alarm point back to BAS for monitoring.

SECTION 23 31 14: SHEETMETAL DUCTWORK

Part 1 - General

1.1 Work Included:

A. Design Engineer to design medium pressure duct systems using rectangular and round ductwork where space allows. Flat oval may be used in areas where space does not allow for rectangular or round ductwork. When flat oval is used due to space limitations, the complete run of ductwork will be flat oval from the air handler or riser until space allows for transition to rectangular ductwork. Do not start and stop usage of flat oval at obstructions or conflicts. Contractors may substitute flat oval at no cost for rectangular ductwork sizes to be approved by engineer.

B. Medium Pressure rectangular elbows will be full radius elbows or provided with turning vanes. On medium pressure flat oval systems use only 5-piece, long radius elbows and 3-piece, 45° ells. Tees and taps shall be conical. All fittings shall be manufactured. Saddle taps in lieu of conical tees will not be allowed.

C. Flexible duct, where allowed by codes, shall be carefully used to reduce sound level transmission into rooms without causing excessive pressure drops. Design documents should require a minimum of one 90° turn above ceiling prior to grille connection. (Refer to tab 12 – Standard Drawing Details)

D. Specifications shall refer to specific requirements HCA provided the general contractors regarding duct leakage pressure test procedures to be followed as well as record keeping requirements.

E. Return and exhaust air shall be ducted including shafts, i.e. do not use drywall shafts as air plenums. Do not use ceiling return or exhaust air plenums.

F. Ductwork design and construction shall be in accordance with SMACNA Standards. Ductwork to be no lighter than 24 ga Contractor may substitute heavier ga at no additional cost.

G. All duct shall be cleaned and capped prior to installing and installed duct shall not have the ends uncapped to prevent the entry of dust during construction.

Part 2-Products

2.1 Sealant: Single part, brush on water based sealant equal to Hardcast Iron-Grip.

2.2 Flexible Duct: Thermoflex MK-e and Flexmaster M-8 are recommended.

2.3 Pressure Classification

A. Construct the following for 1″ w.c. pressure class:

1. Supply ductwork downstream of terminal boxes
2. Low pressure supply and return ductwork at fan coil units

B. Construct the following for 2″ w.c. pressure class:

1. Return ductwork (Use 3″ w.c. pressure class for 100′ from fan.)
2. Exhaust ductwork

C. Construct the following for 4″ w.c. pressure class:

1. Supply ductwork and plenums downstream of supply fans up to terminal boxes.

Part 3 - Execution

3.1 All ductwork, including supply, return and exhaust shall have circumferential joints, longitudinal joints, and duct wall penetrations externally sealed in accordance to SMACNA Class A. The sealant used to seal the longitudinal joints of low pressure ductwork must be visible or the joints shall require resealing in the field.

3.2 Ductwork installed on the exterior of the building is strongly discouraged. Where absolutely necessary, use round duct or rectangular duct sloped as to allow rain and snow to run off. Provide exterior ductwork with gasketted standing seam joints, weatherproofed with sufficient stiffening to prohibit low-points on which water may pool.

3.3 Insulation installed outside is to be closed-cell and/or waterproofed. Fiberglass insulation is not permitted to be installed outside. Insulation and ductwork installed outside are to be protected from hail.

3.4 Provide secure metal cross-overs with stairs and railings wherever maintenance personnel would need to gain access to both side of ductwork installed on a roof.

3.5 Install ductwork on roof securely but in such a way as to facilitate future roof replacement as much as possible.

3.6 Duct Leakage Testing:

A. Specify leak testing for all ductwork with a pressure classification of 2″ and above, ductwork with a cross-sectional area greater than 6 square feet, and all ductwork enclosed in shafts.

B. Leak test at least 50% of the low pressure supply, and 50% of the return and exhaust ductwork to ensure duct tightness and air handler system performance. Leak test the supply duct from the AHU to the terminal boxes. Leak test return and exhaust duct that is the equivalent of 8 inches in diameter and larger. Leak test all duct that is an enclosed in a chase or above a drywall ceiling.

C. Follow procedure published by United Sheet Metal Division of United McGill Corporation entitled "System Pressure Testing for Leaks" using prescribed test kit containing test blower, two U-tube manometer, and calibrated orifice tube. Orifice flow measurement device to be individually calibrated against a primary standard and a calibrated curve permanently attached to orifice tube assembly.

D. If system is tested in sections, leakage rates may be totaled to give performance of the whole system.

E. All leak testing is to be witnessed by General Contractor's Quality Control on-site representative. Require the General Contractor to maintain, on-site, a set of ductwork prints that are shaded in different colors to show the duct sections isolated for each test. Specify that the General Contractor shall also indicate on the print, the date each section of duct was tested and the final percent leakage rate measured for each test section.

F. The final duct leakage test report is to be submitted to the Commissioning Authority.

G. For low pressure ductwork,~~W~~where both longitudinal and transverse seams are fully sealed, leakage test described herein may be omitted.

SECTION 23 31 15: SHEETMETAL - SPECIAL DUCTWORK

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Dishwasher exhaust duct shall be continuously welded aluminum above the ceiling and welded stainless steel below the ceiling or continuously welded stainless steel.

2.2 Research each project to determine if special ductwork, such as a welded duct system or acid resistant ductwork is required in project laboratories. Aluminum or Stainless steel ductwork shall be designed for all moisture prone areas.

Part 3 - Execution

3.1 Slope ductwork serving dishwasher hood to drain back to hood. Provide condensate drains as required to prevent the accumulation of water within ductwork.

SECTION 23 31 18: FIBERGLASS DUCTWORK

Part 1 - General

1.1 Do not use fiberglass ductwork on HCA projects.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 33 00: AIR DUCT ACCESSORIES

Part 1 - General

1.1 Face Dampers in diffusers and grilles are to be avoided. Any exception to this design standard must be approved by HCA Corporate Engineering.

1.2 Laminar flow diffusers for ORs shall be Titus, Price, Anemostat or Precision Air Products.

Part 2-Products

HCA is electing at this time not to provide guidelines.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 33 19: SOUND ATTENUATORS

Part 1 - General

1.1 Work Included:

A. Design for sound attenuators where necessary to obtain room NC levels specified in Section I.

B. Prior to considering sound attenuators downstream of room terminal units to meet the specified room NC levels attempt to meet the room sound criteria by doing the following: Select fans with raw sound discharge levels of 95 db or less in the 63, 125 and 250 Hz bands, select terminal units meeting the criteria above, use Thermoflex MK-E or Flexmaster 8M sound attenuating low pressure flex, and specify diffusers/ grilles without face dampers.

Part 2-Products

2.1 Acceptable Manufacturers: Rink, McGill, IAC, Vibro-Acoustics.

2.2 Limit pressure drop to 0.25″ w.c. for compliance with ASHRAE guidelines.

Part 3 - Execution

3.1 Locate sound attenuators to be accessible for cleaning. Locate an access door on upstream and downstream sides of attenuators

SECTION 23 36 00: AIR TERMINAL UNITS

Part 1 - General

1.1 Work Included

A. Variable volume air terminal units to be pressure independent, single duct, DDC control type with hot water reheat coil pre-assembled unit with factory installed piping and controls and shall be pre-commissioned.

B. Electric heating coils or pneumatic controls are not to be used without written permission from the appropriate FacilitiGroup Engineering Manager.

C. Air terminal unit airflow and sound performance ratings to be certified in accordance with AHRI Standard 880. Specify units for maximum 26 NC level at 3″S.P. Provide criteria for sound power levels and NC levels to ensure manufacturers' ratings are comparable.

D. A discharge air temperature sensor shall be provided on each terminal unit. (Do not allow deletion of sensors as a value engineering option.)

E. Refer to HCA standard VAV terminal box details for more information.

1.2 Air terminal units shall be single-duct type, except for renovations to existing dual duct systems where units may be dual duct type with independent control over both dampers.

1.3 Box produced noise shall be coordinated with other system components to limit the HVAC produced sound levels in occupied spaces to the maximum values contained in Section I in all damper positions from minimum to 100% open. Correction of noise excesses shall not constitute additional charges to owner.

1.4 Every terminal unit shall have a unique ID on design drawings. Incorporate AHU ID as a part of the unique ID of terminal unit.

1.5 Engineer is to indicate which terminal boxes get 2-way valves and which get 3-way valves on plans and, more importantly, on schedules for the benefit of box selection by the supplier.

Part 2-Products

2.1 Acceptable Manufacturers:

A. VAV terminal units: JCI VAV Ready Units (VRU) or Siemens Industry Zone Control Units (ZCU) as follows: Siemens will be used when the existing facility already uses Siemens controls. JCI will be used where JCI already exists or in new facilities. Refer to Innovation Memorandum No. 9.

1. Johnson Controls, Inc.
    a. Contact: Kevin Tolbert
    b. email: kevin.p.tolbert@jci.com
    c. 478-952-8740
2. Siemens Industry Inc.
    a. Contact: Edward Tambornino
    b. email: ed.tambornino@siemens.com
    c. 847-271-8136

B. Air valves to be Phoenix Control Theris line, Siemens Venturi, Price model VVA, or Triatek.

2.2 Air terminal units shall be pressure independent type.

2.3 On terminal units with a 6″ or greater inlet, multi-point flow sensing devices, flow rings or flow crosses, by unit manufacturer shall be used in conjunction with

DDC controller. On terminal units with inlets less than 6″ a single point flow measuring device is acceptable.

2.4 Specify a maximum differential pressure drop of 0.75" across the terminal unit at cooling design flow where practical.

2.5 VAV Terminal Box Requirements

A. Provide terminal units with minimum 22-gauge welded galvanized steel housing, slip and drive duct connection, ½ inch thick internal fiber free closed cell insulation. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire, smoke, and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. Material shall be chemically resistant to most hydrocarbon based solvents.

B. Double wall type terminal boxes are to be avoided except where specifically required by the local code.

C. Terminal units to be pressure independent. Terminal unit airflow to be monitored by an integral, multiple point, averaging airflow sensing ring or cross to maintain constant airflow within 5 percent of rated cfm down to 25 percent of nominal cfm, independent of changes in system static pressure. Sampling points to be evenly spaced across the air terminal box inlet for better readings. Factory set, field adjustable settings for terminal unit maximum and minimum airflows to be provided in accordance with schedule on drawings. Integral flow taps and calibration chart to be installed at factory for each terminal unit.

D. Internal resistance of terminal unit shall not exceed that scheduled on drawings when handling maximum scheduled air volumes.

E. Terminal unit leakage rate to be maximum 2 percent of nominal catalog rating cfm at 3.00" w.g. inlet static pressure when tested in accordance with ASHRAE 130.

F. All interior features of the boxes (such as mixing baffles, damper housings, etc.) shall be secured within the casing to avoid excessive movement or rattling with air movement or extremely generated vibration.

G. Terminal units to be complete with factory installed direct digital control actuator for connection to DDC controls provided by controls contractor.

H. Where box supplier has an offering for a constant volume box or a variable volume box controlled to a constant volume, provide the latter to obtain the most data points and for flexibility.

I. Provide a discharge air temperature on each terminal unit. Temperature measurement to be 1000 Ohm RTD, 2-wire sensing element with +/- 0.3°F accuracy and a stability of less than 0.1°F in five years.

J. An 8 inch diameter or 7.75 inch by 7.75 inch gasketed hinged access door shall be provided on the terminal unit. Door frame may be bolted, sealed or flanged to the casing. The door shall be double wall construction, gasketed and insulated. The Door shall be held in place with a cam lock latch allowing quick access without the use of tools.

2.6 Pre-Piped VAV Terminal Assembly Requirements

A. Terminal box assembly shall consist of factory fabricated terminal unit, integral controls, coil, piping of the sizes, capacities and configurations shown on the drawings with catalogued part numbers. All controls and hydronics piping shall be accessible from the same side of the unit. All hydronics piping packages shall be piped in the opposite direction of the control panel, downstream of the VAV terminal unit. Controls Contractor shall be responsible for proper selection/sizing of the VAV based on scheduled performance parameters and the supplying of the VAV.

B. The entire VAV assembly (terminal unit, coil, hydronics piping packages, controls hardware, electrical components and wiring) shall be seismically certified per IBC 2010 code with a 2.5 allowance factor and carry the OSHPD (OSP) certification.

C. If required for single-side access, single duct terminal units with hot water coils shall be shipped with a factory supplied 16 inch duct extension attached downstream of the coil. The construction of the duct extension shall be equal to the quality of materials and workmanship to that of the terminal unit. All connections to be sealed with silver foil tape rated at 6" of total pressure. The insulation shall match the insulation of the VAV box.

D. A control panel manufactured with a minimum 20 gauge sheet metal shall be supplied. The enclosure cover design shall allow for the following motions with a single universal design: a 180 degree hinged motion, a sliding motion from left to right and right to left including full removal of the enclosure cover without tools. The controls cover shall reside in a set position without the use of mechanical fasteners or screws. "Quick Release" sheet metal tabs/guide stops shall be supplied to allow the cover from slipping off when in the fully open position. The "Quick Release" tabs/guide stops shall be designed in such a way to allow the complete removal of the cover. A handle shall be supplied on the controls cover for opening and closing the controls cover. The control enclosure shall have factory installed knock outs for mounting all the electrical and controls components required. All electrical and electronic components including both line voltage and low voltage shall be mounted in the metal controls enclosure per applicable codes. The control panel shall include stand-offs to allow mounting of the controls and electrical items without penetrating the VAV terminal box casing.

E. A single point power connection shall be provided to the VAV unit. Low voltage wire from the ATC control valve actuator to the DDC controller shall be wired in 3/8 inch flexible conduit in accordance with UL-1995 and the

National Electric Code. An electrical junction box with a disconnect switch, 24 volt transformer with low voltage wiring shall be provided and mounted on the VAV by the VAV manufacturer. All relays required shall be installed and wired in the electrical enclosure.

F. Hot water coils shall be factory installed with a maximum of ten (10) aluminum fins per inch and rated in accordance with ARI 410.The coil circuiting shall be a multi circuited header with corrosion free brass manual air vent piped in at the highest and lowest point of the piping header to ensure efficient drainage and air removal from the coil. A metal coil-u-bend cover shall to be factory installed on the coil u-bends to protect the coil u-bends during shipment and installation. Upstream and downstream coil casing connections to terminal unit and duct extension to be sealed with silver foil tape rated at 6" TSP. Tube thickness shall be a minimum of 0.016"

G. Braided stainless steel hose kits are acceptable for terminal boxes. Hoses to be a minimum of ¾" diameter and 24" long and to have operating temperature range from -40° to 250° Fahrenheit, a working pressure of 400 psi, and a minimum burst pressure of 1600 psi. . Hose kits to ship with one end attached to the VRU piping valve assembly and the other end with a minimum 3/4" diameter 8 " long sealed copper air chamber. The sealed end of the copper air chamber should be cut, prepped and connected to the loop piping. Do not twist the hose kit during installation and keep all flux and other chemicals off the braided hoses. Pay close attention during construction to allowable hose bend radius.

H. VAV boxes serving operating rooms and C-section rooms shall have a minimum of two-rows for rapid room warm-up. Heating coils in all other VAV terminal units shall be selected to maintain a minimum space temperature of 75˚F with 140˚F hot water supply temperature. Two-row coils are preferred in all applications to reduce fan power requirements and sound transmission.

I. Two (2) 90 degree copper pipes formed on a tube bender shall be sweated directly to the header of the coil with a minimum distance of 6 inches from the coil inlet and to the coil outlet regardless of the coil size. Sweated copper elbows and fittings are not acceptable to achieve the same result.

J. A minimum of two adjustable Universal Handle Brackets with built in handles shall be supplied for every VAV furnished. Handles shall be constructed with a minimum of 14 gauge metal shall be painted to avoid corrosion and stress fractures of hydronics. Handle opening shall be able to accept a minimum of the following lifting devices through the handle portion of the bracket without damaging the product: human hand, forklift, Unistrut, pipe or other lifting devices. The handle shall have a 180 degree – "rolled up edge" to prevent injury to the human hand: raw edges or non-rolled edges shall not be accepted.

K. The shipping handle brackets shall use 4 military grade rubber grommets for elimination of galvanic corrosion and isolation between copper piping and support handles. The rubber grommets shall be made of Buna-N and be resistant to petroleum-based oils and fuels, water and alcohols.

L. The piping assembly and coil shall be field reversible. The hydronics piping structure and 2 handle shipping brackets shall be attached to the coil inlet and outlet connections as one assembly integral to the VAV. All piping assemblies for the VAVs supplied shall be identical and interchangeable for inlet sizes of four (4) inch through 24 inch. The supply and return aspect ratios of the inlet and outlet piping shall be 6 inch on center of the coils. The piping aspect ratio is identical for all VAVs supplied regardless of VAV box/coil size.

M. The following minimum factory installed piping components shall be supplied; a valve package consisting of a stainless steel ball valve with a #20 stainless steel screen to act as a strainer, a union, P/T (pressure temperature) port, drain or blow-down with integrated stainless ball valve and removable brass end cap to seal the drain connection. Union with P/T port. All P/T ports require an extension of a minimum of 1.5 inches. Stainless steel isolation valve, union, and P/T readout ports. Pressure gauge to confirm 100% leak free product delivery. Type "L" ¾ inch copper pipe. Two (2) 24 inch long stainless steel hose kits tested to meet UL94 with a VO rating and a washer-less design with a 6" long 3/4:" sealed copper air chamber attached to each end of the hose.

N. Memory stops shall not be provided with VAV boxes, but shall be available from the manufacturer for field retrofit without the need to replace the entire valve, should the need arise.

O. A ½ inch control valve with stainless steel ball and stem shall be provided and factory installed in the piping trim at the factory. A 24 volt electric non-spring return modulating valve actuator shall be provided. The actuator wires shall be terminated to the VMA controller. Both the actuator and control valve shall be tested before leaving the factory.

P. Four aircraft cables shall be factory installed on the VAV with the job specific platform fastening mechanism at the end of the aircraft cables. Cables shall be a minimum of 10 feet long. Cables shall be rated for a minimum of 100 lbs each with a 5:1 safe working load allowance.

Q. A transformer with primary and secondary transformer fusing with a toggle disconnect switch shall be provided and installed at the factory. All secondary wiring from the toggle switch and transformer to the VMA vav controller shall be factory installed and tested before shipment.

R. A platinum 1k ohm DAT (Discharge Air Temperature) Sensor shall be provided. The DAT sensor shall have a stainless steel mounting flange with two hex-head self-drilling mounting screws and come equipped with a 10 ft plenum rated cable with ¼" female insulated quick-connect terminator leads. Cable must meet UL 1995 requirements for installation within an air plenum. The DAT sensor shall be factory installed in the duct extension at the farthest point downstream of the coil. The DAT sensor shall be factory checked for proper resistance range and factory-wired to the VMA- 1630 controller.

S. A VAV box controller shall be provided and factory installed. All wiring from the DAT, transformer and control valve shall be connected and tested at the factory. The pneumatic tubes from the air flow sensor shall be connected to the controller transducer at the factory

2.7 Quality Assurance

A. The hydronics piping structure and coil shall be charged with nitrogen or other appropriate dry gas at the factory before shipment at greater than sea level pressure at the assembly area; seal the gas in the piping structure: Test the sealed piping structure and coil for a minimum of 12 hours to determine whether the gas stays within the hydronics Piping Structure and coil through the use of a pressure gauge. If the gas leaks from the hydronics piping structure per the pressure gauge identify the leak, fix it and re-test upon verification of the piping structure having zero leakage of the gas prior to shipment.

B. Transport the sealed and pressurized piping structure with coil from the factory to the construction site; determining a pressure of the gas at the construction site. If hydronics structure and coil arrives without holding pressure, then Contractor to trouble shoot and fix leak.

C. Inside of terminal unit and duct extension to be cleaned and wiped down. Inlet and discharge shall be wrapped with a protective cover. All VAVs shall be individually tagged, strapped down, palletized, enclosed in cardboard boxes and shrink wrapped with a pallet stretch machine. Labels with bar codes shall be adhered to the to each unit with the following information: Tag numbers, Model no, Serial no., Date of manufacture, Manufacturer, Inlet size, MFG, ID # and Job Name. Electrical wiring schematic shall be adhered to the outside of each control enclosure. Additional tagging to be placed on the outside of the cardboard box shrink wrapping. Shipping boxes shall list all relative shipping information including reference ID no., telephone number and name of person/entity receiving the product(s), and tags of individual VAV units on the pallets

D. Inlet of terminal unit and outlet of duct extension to be sealed with a plastic wrap to keep air borne particles out of the inlet and outlet of the VAV. In addition, the entire assembly shall be wrapped and secured to the shipping pallet.

E. Factory Commissioning of Controls and Software

    1. Load appropriate VAV program into the DDC controller and program all the performance parameters commensurate for each zone/VAV unit per schedule supplied by the controls contractor

2. Properly address each controller with the correct address in order for the BAS system to identify each DDC controller.
3. Power up the VAV and run the program through full cycle operation. Stroke the damper actuator to full open and then to closed position. Stroke the temperature control valve to full open and full closed.
4. Set and Ship all actuators in the open position

F. Digital Data Retrieval System – VAV manufacturer shall provide the following as part of the Operational and maintenance manuals in digital form:
1. Digital images of each individual VAV shipped including the hydronic piping packages, controls hardware, electrical, coil and terminal unit taken before shipment.
2. Controller software and individual VAV performance files specific for each VAV by tag number.
3. Approved Submittals
4. Operational and maintenance instructions
5. Drawings
6. Part numbers

Part 3 - Execution

3.1 Installation

A. Install terminal units in strict accordance with manufacturers' published installation instructions.

B. Terminal units to be supported directly from unit to structure with appropriate supports.

C. Refer to section 23 08 00 and Appendix A for terminal box commissioning requirements and methodologies.

D. The HCA standard is that heating coils on VAV boxes are not provided with individual balancing valves. Balancing valves are instead to be provided at every floor, wing, and at every branch serving a minimum of 3 VAV boxes. Confirm balancing of individual terminal box is not included in the base scope of work of the Test and Balancing agent.

E. Provide shutoff valves as required for maintenance and replacement without a large-scale shutdown of equipment.

F. The mechanical contractor is to provide and install a set of isolation valves at the connection of the hot water distribution piping and the braided steel hoses so the boxes can be isolated from the rest of the system in the event of a hose failure.

SECTION 23 38 13: COMMERCIAL KITCHEN HOOD

Part 1 - General

1.1 Work Included:

A. Kitchen ventilation and exhaust systems shall be constructed in accordance with NFPA 96 requirements.

B. Coordinate make-up air requirements with HCA Corporate Equipment Manager.

Part 2-Products

2.1 Acceptable Manufacturers: Hoods are provided by HCA Corporate Equipment Manager

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 40 00: HVAC AIR CLEANING DEVICES

Part 1 - General

1.1 Work Included:

A. Filters shall be rated based on ASHRAE 52.1 and 52.2.

B. Use front loading filters.

C. Final filters, 90% (MERV 14) efficiency, should be provided on all air handling systems serving patient care areas.

D. Do not use roll type filters. Use 2″ thick, 60% (MERV 11) efficient filters for pre filters by 3-M, Tri-Dim, or approved equal.

E. Pre-filters shall be utilized ahead of any higher efficiency filter.

F. HEPA filters, 99.97% DOP efficient, shall be used for exhaust systems serving radioactive waste or where required by codes (e.g. orthopedic ORs, protective environment rooms).

Part 2-Products

2.1 Acceptable Manufacturers: American Air Filter, CamFilFarr, Flanders, TriDim, and 3M

2.2 Provide Dwyer magnehelic gauge across each filter bank to indicate the level of filter loading. Specify the clean and dirty filter pressure drops and require these values to be permanently marked on the gauge by the mechanical contractor.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 51 23: FLUE PIPING

Part 1 - General

1.1 Work Included: Flue piping shall be installed meeting requirements of all state and local codes.

Part 2-Products

2.1 Acceptable Manufacturers: American Metal Products, Metal-Fab, Selkirk Metalbestos

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 52 16: CONDENSING BOILERS

Part 1 - General

1.1 Summary

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.2 Submittals

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
    a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
    b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having

jurisdiction, and document hydrostatic testing of piping external to boiler.

1.3 Quality Assurance

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

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.4 Coordination

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.5 Warranty

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Pulse-Combustion Boilers:

a. Leakage and Materials: 10 years from date of Substantial Completion.

b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

Part 2-Products

2.1 Manufacturers

A. Manufacturers:

1. AERCO International.
2. Cleaver Brooks.
3. Fulton Boiler Works, Inc.
4. Lochinvar Corporation.

2.2 Manufactured Units

A. Description: Factory-fabricated, -assembled, and -tested, condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger:

1. Type 316L, stainless-steel primary and secondary combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Burner: Dual Fuel (where required)

1. Natural gas, self-aspirating and self-venting after initial start.
2. No. 2 Fuel Oil.
3. The system piping, controls, and sequences must be provided to protect against firing fuel oil in condensing mode.

E. Blower: Centrifugal fan to operate during each burner firing sequence. Blower shall also prepurge and postpurge the combustion chamber as required by design.

F. Motors: Comply with owner requirements in guidelines Section 23 05 13, "Electric Motors for HVAC."

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

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

H. Ignition: Spark or carbide hot surface source with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: Baked-enamel or powder-coated protective finish.
4. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
6. Mounting base to secure boiler to concrete base.

a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and

Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

J. Circulator Pump: Loose shipped circulation pump with cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.

K. Condensate Trap: Cast-iron body with stainless-steel internal parts.

2.3 Trim

A. Hot Water

1. Include devices sized to comply with ANSI B31.1, "Power Piping."
2. Aquastat Controllers: Operating, firing rate, and high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gauge: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gauge. Gauges shall have operating-pressure and - temperature ranges so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: Automatic.
6. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
7. Circulation Pump: Non-overloading, in-line pump with electrically-commutated or split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 Controls

A. Refer to owner requirements in guidelines Section 23 09 13, "Building Automation System and Direct Digital Control."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 2 percent.
   a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
   b. Include manufacturer’s firing sequence for selection of multiple boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

   1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
   2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
   3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
   4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Automation System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

   1. Hardwired Points:

      a. Monitoring: On/off status, common trouble alarm.
      b. Control: On/off operation, hot water supply temperature set-point adjustment.

   2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.5 Electrical Power

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are described in Division 26 of the Guidelines.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

   1. House in NEMA 250, Type 1 for indoor enclosures.
   2. Wiring shall be numbered and color-coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a metal raceway.
   4. Field power interface shall be to fused disconnect switch.
   5. Provide branch power circuit to each motor and to controls with a circuit breaker.
   6. Provide each motor with overcurrent protection.

2.6 Venting Kits

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 Source Quality Control

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers before shipping according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Engineer 14 days in advance of testing.

Part 3 - Execution

3.1 Examination

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 Boiler Installation

A. Install boilers level on 6” tall concrete base.

B. Owner requirements for vibration isolation devices and installation are specified in Guidelines Section 23 05 48, "Vibration and Seismic Controls for HVAC."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

3.3 Connections

A. Install piping adjacent to boiler to allow service and maintenance.

B. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

D. Connect fuel oil piping to boiler where required.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection for ease of removal.

F. Install piping from safety relief valves to nearest floor drain.

G. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

H. Boiler Venting:

  1. Install flue venting kit and combustion-air intake.
  2. Connect full size to boiler connections. Comply with owner requirements and all applicable code requirements.

I. Refer also to owner requirements in Guidelines Division 26 – Electrical.

3.4 Field Quality Control

A. Refer to commissioning requirements in specification Section 01 91 13.

B. Perform tests and inspections and prepare test reports.

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

C. Tests and Inspections:

  1. Perform installation and startup checks according to manufacturer's written instructions.
  2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
     a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
     b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Remove and replace malfunctioning units and retest as specified above.

E. Occupancy Adjustments: Provide on-site assistance in adjusting system to suit actual occupied conditions for 12 months of Substantial Completion.

F. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
    a. Test for full capacity.
    b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Engineer in advance of test dates.
8. Document test results in a report and submit to Engineer.

3.5 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions.

SECTION 23 52 39: FIRE-TUBE BOILERS

Part 1 - General

1.1 Scope

A. Provide factory assembled steam boilers as specified herein and as sized and detailed on Contract Drawings.

1.2 Work Included:

A. Specify that at time of submission to Architect/ Design Engineer, contractor shall submit an information only copy of the complete boiler submittal to HCA FacilitiGroup, 6100 Tower Circle, Suite 400, Franklin, TN 37067

B. Careful consideration should be given to boiler sizing. Provide N+1 redundancy on boilers system without oversizing the boilers.

C. Contact local propane supplier. Installation shall be in accordance with all State and local code requirements. The propane supply to the boiler pilot light shall be permanently piped to propane tank storage location.

1.3 Related Work:

A. Section 23 25 00: HVAC Water Treatment

B. Section 23 53 00: Heating Boiler Water Feedwater Equipment

1.4 Design Considerations:

A. Process Steam:

1. Utilize shell and tube heat exchangers for HVAC reheat purposes as much as possible with the exceptions as listed under B of this section.
2. For central steam systems, use natural gas-fired dry-back steam boilers with not less than two boilers and dual fuel burners. Packaged fire tube boilers are preferred. Be aware that point of use electric steam generation could have a significant impact on electrical first cost and energy costs and should be avoided if possible.
3. HCA uses FDA approved amines as part of their chemical treatment program for steam boilers. There is no need for special clean steam systems for humidification.
4. Consider the cost of a stationary engineer watch which may be required by an AHJ. Determine if alternatives are available with lower life cycle cost and report the options to HCA Design and Construction.

B. Heating Boilers:

1. Hot water boilers shall be used on projects where steam requirements are minimal or where full time operators would be required for a steam boiler. Design Engineer shall specify the efficiency and the method of calculation. System design measures shall be taken to avoid thermal shock and condensation of combustion gases in non-condensing boilers.

C. Where dual fuel is required consider propane for these appliances where the winter outside design temperature is 20°F, or lower.

D. Where appropriate, engineer is to investigate the use of stack economizers for new boiler installations. Investigation should consider impact on roof height, floor space, piping, equipment, flue materials of construction and controls. Preferred design is for economizer to be located within the building to eliminate need for freeze protection. Economizer is preferred to be integral to or directly supported from the boiler in such a way as to maintain ASME rating of shell. System is preferred piped to preheat makeup water to deaerator tank or heating hot water.

E. Engineer to verify that other manufacturers can comply with efficiency requirements described.

F. Engineer to verify NOx emission requirements for project location and specify appropriate NOx level and equipment for the boiler.

G. Engineer to specify CB Level Master or equal for all steam boilers

H. Engineer to specify Hawk ICS Advanced Boiler Control System Series 4000 or better or approved equal for all boilers 150 bhp and larger. Also, specify servo-motors and parallel positioning for all boilers over 150 bhp.

I. Engineer to specify O_2 trim only on boilers 250 bhp and larger. Hawk Master Panel lead lag controller, or approved equal, shall be specified by plant with two or more boilers exceeding 250 bhp.

1.5 Quality Assurance

A. Design, construct, and factory test boiler in accordance with ASME Code for Boilers and Pressure Vessels, Section 1, Power Boilers, and state and local boiler codes. A copy of the ASME inspection report shall be furnished to the owner by the manufacturer's representative. The complete packaged boiler shall be approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label.

1. Comply with ASME CSD-1 or NFPA 85 as required by local AHJ.
2. Test and certify all boiler external piping in accordance with ASME Section 1. Factory mount, test and certify boiler external piping, fittings, and valves and run hydrostatic tests at factory for certification by an authorized inspector.
3. Boiler shall receive boiler inspection and bear ASME stamp.
4. Fire test with the specified fuels to verify operation and function of all controls.

B. Burner assembly shall meet requirements of HCA's insuring agency, AIG.~~Global Risk Consultants.~~ Contact Anthony Terrick with any questions. His contact information is:

Anthony J. Terrick, PE
Anthony.Terrick@aig.com
625 Liberty Avenue, Suite 1100, Pittsburgh, PA 15222
Tel +1 412 288 5310 | Cell +1 412 290 5622 | Fax +1 617 206 9301

~~B.~~

C. Boiler shall be guaranteed to operate at fuel-to-steam efficiency of at least 81% while firing natural gas and 83% while firing No.2 fuel oil over the operating range at time of startup. Boiler manufacturer shall guarantee that, at the time of startup, the boiler will achieve the required fuel-to-steam efficiency at 25%, 50%, 75% and 100% of rating. Efficiency verification testing will be based on the stack loss method.

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1. Natural gas:
   a. Carbon, % (wt) = 69.98
   b. Hydrogen, % (wt) = 22.31
   c. Sulfur, % (wt) = 0.0
   d. Heating value, Btu/lb = 21,830
2. No. 2 fuel oil
   a. Carbon, % (wt) = 85.8
   b. Hydrogen, % (wt) = 12.7
   c. Sulfur, % (wt) = 0.2
   d. Heating value, Btu/lb = 19,420
3. Efficiencies will be based on ambient air of 80°F., relative humidity of 30% and 15% excess air in the exhaust flue gas.

1.6 Submittals

A. Submit manufacturer's product data including project specific ratings, dimensional data, boiler accessories, burner assembly, burner management system and components for review.

1.7 Documents

A. Provide the following documents to be delivered to the Owner upon completion of work:
   1. Test Reports:
      a. Factory Test
      b. Startup Test Results and Report (legible writing or typed)
   2. Certificates/Permits
      a. ASME Certificate
      b. National Board of Pressure Vessels Inspectors Certificate
      c. Manufacturer's Warranty
      d. Construction and Operating Permits, as required by state and local regulations, from Air Pollution Control Authorities.
      e. Certificate of Acceptance or Boiler Operating Permit from State Boiler Inspector or insurance company.

1.8 Warranty

A. The entire boiler/burner package shall be guaranteed and warranted by the boiler manufacturer. Warranty shall include all parts for a period of (12) months from the date of startup.

1.9 Permits

A. Obtain applicable construction and operating permits from local EPA, boiler, and insurance inspectors.

Part 2-Products

2.1 Acceptable Manufacturers: Cleaver-Brooks (Model CBLE), Superior Boiler Works, Inc., and Hurst.

2.2 The listing of manufacturers above does not indicate compliance with the specifications contained herein. It is the responsibility of the boiler manufacturer's representative in conjunction with the bidding contractor to determine compliance. Any bid determined not to be in compliance with the specifications contained herein shall be clearly submitted as an alternative bid noting all exceptions with respect to the specifications contained herein.

2.3 At time of bid, submit a base bid indicating compliance with the specifications. Deductive alternates, along with the boiler manufacturer's name and model number, may be submitted at bid time indicating those items that are not in compliance with the specifications for review and approval by the Design Engineer and the HCA Director of Engineering and Facility Management Services.

2.4 HCA prefers high pressure steam boilers with a minimum of 5 square feet of heating surface per boiler horsepower. Contact HCA FacilitiGroup for exceptions.

2.5 Use modulating feed water pump control to automatically maintain boiler water level.

2.6 Combination natural gas and air atomizing oil burner capable of operating on No. 2 fuel oil. If a fuel other than main fuel is required for the pilot light, show the system piping and storage in the design documents.

2.7 Provide minimum temperature low fire hold control to keep the standby boiler's burner at low fire position to prevent thermal shock to tube sheets and reduce the time to reach system operating pressure when the boiler is needed.

2.8 On HCA projects, specify HAWK ICS Advanced Boiler Control System or equal for all boilers 150 bhp and larger (Series 4000 or above). Also, specify servo-motors and parallel positioning for all boilers over 150 bhp. Specify O2 trim only on boilers 250 bhp and larger. If new boilers are added to an existing plant design engineer shall research the feasibility of retrofitting existing boilers with an HAWK ICS system. Design engineer shall consider the use of a boiler sequencer / controller

2.9 CB Level Master or equivalent should be the basis of design for water level monitoring and control.

2.10 Specify a 4:1 turndown on boilers up to 200 bhp. Specify a 10:1 turndown on boilers exceeding 200 bhp.

2.11 General Description

A. Factory packaged unit shall include boiler, burner, heavy duty skids, painted steel jacket with two inches of fiberglass insulation, controls and accessories all piped and wired for single point field connections.

B. Units shall carry packaged label of Underwriters Laboratory (UL) and be in accordance with ASME/CSD-1, all codes required by the local governing authorities and as indicated on the design performance data sheet.

C. A certified factory fire-test shall be provided on all fuels with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for 150 PSIG steam in accordance with Section I of ASME Code.

2.12 Boiler Design

A. Three or four pass steel scotch marine firetube boiler for positive pressurized firing with forced draft burner. Dryback design with a minimum of five (5) square feet of heating surface per boiler horsepower.

B. Front and rear doors shall be davited and sealed with tad-pole gaskets using heavy duty cap screws threaded into replaceable brass nuts. When opened, doors shall expose all tubes, tubesheets and furnace for ease of inspection and maintenance. Lifting loops shall be provided.

C. Rear door shall be refractory lined with air cooled observation port.

D. Tubes shall be rolled, beaded and/or welded into tube sheets and tubes shall be cleanable and removable from either front or back. Tubes shall be a minimum 2.5″ O.D., with a tube wall thickness of not less than 0.095″.

E. The boiler pressure vessel shall be completely insulated with a minimum of 2″ of insulation and shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint.

2.13 Burner Design

A. General: Forced draft burner mounted in and integral with boiler hinged front boiler door so when door is opened burner head, furnace, tubesheet and tubes are exposed; reversed curve cast aluminum blower fan; motor(s); air flow switch; fuel trains and control panels. To conform to UL and other insurance requirements as indicated.

B. Gas Burner: High radiant, multi-port type design for natural gas. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Minimum main gas train shall include manual shut-off valve, pressure regulating valve, dual safety gas valves, manual test valve, high-low pressure switches, manifold pressure gauge and butterfly gas valve. Gas train shall be factory packaged to meet insurance requirements as indicated. Gas turn down shall be minimum 10:1.

C. Oil Burner: Oil burner shall be of the low pressure air atomizing type for No. 2 oil. Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Oil train shall consist of retractable nozzle with flexible hoses; gauges; manifold block; air purge valve; fuel-oil controller; dual oil solenoids; temperature switch, air compressor assembly and oil pump assembly. Oil train shall be factory packaged to meet insurance requirements as indicated. Oil turn down shall be minimum 8:1.

D. Combination Burner: Provide gas-oil fuel selector switch to provide fuel switch over without any required adjustments to burner.

E. Fuel-Air: Modulating fire with proven low fire start. Provide manual potentiometer with manual-auto switch on boiler control panel in addition to automatic fuel-air controller. Provide automatic operating control and manual reset high limit.

F. Forced Draft Blower: All air for combustion shall be supplied by a blower mounted on the front boiler door. The backward curved cast aluminum radial impeller shall be directly connected to a flanged type ODP motor. This rigid mounting with the blower wheel inside the head shall eliminate vibration and reduce noise level. The balanced blower wheel shall be cast aluminum with radial blades. The combustion air damper shall be an integral rotating damper and shall be automatically adjusted for proper air quantity by a positive actuator to maintain proper fuel-air ratios. Motors 15 hp and higher shall be provided with a VFD.

G. Emission Control: Boiler NOx shall be furnished with guaranteed internal induced NOx control for 60 PPM NOx systems corrected to 3% O2 over the entire turndown range. Boiler capacity, turndown, flame stability and efficiency shall not be affected by the internal NOx control.

2.14 Boiler Trim

A. To include the following:

1. 8.5” diameter pressure gauge.
2. ASME safety relief valve(s). Comply with ASME Section I, para. PG-61 of the B&PV Code which states that “each source of feeding shall be capable of supplying water to the boiler to the boiler at a pressure of 3% higher than the highest setting of any safety valve on the boiler.
3. Auxiliary Low Water Cutoff, Warrick 150 with manual reset.
4. Primary low water cut-off.
5. Operating control.

6. Limit control with manual reset.
7. 5″ stack thermometer.
8. Feedwater regulating valve with 3 valve bypass.
9. Low fire hold controller.
10. 1 Slow Opening Blowdown Valve, Size 1.5″, Class 200#
11. 2 Quick Opening Blowdown Valves, Size 1.5″, Class 200#
12. Feedwater Globe Valve, Size 2″, Class 240#
13. 1 Feedwater Check Valve, Size 2″, Class 240#
14. Factory mounted, installed, tested, and certified piping (by A, S, or PP ASME stamp holder) and valves per ASME Code, including:
    a. Water Column piping
    b. Bottom Blowdown (from boiler to last code valve)
    c. Feedwater assembly (shipped loose)
    d. Surface Blowdown piping with stop valve and metering valve
    e. Modulating Feedwater Control Valve, including 3-Valve Bypass
15. Oil Pump, Mounted and Wired
16. Air Atomizing Compressor, Mounted and Wired

B. Water Column/Low Water Cutoff and Water Level Control System
1. Cleaver Brooks LEVEL MASTER Water Level control system, or approved equal.
2. System shall be comprised of a microprocessor-based electronic controller, a non-contact, non-wearing, continuously reading absolute level sensor and pressure chamber. The control system shall be designed as follows:
    a. The electronic controller shall be panel mounted and operate in ambient temperatures from 32°F to 125°F, the pressure chamber shall be boiler mounted and operate to pressures of 250 PSIG and the level sensor shall operate to pressures of 250 PSIG and temperatures to 400°F. The pressure containing components shall be constructed in accordance with ASME Code. A shielded, four conductor cable with ground shall be run in metal conduit between the level sensor and the controller. Supply power shall be 115VAC-1 phase-60Hz. All wiring shall be in compliance with the National Electrical Code.
    b. The pressure chamber shall have a sight glass mounted on the side. The level sensor shall have an accuracy of 0.01″ or greater. The electronic controller shall have level and error

indicating lights, alphanumeric display for messaging, reset/menu switch and the following features:

i. Continuous Level Indication

ii. Low Water Cutoff & Alarm

iii. High Water Alarm

iv. Low & High Water Warning

v. Full Modulating Control of Modulating Feedwater Control Valve

vi. Continuous Monitoring of Float Operation

vii. Column Blowdown Detection and Reminder

viii. Auto or Manual Reset

ix. Real Time Clock

x. Alarm Annunciation

xi. Alarm History Files with Time Stamp

xii. Water Column Blowdown Record

xiii. Auxiliary Low Water Cutoff Check

xiv. RS 232 Interface

xv. Maximum Contacts Rating 15 amps Resistive Load

2.15 Boiler Controls

A. Boiler mounted NEMA 1 enclosure(s) with key lock; fusing, magnetic starters; step-down control transformer; flame safeguard and burner management system as indicated; enunciator lights for load demand, fuel on, low water and flame failure; selector switches, required by dry contacts, relays and terminal strips. Oil, heat and moisture resistant wire with circuit number corresponding to electrical wiring diagrams. In accordance with UL and National Electric Code.

B. Each unit shall be factory equipped with a Boiler Control System providing technology and functions equal to the Cleaver Brooks Hawk ICS 4000 or 5000 Boiler Control system.

1. Each Boiler Control System shall be factory equipped with a pre-configured Programmable Controller and a 10″ color touch screen Human Machine Interface (HMI).

2. Major system components shall include:

    a. Allen Bradley L35E Programmable Control Processor.

    b. 10″ Touch Screen HMI.

    c. Local Modbus Communication Network (Not for customer use).

   d. Various Controller Input/Output Modules.
   e. One Burner Management Controller and Wiring Sub-Base.
   f. One Flame Scanner: Infrared, Ultra-Violet, or UV Self-Check.
   g. One Flame Amplifier, to correspond with the selected Flame Scanner.
   h. Various Temperature and/or Pressure Sensors.

3. Major functions that the Boiler Control System shall provide:
   a. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run and post purge.
   b. Flame proving and lockout on flame failure during pilot flame proving, main flame proving, or run.
   c. Low fire damper/valve position for flame ignition trials.
   d. Full modulating control of fuel and combustion air.
   e. Utilize solid state controls and sensors to provide various control functions, such as:
   f. On/Off, and Modulating Control.
   g. Modulating Control algorithm shall be Proportional-Integral-Derivative (PID) type.
   h. Thermal Shock Protection with water temperature monitoring and set point.
   i. Various High and Low limit alarms and shutdowns.
   j. Touch Screen graphical operator interface and monitoring.
      i. Manual control of the boiler-firing rate utilizing control screens on the HMI to increment and decrement the firing rate.
      ii. On screen indication of burner management controller status and diagnostics.
      iii. On screen real-time display of all connected process parameters.
      iv. On screen commissioning of O2 Trim, Parallel Positioning, and Draft
      v. On screen commissioning of boiler set points and configurable alarms
      vi. On screen display of system alarms and faults.
      vii. On screen history of alarms and faults.

viii. Alarm history serial printing capabilities.

ix. On screen troubleshooting for alarm's, burner management, and fault conditions.

x. On screen water level indication and alarm(s) with CB Level Master Option.

4. Integrated Parallel Positioning Programming with Parallel Positioning Actuators-Programming and Commissioning is provided via the Touch Screen HMI to provide independent fuel to air ratio control instead of a common jack shaft control arrangement. Each Air or fuel connection will be fitted with individual actuator and independently set and made capable of independent commissioning to provide better overall efficiency of the system.
   a. Integrated O2 Trim Programming with O2 Probe for Flue Gas-Measure the Boilers Flue Gas exit O2 concentration and transmits the corresponding signal to the HAWK ICS-4000 or 5000 controller. It is then used to provide a more accurate boiler efficiency calculation and is also displayed on the HMI. The signal is used for a low O2 alarm. A Combustion Air Temperature Sensor is also provided. It is used in the boiler efficiency calculation and is also displayed on the HMI.
   b. Integrated programming for draft control option
   c. Four User Defined Analog Inputs with Totalization on flows (3 if draft control is used)
   d. Expanded Annunciation with 3 User Discrete (On/Off) inputs (2 if draft control is used)
   e. High Stack Temperature Cut-Off and Alarm
   f. Printing capabilities from serial port on HMI
   g. Economizer Inlet and Outlet Flue Gas Temperature
   h. Economizer Inlet and Outlet Feedwater Temperature
   i. Building and Plant Automation System via BACnet.
   j. Ethernet Communications Port
   k. Tamper resistant control logic and password protection.
   l. Dual Set Point Capabilities.
   m. Stack Flue Gas, Combustion Air, and Shell (water) temperatures.
   n. Boiler Efficiency calculation (with O2 analyzer).
   o. Outdoor Reset for Hot Water Boilers.

p. Remote Modulation or Firing Rate Set Point control (when lead lag is not used).

q. Assured Low Fire Cut-Off (ALFCO). (Used to remote stop/start the burner when lead/lag is opted for, or remote enable / disable)

r. Integrated lead lag programming. Master panel to be provided for 3 boiler lead lag capabilities.

s. Hot Stand By

t. Flash Card Reader Interface for uploading/downloading of programs

u. Alarm Silencer via touch screen HMI

v. Alarm Bell

5. The Boiler Control System shall provide the following safety provisions for:

   a. Integrated Burner Management

      i. Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the burner management system should lockout on safety shutdown.

      ii. Closed-loop logic test verifies integrity of safety critical loads (ignition, pilot, and main fuel valves) and must be able to lockout on safety. Shut down if any safety critical load is identified as proper or improper.

      iii. Pre-ignition interlocks (fuel valve proof of closure, etc.) and flames signal checked during Standby and Pre-Purge.

      iv. Dynamic checking of the flame signal amplifier. The control flame signal amplifier must be able to recognize a no flame signal during this dynamic amplifier check.

      v. Safe start-check and expand check to include monitoring flame signal during standby.

      vi. High and Low fire switches checked for proper sequencing.

      vii. Tamper-proof Purge Timing and safety logic.

   b. Integrated Boiler Controls

      i. Operating and High Limit Control.

      ii. Primary and Secondary Low Water Cut-Off.

      iii. Variable Speed Drive (if used) fault shutdown.

      iv. Password protection of Programmable Controller logic.

v. Password protection of Parallel Positioning Control (if used).

6. The Boiler Control System shall provide annunciation and diagnostics:
    a. First out annunciation, plus time and cycle, in sequence of fault occurrence.
    b. Indication of failures at startup or during normal operation.
    c. Provide historical alarm information for on screen display or printout.
    d. Detects and isolates an alarm, and reports internal circuit faults.
    e. English text description of the system fault and troubleshooting procedures.
    f. Water Level alarms and/or indication.
7. The Boiler Control System shall be able to operate in these environmental conditions.
    a. Supply Voltage: 120vac (+10%/-15%) 50 or 60 Hz. Provide control circuit transformer powered from main power feed.
    b. Maximum total connected load: 2000 VA.
    c. Operating temperature limits: 32°F to 130°F
    d. 85% RH continuous, non-condensing, humidity.
    e. 0.5G continuous vibration.
8. All Boiler Control System wiring shall be in accordance with the National Electrical Codes and local electrical codes.
9. NFPA 85 Compliant
10. Boiler Control System component functions shall be as follows:
    a. Burner Management Controller: Provides boiler sequencing logic to meet ~~Global Risk~~AIG ~~Consultants approval body~~ requirements.
    b. Touch Screen Graphical Interface: Provides user interface to the control system, boiler overview screen with connected boiler parameter readouts, Burner Management Control status screen, alarm screens, diagnostic screens for fault troubleshooting, alarm history screen, water level control screen, and system firing rate screen.
    c. Local Modbus Communication Network: Provides communication between the Programmable Controller and other peripheral devices. Not for customer use.
    d. Various Programmable Controller Input/Output modules: Provides interface for discrete powered and/or isolated relay

signals, as well as for analog signals, from and/or to other input/output devices.

e. Stack Temperature Sensor: Measures and transmits a signal to the Programmable Controller in relation to boiler exit flue gas temperature for indication and for use in the calculation of boiler efficiency. Also can be used for high stack temperature alarm and shutdown.

f. Steam Pressure Transmitter for Steam Boilers: Provides an analog signal to the Programmable Controller for indication of boiler steam pressure. Utilized for on/off and modulating control of the burner.

g. Water (shell) Temperature Sensor on Steam Boilers: Measures and transmits a signal to the Programmable Controller in relation to boiler water temperature. Used for indication and thermal shock protection.

Part 3 - Execution

3.1 Shop Test

A. The complete packaged boiler shall receive factory tests to check construction and function of all controls. All shop tests may be witnessed by the purchaser at his own expense upon sufficient notice to the company.

3.2 Installation

A. Install boilers in accordance with NFPA 85, ASME, local codes, and manufacturer's instructions, and Factory Mutual requirements. If applicable comply with NFPA-31 which requires a high ambient temperature control mounted above the burner.

1. Boilers and accessories shall be installed and piped per manufacturer's recommendations and under his supervision. Feed water columns, condensate receivers, and boiler feed unit tanks shall be piped to the nearest drain, full size of the connection. Relief valves and vents shall be piped to outside the building using either the connection size or the size shown on the drawings, whichever is the larger. Ells on relief lines turning up through the roof shall be drip pan ells. Pipe gas vent connections on gas controls to outside of the building.
2. Install boiler stacks constructed or furnished as required by Section 23 31 14.
3. Boilers shall receive factory startup supervision tests to check construction, operation, and function of controls and to ensure proper preparation for use by a factory trained service technician.

Startup, instruction and warranty: Manufacturer's representative shall provide startup and instruction of each new boiler, including burner and boiler control system as specified erein. Startup and instruction shall cover all components assembled and furnished by the manufacturer whether or not of own manufacture. Boiler and burner manufacturers' factory trained service (technicians) representative(s) to perform services described.

SECTION 23 53 00: HEATING BOILER FEEDWATER EQUIPMENT

Part 1 - General

1.1 Work Included:

A. Deaerator is required for all steam boiler plants whose aggregate capacity exceeds 100 boiler horsepower (BHP).

B. 0.005 cc/liter deaerators preferred. Specify field performance testing to verify 0.005 cc/liter is achieved during normal boiler operation.

C. 1.01.C

1.2 Field Performance Test:

A. To verify system performance, the deaeration system will be field tested during normal facility operation at a time to be defined by the Owner's Representative. Test pressure and operating conditions shall be as they exist at the time the test is conducted. The performance test shall consist of four (4) individual test measurements performed at 30 minute intervals over a two-hour period. The deaeration system shall meet the performance standards specified at each and every test point. The test shall be performed using the Chemetric Calorimetric test method.

B. If the deaeration system fails to meet the performance standards on any test, the supplier shall make a list of modifications required and submit them to the Owner's Representative. The modifications shall be made, if approved by the Owner's Representative, and the unit re-tested at the time of the Owner Representative's choosing, but within 30 days of the original test. This process shall be repeated as many times required until the system meets the performance criteria.

C. To facilitate deaerator testing, provide one (1) factory mounted and piped sample cooler with deaerator. Sample cooler shall consist of 35 copper coils enclosed in a 3″ pipe, a sample valve between the deaerator and the unit, a 0.25″ sample inlet and outlet and 0.25″ cooling water inlet and outlet. Sample cooler shall be designed for 300 psig with a height not to exceed 20".

Part 2-Products

2.1 Acceptable Manufacturers: Cleaver Brooks, Chicago Heater Co., Crane Cochrane, Industrial Steam

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 62 00: PACKAGED COMPRESSOR AND CONDENSER UNITS

Part 1 - General
HCA is electing at this time not to provide guidelines.

Part 2-Products
2.1 Acceptable Manufacturers: Carrier, Trane or York.

2.2 Compressors shall be scroll or reciprocating hermetic type, spring isolated.

2.3 Motor and compressor shall be warranted for five years from startup.

2.4 Air cooled condenser shall have head pressure control for stable operation at low load conditions.

2.5 Unit shall be equipped with anti-short cycle timer.

2.6 Units shall be fully automatic, including factory pre-wired controls and starters.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 64 13: ABSORPTION WATER CHILLER

Part 1 - General
1.1 Design Considerations: In general, avoid absorption chillers. See general chiller comments below.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 64 16: CENTRIFUGAL CHILLERS

Part 1 - General
1.1 Work Included

A. Specify that at time of submission to Architect/ Design Engineer, contractor shall submit an information-only copy of the complete chiller submittal to HCA FacilitiGroup, 6100 Tower Circle, Suite 400, Franklin, TN 37067.

1.2 Design Considerations

A. For plants with two chillers, size each chiller for 70% of the block load (peak load). For new construction and project additions where three or more chillers will ultimately serve the building, size new unit(s) so that upon loss of a single chiller, the remaining machines will provide a minimum of 70% of block load but no more than 100% of the block load. The design engineer and selecting factory representative should take into account the price "break points" of the chillers to maximize the equipment capacity and efficiency for the least incremental cost. Consult and review chiller options for the project with HCA FacilitiGroup.

B. Water-cooled machines are preferred due to efficiency. However, budget and project size may drive the use of air-cooled chillers. Typically use centrifugal chillers above 300 tons and screw chillers below 300 tons. Investigate the use of gas absorption chillers where fuel cost may be a factor. Do not use absorption type chillers unless there is a significant difference in life cycle costs. Submit this analysis to HCA FacilitiGroup for review.

C. Chillers with variable speed drives shall be the standard basis of design for all new chillers. Chiller efficiency and scheduled selection shall be based on chiller load profile according to its intended use, lead, lag, or standby. Fixed and variable speed drives shall be evaluated. Chiller manufacturers shall be requested to bid alternates that lower the owner's life cycle cost. Specify that the engineering design consultant will analyze the chiller bids and make a recommendation to HCA Design and Construction prior to the Mechanical Contractor committing to any chiller manufacturer. The HCA FacilitiGroup Chiller Analysis spread sheets or equivalent shall be used to analyze the chiller bids. These forms can be found in Appendix G. Include the appropriate form as part of the specifications.

D. Specify an interface between the chiller control panel and BAS to enable the BAS to see all the parameters available in the chiller control panel.

E. The preferred system for new chilled water plants is variable speed primary configuration.

F. Avoid pump control systems from a controls vendor different from the BAS.

G. The chiller plant shall be designed to prevent downstream blending of non-chilled (return) chilled water and chilled water supply. If necessary, include automatic chilled water shutoff valves to close when the chiller is off.

H. In existing primary/secondary piping arrangements, locate the bypass/decoupler loop upstream of the takeoff to the first set of secondary pumps. The bypass loop length is to be minimized, but is to be no less than 6 equivalent pipe diameters long. Locate a temperature sensor in the middle of the bypass/decoupler pipe connected to the BAS. Maximum pressure drop through bypass/decoupler pipe at maximum flow is not to exceed 1.5′ head (total).

I. On primary/ secondary chilled water systems ensure proper mixing by specifying a minimum of 10 pipe diameters between the bypass / decoupler and first take-off or pump intake.

J. Chiller starters or VFDs shall be unit mounted on the chiller by the manufacturer whenever possible.

K. If cooling tower bypass is needed, consider using an open instead of a closed bypass arrangement.

L. For starting with cold condenser water, specify a chiller cold start feature including modulating head pressure control valve, controlled by a signal from head pressure controller furnished with chiller. Avoid the use of cooling tower bypass directly to the pump suction.

M. Chillers with variable speed drives are preferred to facilitate starting the chillers with either the essential electrical system or a portable generator set.

1.3 Section Includes

A. Centrifugal compressor water chillers as indicated on the schedules and shown on the drawings.

B. Water connections (chilled water, condenser water and auxiliary water connections)

C. Motor starters and variable frequency drives

D. Electrical Connections

E. Controls and control accessories

F. Charge of refrigerant and oil

G. Refrigerant purge system.

1.4 Related Guidelines Sections

A. Section 230548 – Vibration and Seismic Controls for HVAC

B. Section 230700 – HVAC Insulation

C. Section 230593 – HVAC Systems Test and Balance

D. Section 230800 – Commissioning

E. Section 230913 – Building Automation System and Direct Digital Controls

F. Section 232000 – HVAC Piping

G. Section 232116 – Hydronic Piping Specialties

H. Section 232123 – Hydronic Pumps

I. Section 232300 – Refrigeration Piping System

J. Section 232500 – HVAC Water Treatment

K. Section 236500 – Cooling Towers

1.5 References

A. ARI 550/590 – Standard for Water Chilling Packages Using the Vapor Compression Cycle

B. ARI 575 – Method of Measuring Machinery Sound Within an Equipment Space

C. ARI 580 – Non-Condensable Gas Purge Equipment for Low Pressure Centrifugal Chillers

D. ARI 740 – Refrigerant Recovery / Recycling Equipment

E. ASHRAE 15 – Safety Standard for Refrigeration Systems

F. ASHRAE 34 – Designation and Safety Classification of Refrigerants

G. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

H. ASME Boiler and Pressure Vessel Code: Section VIII, Division 1

I. NFPA 70 / NEC – National Electrical Code

J. OSHA – Occupational Safety and Health Act

K. UL 465 – Construction of Centrifugal Chillers

L. UL 508 – Industrial Control Equipment (Short Circuit Current Rating)

M. UL 1995 – Standard for Safety for Heating and Cooling Equipment

1.6 Quality Assurance

A. Comply with codes and standards in Section 1.03.

1.7 Ratings And Certifications

A. Chiller rating and testing: current version of ARI 550/590.

B. Chiller energy efficiency requirements: ASHRAE 90.1 – Affix compliance label to chiller

C. Safety: UL 465 and UL 1995 – Provide UL / CUL label.

D. Motor manufacturing and performance: NEMA MG1

E. Pressure vessel construction and testing: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 – Provide ASME 'U' stamp.

F. Electrical and control wiring: NEC codes & ETL requirements – Affix certification labels to control panel and starter.

G. Refrigeration system design, construction, installation and operation: ASHRAE 15

1.8 Submittal Documentation Required

A. Chiller performance ratings conforming to and reported in accordance with ARI-550/590 including capacity (tons), energy efficiency (kW/ton), water pressure drop (ft of water), Integrated Part Load Value (IPLV) efficiency or, if specified, Non-Standard Part Load Value (NPLV).

B. Include additional power or water sources for auxiliaries (water for oil coolers, etc.) and the effect of compressor motor heat losses to the refrigerant stream in all rating calculations.

C. NPLV calculated to ARI Standard 550/590 equation.

D. Statement of Compliance with ASHRAE 90.1

E. Part Load Performance: Document performance efficiencies at 10% load increments at the following entering condenser water temperatures (ECWTs): 85°F, 80°F, 75°F, 70°F, 65°F, 60°F, 55°F and at minimum possible. At minimum ECWT, state the minimum continuous operating load the chiller is capable of satisfying while exhibiting stable operation. Document that chiller will provide 100% design capacity at 55°F ECWT. Also, document that chiller will provide stable operation at 50% load with 85°F ECWT (or design ECWT) and 55°F ECWT. Clearly note any points where continuous, stable operation may not be achievable. Hold condenser water flow constant for all points.

F. Provide a plot of purge inefficiency (in pounds of refrigerant per pound of air) from 100% load to 10% load, using ARI schedule condenser water relief (4°F per 10% reduction in load). This number must represent the total air and refrigerant that leaves the shells including what will be pumped into secondary containers or tanks.

G. Sound pressure level ratings expected from measurements performed in accordance with ARI-575. Include estimates for each octave band at each of the four standard ARI points.

H. Unit Drawing: Indicate overall unit dimensions, key component locations and dimensions, required clearances and field connection details for piping and electrical wiring.

I. Floor layout drawing: Indicate centerlines; Indicate locations and dimensions of chiller points of contact with the floor.

J. Other Diagrams: Thermal insulation requirements diagram and vibration isolator diagrams

K. Weights: Shipping weight, operating weight, weight of each major component, weight load at each vibration isolator

L. Capacities and Charges: Refrigerant and Oil

M. Wiring Diagram: main power connections, control wiring connections (contacts and terminations), internal wiring schematic including transformers and other devices.

N. Electrical data: Motor full load amperage, job full load amperage, inrush amperage, minimum circuit ampacity, max fuse size / breaker size.

O. Electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

P. Control Panel Details: system operating data points, status messages, safety shutdowns, cycling shutdowns, trending capability, programmable set points, interface capability for data transfer.

Q. Material Safety Data Sheet (MSDS) for any refrigerant used that is NOT classified as 'A1' for flammability and toxicity by ASHRAE 34.

R. Manufacturer's warranty certificate.

S. Chiller spreadsheets for all manufactures showing base bid options as well as alternate selections are to be submitted to HCA FacilitiGroup for approval before chillers are approved.

1.9 Shipment

A. Protect, pack and secure loose-shipped items and attach to chiller. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.

B. Cap and seal water nozzle openings to prevent moisture, foreign materials and other objects from entering heat exchangers.

C. Provide fiber-reinforced shrink-wrap around entire exterior of the chiller. The membrane shall cover the entire top, sides and ends to fully protect the chiller during shipping and storage. Cover equipment, regardless of size or shape.

D. Ship units that are not shrink wrapped in an enclosed truck or shipping container. Tarping is not acceptable.

E. Ship chiller in one major assembly where practical.

F. Delivery, Storage and Handling

G. Follow manufacturer's recommendations for storage, handling and unloading.

H. Do not store equipment in wet or damp areas even when sealed and secured.

1.10 Warranty

A. Provide manufacturer's warranty for 12 months from the date of owner acceptance covering parts and labor required to remedy defects in materials or workmanship for the entire chiller. Perform warranty work with manufacturer's factory-trained and factory-employed service technician.

1.11 Close-Out Documentation

A. Provide Installation, Operation & Maintenance Manual(s) in each chiller's control panel door. Provide one additional copy for owner's project system manual with a copy of the approved submittal data as well as an electronic version.

B. Provide one hard copy of Spare Parts Manual for owner's project system manual as well as well as an electronic version.

1.12 Maintenance

A. Perform maintenance work using with manufacturer's factory-trained and factory-employed service technician.

B. In-Warranty Maintenance Agreement: Provide a thorough in-warranty maintenance agreement, covering the period from the date of shipment to 18 months after the ship date or 12 months from startup (whichever is the later date). Provide the following:

1. Seasonal shutdown
2. Four inspections including – but not limited to – the following:
    a. Operating temperatures and pressures
    b. Operating and safety controls
    c. Motor windings (test with a mega ohmmeter).
    d. Purge unit
    e. Starter: mechanical linkages, start contactors and timers. Dry run starter to ensure proper timing of starting sequence and proper starter operation. Recalibrate starter overloads
    f. VFD: Perform annual preventive tasks
3. Oil analysis and a refrigerant analysis. Submit results and recommendations to the Owner.
4. Oil filter changes as necessary
5. Eddy current testing of evaporator (for baseline)
6. Eddy current testing of condenser (for baseline)
7. Vibration analysis (for baseline)

Part 2-Products

2.1 Acceptable Manufacturers: York by Johnson Controls. Daikin magnetic bearing chillers are an acceptable alternative where project conditions dictate but Johnson Controls does not have a suitable product.

2.2 General Description

A. Packaged centrifugal chiller including the following: evaporator, motor and compressor, capacity control device, condenser with integral sub cooler, refrigerant metering device, lubrication system, variable speed drive, control panel with user interface, and – if required – a refrigerant purge system.

B. Refrigerants: Manufacturer shall provide machines with HFC refrigerants only.

C. Provide chiller to meet or exceed the scheduled performance within the limits of the scheduled parameters.

D. Provide manufacturer's warranty for 18 months from date of shipment from the factory or 12 months from startup (which ever date is later), covering parts and labor required to remedy defects in materials or workmanship for the entire chiller. Perform warranty work with manufacturer's factory-trained and factory-employed service technician.

2.3 Do not require factory performance testing.

2.4 During startup and commissioning of each chiller, chiller manufacturer shall provide a report showing design and actual performance parameters of chiller including evaporator and condenser temperatures and pressures to insure heat exchanger surfaces are within recommended tolerance. If measurements indicate tubes are fouled, contractor shall clean tubes and new measurements recorded to establish a performance baseline for the heat transfer surfaces. Performance measurements shall be included in close-out/O&M documentation with chillers. Heat Exchangers

A. General requirements: evaporator and condenser

1. Type: shell and tube
2. Shells: carbon steel with fusion welded seams
3. Tubes: Internally rifled, externally enhanced, individually cleanable and individually replaceable, roller expanded into tube sheets
4. Tube supports: carbon steel, 3/8″ thick minimum, no more than 4′ apart, self-supporting and welded to the shell
5. End sheets: carbon steel, 3/8″ thick minimum
6. Water boxes: steel, bolted to end sheet, cover plate bolted to box, taps for vent and drain
7. Pressure Relief: automatically reseating relief valves

B. Evaporator

1. Waterside working pressure: 150 psig (or 300 psig)
2. Water boxes: compact or marine (where required), end nozzle locations with grooved or flanged connections.
3. Tubes: Copper, removable from either end, 0.028 ″minimum thickness at enhanced areas and 0.045″ minimum thickness at tube supports and end sheets.

4. Suction Baffle/mist eliminator: installed along the entire length of the evaporator
5. Sight glass: located such that the proper refrigerant charge is near the center of the glass when the machine is off.
6. Oil return: oil eductor to recover and return oil from evaporator to the main oil sump.
7. Maximum evaporator pressure drop typically to be below 15′ of water column except where a more efficient selection requires more.

C. Condenser

1. Waterside working pressure: 150 psig (or 300 psig)
2. Water boxes: compact or marine (where required), end nozzle locations with grooved connections or flanged connections.
3. Tubes: Copper, removable from either end, 0.035″ minimum thickness at enhanced areas and 0.045″ minimum thickness at tube supports and end sheets.
4. Maximum condenser pressure drop typically to be below 15′ of water column except where a more efficient selection requires more.

2.5 Refrigerant Flow Control

A. Variable orifice or multiple fixed orifices.
B. Refrigerant level sensing: monitor refrigerant level in the condenser; report refrigerant level back to unit control panel and control chiller accordingly.
C. Refrigerant level control: adjust valve position via control panel to optimize refrigerant level.

2.6 Compressor

A. Single stage or multi-stage.
B. Fully accessible housing with vertical circular joints
C. Gear driven or direct driven. Each gear (low speed and high speed) shall have its own journal and thrust bearings
D. Solid metal journal bearings, roller element bearings, or magnetic bearings.
E. External shaft seal or internal shaft seal.
F. Pre-rotation guide vanes positioned by solid rod linkage or cable or chain linkage and connected to an easily serviceable, externally mounted electric actuator.

2.7 Motor

A. Open drive motor or semi-hermetic motor. Semi-hermetic motors must include motor winding temperature RTDs, one per phase.

B. Support and bearings: support the motor shaft on the inboard and outboard ends of the shaft with solid metal journal bearings, roller element bearings, or magnetic bearings.

C. Electrical connection: steel terminal box with gasketed front access cover; overload and overcurrent transformers

2.8 Lubrication System

A. Force-feed oil to all bearings, gears and rotating surfaces

B. Oil reservoir: designed and stamped in accordance with ASME; contains oil pump and oil heater

C. Oil pump: positive-displacement type, submerged in oil reservoir;

D. Oil filter: single filter or dual filter, externally mounted, ½ micron, replaceable cartridge, with service valves

E. Oil return system: oil eductor to recover and return oil in the evaporator to the main oil sump.

F. Oil cooler: refrigerant cooled, factory mounted, factory piped and pressure tested

G. Oil heater: immersion type or belly band type, thermostatically controlled

H. Oil temperature: sense via thermocouple located between bearing pads

I. Pump operation: automatically operate oil pump for 50 seconds (minimum) prior to startup. Prevent startup until operating oil pressure is established via an interlock with the control panel. Maintain pressure during compressor coast down, and for 2 minutes (minimum) after coast down.

J. Means of lubrication after power failure during coast down of driveline. A gravity-fed oil reservoir or a UPS / battery backup to oil pump or a shaft-driven oil pump are acceptable.

2.9 Refrigerant Purge System (Negative Pressure Machines)

A. Operates automatically at all load and head pressure conditions. Operates when the machine is idle.

B. Efficiency: maximum of 0.002 pounds of refrigerant per pound of air at design conditions, not to exceed 0.007 at any operating condition in a 90°F room.

C. Provide a plot of purge efficiency from 100% load to 10% load, using ARI schedule condenser water relief (4°F per 10% reduction in load).

D. If separate canisters are required to meet these efficiencies, then provide disposal to an EPA-approved disposal site for the life of the chiller. To maintain purge efficiency, provide the virgin refrigerant and labor required to replace the lost refrigerant.

2.10 Positive Pressure System (Negative Pressure Machines)

A. Operates automatically when chiller is idle to prevent non-condensables from entering the system.

B. Factory install pressurization unit, including heater, wiring, pump, piping, valves, and controls.

C. Heater: of sufficient capacity to pressurize machine above atmospheric pressure within 2 hours.

D. Controls: On/off/auto switch to automatically maintain positive pressure during idle periods.

E. Valves: check valves and balancing valve

2.11 Source Quality Control: Tests and Inspections

A. Heat Exchangers (evaporator and condenser):

1. Design and test in full conformance to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for both positive and negative pressure machines.
2. Hydrostatically test evaporator and condenser refrigerant side at 1.3 times design working pressure AFTER tubing using LIQUID REFRIGERANT.
3. Alternately to item '2' above, test at 1.3 times design working pressure BEFORE tubing, using WATER; then test at 1.1 times design working pressure AFTER tubing, using AIR.

B. Compressor components:

1. Leak tested at design working pressure using air under water.
2. Hydrostatic strength test at 1.5 times design working pressure.
3. To ensure UL label qualification, manufacturer shall perform a hydrostatic strength test at 3 times design working pressure every year on the compressor castings.
4. Statically and dynamically balance each impeller
5. Over-speed test each impeller at 120% of its maximum design RPM

C. Motor (performed by motor manufacturer)

1. Balance rotor in accordance with NEMA MG1
2. High-potential test stator for dielectric strength for 1 second per NEMA MG1 and the following formula: $1.2 \times (2 \times \text{RATED VOLTAGE} + 1000)$
3. 400 hp motors and larger: Mega ohmmeter reading after high potential test

4. No-load readings of current and speed at design voltage and frequency per NEMA standard MG1, including current input at rated frequency with rotor locked

D. Chiller air run test for 30 minutes:

1. Measure current and voltage across each phase
2. Stroke pre-rotation vane actuator and cycle vanes from fully closed to fully open
3. Operate control panel, test functionality and log instrument readings at 10 minute intervals
4. Operate oil pump motor and search lubrication system for leaks
5. Check compressor oil pressure
6. Vibration readings on driveline assembly in the horizontal, vertical and axial planes
7. After the test, remove and replace oil filter

E. Chiller leak integrity testing: Pressurize entire system to design working pressure. Leak test using soap and water. Repair any leaks and repeat test until leak tight.

F. Vacuum hold testing: Evacuate system to 500 microns and hold for one hour. Ensure that pressure does not rise more than 150 microns during the hour. Repair and repeat until passes.

2.12 Control Panel

A. Type: Microprocessor based, stand alone

B. Scope: chiller operation; monitoring of chiller sensors, actuators, relays and switches; display of all operating parameters

C. Capability: stable chiller operation at 36°F leaving chilled water temperature without warnings or shutdowns; no freezing or slushing of chilled water.

D. Enclosure: lockable, NEMA 1

E. Information Display: Color display mounted on control panel enclosure door.

F. User interface: operating parameters displayed in a user-friendly, color and graphical format.

G. Keypad: universal type with soft-keys

H. Height: Eye level; readable and operable without the need for ladder or stool.

I. Temperature rating: 0°C to 40°C

J. System status information: displayed on screen at all times, including the following as a minimum:

1. System status

2. System details
3. Control source (remote or local)
4. User access level
5. Date and time
6. Startup sequence timer
7. Shutdown sequence timer

K. Status messages: in color according to importance, indicate the following as a minimum:
   1. Ready to start
   2. System pre-lube (with countdown timer)
   3. Running and running mode (chilled water set point control or current limit control)
   4. Coasting down (with countdown timer)
   5. Safety shutdown – chiller requires manual restart
   6. Cycling shutdown – chiller will automatically restart
   7. Start inhibit and inhibit mode (anti-recycle, vane motor switch open, excess motor current)

L. System operating information, including the following as a minimum:
   1. Return and leaving chilled water and condenser water temperatures
   2. Evaporator and condenser refrigerant saturation temperatures
   3. Evaporator and condenser pressure
   4. Evaporator tube and condenser tube small temperature difference
   5. Compressor discharge temperature
   6. Oil sump temperature
   7. Oil pump pressure differential
   8. Percent of motor full load current
   9. Number of compressor starts
   10. Operating hours
   11. Pre-rotation vane position
   12. Refrigerant level position (condenser)

   (Variable Speed Drive)

   13. Variable Speed Drive – output frequency
   14. Variable Speed Drive – output voltage (each phase)

15. Variable Speed Drive – current (each phase)
16. Variable Speed Drive – Internal ambient temperature
17. Variable Speed Drive – converter heat-sink temperature
18. Variable Speed Drive – inverter heat sink temperature (each phase)
19. (Active harmonic filter option)
20. Active harmonic filter – Total supply KVA
21. Active harmonic filter – Total power factor
22. Active harmonic filter – Voltage total harmonic distortion (each phase)
23. Active harmonic filter – Current total demand distortion (each phase)
24. Active harmonic filter – filter heat sink temperature
25. Vibration levels (g equivalent) – requires accelerometers and Motor Monitoring Board

M. Programmable set points: including the following as a minimum:
1. Chilled liquid temperature (set point and range)
2. Chilled liquid temperature cycling offset (shutdown and restart)
3. Motor current limit (%)
4. Pull-down demand (limit and time)
5. Remote chilled liquid temperature (reset set point and range)

N. Warning Messages: the following, as a minimum:
1. Real time clock failure
2. Transducer errors
3. Refrigerant level out of range
4. Set point overridden
5. Condenser high pressure limit
6. Evaporator low pressure limit
7. Motor high current limit

O. Safety Shutdowns: trigger a safety shutdown for any of the following as a minimum:
1. Evaporator – low pressure
2. Condenser – high pressure
3. Condenser – high pressure contacts open
4. Auxiliary safety – contacts closed
5. Compressor discharge – high or low refrigerant temperature

6. Oil – high temperature
7. Oil – high or low differential pressure
8. Oil – pump pressure set point not achieved
9. Control panel – power failure
10. Motor or drive – current imbalance
11. Thrust bearing – high oil temperature
12. Thrust bearing – oil temperature sensor
13. Watchdog – software reboot
14. Sensor – failure or out of range
15. Transducer – failure or out of range
16. Motor controller – fault

(Variable Speed Drive)

17. VSD – shutdown, requesting fault data
18. VSD – stop contacts open
19. VSD – 105% motor current overload
20. VSD – high converter heat sink temperature
21. VSD – high inverter heat sink temperature (indicate phase)
22. VSD – pre charge lockout

(Active harmonic filter option only)

23. Active harmonic filter – high heat sink temperature
24. Active harmonic filter – high total demand distortion

P. Safety Shutdowns: for each safety shutdown, indicate the following as a minimum:
   1. System status and details
   2. Day and time of shutdown
   3. Cause of shutdown
   4. Type of restart required

Q. Cycling Shutdowns: indicate the following as a minimum:
   1. Multiunit cycling – contacts open
   2. System cycling – contacts open
   3. Oil – low temperature
   4. Oil – low temperature differential
   5. Control panel – power failure

6. Leaving chilled liquid – low temperature
7. Leaving chilled liquid – flow switch open
8. Condenser – flow switch open
9. Motor controller – contacts open
10. Motor controller – loss of current
11. Power fault
12. Control panel – schedule

(Variable Speed Drive)

13. VSD shutdown – requesting fault data
14. VSD – stop contacts open
15. VSD – initialization failed
16. VSD – high instantaneous current (indicate phase)
17. VSD – gate driver (indicate phase)
18. VSD – single phase input power
19. VSD – high or low DC bus voltage
20. VSD – DC bus voltage imbalance
21. VSD – pre charge: low DC bus voltage
22. VSD – pre charge: DC bus voltage imbalance
23. VSD – high internal ambient temperature
24. VSD – invalid current scale selection
25. VSD – low converter heat sink temperature
26. VSD – low inverter heat sink temperature (indicate phase)
27. VSD – logic board processor
28. VSD – run signal
29. VSD – serial communications

(Active harmonic filter option only)

30. Active harmonic filter – logic board or communications
31. Active harmonic filter – high or low DC bus voltage
32. Active harmonic filter – high current (indicate phase)
33. Active harmonic filter – phase locked loop
34. Active harmonic filter – pre charge: low DC bus voltage
35. Active harmonic filter – DC bus voltage imbalance
36. Active harmonic filter – 110% input current overload

37. Active harmonic filter – logic board power supply
38. Active harmonic filter – run signal
39. Active harmonic filter – DC current transformers 1 and 2

R. Security Access: through ID and password recognition defined by a minimum of three different levels of user capability:
   1. View: prevent unauthorized changing of set points
   2. Operator: allow local or remote control of chiller
   3. Service: allow manual operation of pre-rotation vanes and oil pump

S. Chiller information screen: on-screen display of
   1. Model number
   2. Chiller serial number
   3. Control panel serial number
   4. Manufacturer contract number
   5. Design voltage
   6. Refrigerant type
   7. Original factory rating information (per ARI rating)

T. Data tracking and trend display: on-screen graphical display of:
   1. Parameters selected from a list of a minimum of 100 possibilities
   2. Data collected once per second up to once per hour for each parameter
   3. Data trend lines displayed for a minimum of 5 parameters at once

U. History: store last ten shutdowns and display all system parameters at the time of shutdown

V. Memory: non-volatile type containing operating program and set points, capable of retention for 10 years without memory loss, despite AC or backup battery power loss.

W. Over-current protection: fused connection through a transformer in the panel to protect all controls

X. Terminal Strip: clearly numbered to accept field interlock wiring

Y. Remote communications: Communications to chiller control panel from BAS shall be via BACnet or MS/TP interface. The following points shall be either hardwired or communicated via separate 4-20 mA or 0-10V analog signals, if direct BAS interface does not allow adjustment or monitoring of the following points:
   1. Ready to start contacts

2. Safety shutdown contacts
3. Cycling shutdown contacts
4. Running contacts
5. Leaving chilled liquid set point
6. Current limit set point
7. Chiller start and stop
8. All system operating data including vibration levels
9. Shutdown and cycling messages
10. Operating details of last 10 cycling or safety shutdowns

Z. Units of measure: capable of displaying in either English or Metric units

2.13 Compressor Motor Starter: Not permitted

2.14 Compressor Motor Starter: Variable Speed Drive

A. General: Variable Speed Drive (VSD) compressor motor starter to start motor and control motor speed by controlling the frequency and voltage of the electrical power supplied to the motor

B. Drive type: Pulse width modulated (PWM) utilizing insulated gate bipolar transistors (IGBTs)

C. Control Logic: independently control motor speed and pre rotation vane (PRV) position for optimum efficiency and operational stability. Base motor speed and PRV position on a minimum of 4 inputs: leaving chilled water temperature, return chilled water temperature, evaporator refrigerant pressure, condenser refrigerant pressure; Verify motor speed and PRV position and also use as inputs to the control logic

D. Power Factor: At all loads and speeds, provide a minimum of 0.95 power factor

E. Enclosure: NEMA-1; hinged access door with door interlock; lock and keys; capable of being pad locked

F. Packaging: Factory mounted on chiller, piped to cooling circuit; wired to control panel, compressor motor, oil pump and purge; entire package (including active harmonic filter) shall be UL listed

G. Cooling: cool drive and harmonic attenuation components and internal ambient air via fluid-cooled, closed loop; all starter components accessible for service and replacement without opening the chiller’s main refrigerant circuit

H. Factory run test: Perform an electrical and mechanical run test of VSD starter prior to shipment to verify proper wiring and phasing

I. Factory settings: Set starting design current and current overload settings prior to shipment

J. Harmonic Distortion (Active harmonic filter option): Provide a drive and chiller system with an active harmonic filter mounted inside the starter cabinet. System must generate harmonic distortion levels less than the following, measured at the input side of the drive:

   1. Current: 5% maximum current total demand distortion

K. Inrush amperage: limited to the design full load amperage of the chiller.

L. Protective devices: provide the following, as a minimum:

   1. Electronic current-sensing overloads (1 per phase) – with indicating message on the control panel and reset button; shut down chiller upon detection of operating current exceeding 105% full load amperage.
   2. High instantaneous current overload – with indicating message on the control panel and reset button; shut down chiller upon detection of starting current exceeding 115% of design inrush starting current for 1 second
   3. Phase rotation insensitivity
   4. Single phase failure protection circuit with indicating light – shut unit down if power loss occurs in any phase during operation, including startup.
   5. High temperature safety protection system on IGBTs with indicating light and reset button; via thermistors embedded on IGBT heat sinks – shut unit down if IGBT temperature exceeds acceptable limits.
   6. Power fault protection for momentary power interruptions – interrupt power to the compressor motor within 4 line cycles upon detection of power interruptions longer than ¾ of a line cycle.
   7. High and low line voltage protection

M. Features: factory mount and wire the following as a minimum:

   1. Control transformer: 115volt, sized to power control panel and all unit controls
   2. Electrical lugs: tin plated, sized to accept the copper power lines required by the chiller
   3. Single point power: from electrical lugs at starter, power all powered devices on the chiller including control panel, control devices, line reactor circuitry, active harmonic filter, oil pump and refrigerant purge
   4. Circuit-breaker disconnect: door interlocked; ground fault protection; 65,000A short circuit withstand capacity per UL 508.

N. Control panel readouts: display on the control panel and provide to BAS via communication port the following as a minimum:
   1. Output frequency
   2. Output voltage
   3. Three phase current
   4. Input power (kW)
   5. Energy consumption (kWh)
   6. Elapsed running time (with active harmonic filter option)
   7. Three phase voltage total harmonic distortion (THD)
   8. Three phase current total demand distortion (TDD)
   9. Total unit power factor

2.15 Accessories

A. Flow Proving Sensors: thermal type: factory installed in chilled and condenser water nozzles and factory wired to chiller control panel.

B. BAS System Interface –Provide the following as a minimum:
   1. Export system operating data
   2. BACnet or MS/TP interface for direct connection to BAS
   3. Accept set point adjustments for chilled water set point and demand limit
   4. Field commissioning assistance by manufacturer’s technician

C. Refrigerant isolation valves – 2 butterfly valves: one on the compressor discharge line and one on the liquid line.

D. Spring vibration isolators: (for above-grade floor installations): provide four spring-type, level-adjusting, 1″ deflection vibration isolators with non-skid pads for each support point.

E. Neoprene vibration isolation pads (for slab-on-grade or basement installations): provide four neoprene pads 7/8″ thick (minimum) bonded to a steel plate for each support point.

F. For units shipping in a single piece, factory insulate evaporator, end sheets, suction line, liquid line and other cold surfaces with 3/4″ (or 1-1/2″ above 90˚F and 75%RH within equipment room) in closed-cell neoprene foam insulation. Adhere with vapor-proof cement. (Water boxes and nozzles must be field insulated with removable covers over bolts).

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~~F.~~G. For units to be installed within 60 miles of a coast, provide a replaceable sacrificial anode within the condenser endcap.

2.16 Finishes

A. Dry chiller components for shipment, including inside of water boxes and tubes.

B. Blast and clean chiller surfaces thoroughly. Apply prime coat for painting.

C. Paint all exposed surfaces with alkyd-modified, vinyl enamel machinery paint, including all factory-applied insulation for consistent color matching. If not painted in the factory, paint over insulation in the field with manufacturer's standard paint and color.

Part 3 - Execution

3.1 Installation

A. General Requirements: Install per industry standards, applicable building codes and manufacturer's written instructions.

B. Refrigerant and oil: Rig refrigerant and oil into equipment room and place next to what will be the final location of the chiller. Manufacturer will be responsible for charging the machine.

C. Temporary use: Use of any chiller for temporary heating, cooling or ventilation is strictly prohibited unless a complete inspection and startup has been performed by manufacturer's factory-trained and factory-employed service personnel.

D. Concrete base: Install chiller on a minimum 4″ thick reinforced concrete pad, designed to support the operating weight of the unit.

E. Level the chiller to within ¼″ in both directions (end-to-end and side-to-side).

F. Access clearance: For regular service and tube pull clearances, install chiller with the following minimum recommended clearances:

1. End of unit: distance equal to the length of the heat exchanger shell
2. Front of unit (control panel side): 3′6″ minimum
3. Rear of unit: 2′ minimum
4. Top of unit: 2′ minimum

3.2 Field Quality Control

A. Storage: Store per chiller manufacturer's written recommendations. Protect chiller from weather, construction traffic, dirt, dust, water and moisture.

B. Rigging: Follow manufacturer's written instructions for rigging, off-loading, and use of rigging tools such as spreader bars, forklifts, come-a-longs, and shackles.

C. Protect insulation and painted surfaces from dirt, dust, and physical damage.

3.3 Startup Service

A. Provide two week notice to chiller manufacturer's service department for startup.

B. Notify chiller manufacturer's service department once chiller has been fully piped and wired for primary power and controls, including flow switches. Confirm that sufficient load will be available for starting the chiller on the desired date.

C. Coordinate manufacturer's factory-trained and factory-employed service technician startup visit. This visit shall be a minimum of three days to startup, test, check, and adjust chiller. The cost of this work shall be included in the price of the chiller.

D. Technician shall perform the following steps as a minimum:

1. Check chiller installation
2. Charge machine with refrigerant and oil
3. Energize the unit disconnect switch
4. Verify correct voltage, phases and cycles
5. Energize motor briefly ("bump") and verify correct direction of rotation.
6. Start chiller
7. Test machine for performance within design rating parameters
8. Make adjustments as required

E. Submit a startup report summarizing findings and activities performed.

3.4 Owner Instruction

A. Provide training of the owner's personnel. Cover startup, shutdown, general maintenance and troubleshooting. Review operating and maintenance manual and familiarize personnel with control panel, including its special features and capabilities.

B. Provide a minimum of sixteen (16) hours of training for owner's personnel by manufacturer's factory-trained and factory-employed service technician.

C. Training shall include control panel, VSD, lubrication system, operation, and maintenance requirements.

D. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

3.5 Cleaning

A. Clean, repair all insulation damage, and touch up exterior paint prior to transfer to owner.

3.6 Knock Down Shipment And Reassembly

A. Chiller shall be fully assembled and tested before it is disassembled and prepared for shipment.

B. All disassembly work is to be performed at the manufacturer's factory prior to shipment.

C. No insulation shall be applied at the factory. Under a separate contract, field insulate chiller per manufacturer's insulation diagram and bill of materials.

D. Ship chiller knocked-down into major assemblies

E. Ship refrigerant separately. Mechanical contractor shall rig refrigerant into equipment room and place adjacent to the chiller. Manufacturer's technician shall charge unit at startup. Mechanical contractor shall remove and return empty refrigerant vessels.

F. Place compressor/motor assembly on skids. Seal refrigerant suction and discharge openings with a steel plate. Charge with dry nitrogen at 2-3 psig.

G. (If 2- or 4-piece shipment) Separate the evaporator and condenser shells. Close all refrigerant lines between the shells with steel cover plates. Charge with dry nitrogen at 2-3 psig.

H. Prepare and protect each piece for shipment per specification Section 1.07.

I. Perform all rigging work with rigging contractor's labor. Supervise rigging activities with a technician who is factory trained and employed by the chiller manufacturer. The technician (as a minimum) shall be present when the shells are set in place and leveled, and when the driveline, drive, and suction elbow are lowered into position on the shells.

J. The manufacturer's technician shall complete re-assembly, including tightening of bolts to their recommended torque ratings, reconnection of intra-chiller electrical wiring, control wiring and refrigerant lines, etc.

K. The manufacturer's technician shall leak test the unit, checking thoroughly for leaks. Any leaks must be fixed before the technician charges machine with refrigerant.

SECTION 23 64 23: SCROLL LIQUID CHILLERS

Part 1 - General

1.1 General Requirements: The requirements of this Section shall conform to the general provisions of the Contract, including General and Supplementary Conditions, Conditions of the Contract, and Contract Drawings.

1.2 Scope

A. Provide Microprocessor controlled, multiple scroll compressor, air-cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:

1. Chiller package
2. Charge of refrigerant and oil

3. Electrical power and control connections
4. Chilled liquid connections
5. Manufacturer start-up

1.3 Quality Assurance

A. Products shall be Designed, Tested, Rated and Certified in accordance with, and Installed in compliance with applicable sections of the following Standards and Codes:
   1. AHRI 550/590 – Water Chilling Packages Using the Vapor Compression Cycle
   2. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
   3. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration
   4. ANSI/ASHRAE 34 – Number Designation and Safety Classification of Refrigerants
   5. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
   6. ANSI/NFPA 70 – National Electrical Code (N.E.C.)
   7. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
   8. OSHA – Occupational Safety and Health Act
   9. Manufactured in facility registered to ISO 9001
   10. Conform to Intertek Testing Services for construction of chillers and provide ETL/cETL Listed Mark

B. Factory Run Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

C. Chiller manufacturer shall have a factory trained and supported service organization.

D. Unit Warranty: Manufacturer shall include parts and labor warranty on all equipment and material of its manufacture against defects in workmanship and material for a period of twelve (12) months from date of substantial completion.

E. Compressor Warranty: Manufacturer shall warrant all compressors against defects in workmanship and material for a period of sixty-six (66) months from date of shipment

1.4 Delivery And Handling

A. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.

B. Provide protective covering over vulnerable components for unit protection during shipment. Fit nozzles and open ends with plastic enclosures.

C. Unit shall be stored and handled per Manufacturer's instructions.

Part 2-Products

2.1 Manufacturers

A. YORK by Johnson Controls

B. ChillMaster (modular chillers only)

C. MultiStack (modular chillers only)

D. ClimaCool (modular chillers only)

E. Tandem Chillers (modular chillers only)

2.2 Chiller Materials And Components

A. General: Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air cooled scroll compressor chiller(s) as specified herein.

B. Chiller shall be designed, selected, and constructed using a refrigerant with Flammability rating of "1", as defined by ANSI/ASHRAE STANDARD 34 Number Designation and Safety Classification of Refrigerants.

C. Chiller shall include not less than two refrigerant circuits above 30 tons, scroll compressors, direct-expansion type evaporator, air-cooled or water-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components and special features as specified herein or required for safe, automatic operation.

D. Cabinet: For equipment installed outside, external structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1000 hour, 5% salt spray test, yields minimum ASTM 1654 rating of "6".

E. Operating Characteristics: Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 0°F to 125°F ambient temperature.

F. Service Isolation valves: Discharge (ball type) isolation valves factory installed per refrigerant circuit. Includes a system high-pressure relief valve in compliance with ASHRAE15.

G. Pressure Transducers and Readout Capability

1. Discharge Pressure Transducers: Permits unit to sense and display discharge pressure.
2. Suction Pressure Transducers: Permits unit to sense and display suction pressure.
3. High Ambient Control: Allows units to operate when the ambient temperature is above 115°F.
4. Low Ambient Control: Allows units to operate when the ambient temperature is below 30°F.

2.3 Compressors

A. Compressors: Shall be hermetic, scroll-type, including:
   1. Compliant design for axial and radial sealing.
   2. Refrigerant flow through the compressor with 100% suction cooled motor.
   3. Large suction side free volume and oil sump to provide liquid handling capability.
   4. Compressor crankcase heaters to provide extra liquid migration protection.
   5. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown and reverse rotation protection.
   6. Initial oil charge.
   7. Oil level sight glass.
   8. Vibration isolator mounts for compressors.
   9. Brazed-type connections for fully hermetic refrigerant circuits.
   10. Compressor Motor overloads capable of monitoring compressor motor current. Provides extra protection against compressor reverse rotation, phase-loss and phase-imbalance.

2.4 Refrigerant Circuit Components

A. Each refrigerant circuit shall include: a discharge service ball type isolation valve, high side pressure relief, liquid line shutoff valve with charging port, low side pressure relief device, filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line and suction pressure transducer.

2.5 Heat Exchangers

A. Evaporator:
   1. Evaporator shall be stainless steel construction capable of refrigerant working pressure of 650 psig and liquid side pressure of 150 psig.

2. Heat exchangers shall be UL listed.
3. Water nozzles shall be provided with grooves for field provided ANSI/AWWA C-606 mechanical couplings.
4. Evaporator shall include vent and drain fittings and thermostatically controlled heaters to protect to -20°F ambient in off-cycle.
5. A 20-mesh, serviceable wye-strainer and mechanical couplings shall be provided for field installation on evaporator inlet prior to startup.
6. Liquid connection from evaporator shall be at edge of unit. Thermal dispersion type flow switch shall be factory installed in the evaporator outlet pipe extension and wired to the unit control panel. Insulation and heat trace on piping shall be responsibility of installing contractor. Nozzle connections shall be ANSI/AWWA C-606 (grooved).
7. Where specified, the evaporator shall be freeze-resistant design for cold water production below 40˚F without additives.

B. Air-cooled Condenser:

1. Coils: Condenser coils shall resist galvanic corrosion due to dissimilar metals. Sub cooling is included. Coils shall be designed for a design working pressure of 650 PSIG (45 bar). Condenser coil shall be washable with potable water under 100 psi (7 bar) pressure.
2. Low Sound Fans with Variable Speed Drives: All fans shall be powered by VSDs. Fans shall provide vertical air discharge. Fans shall be corrosion resistant. Fan impeller shall be dynamically balanced for vibration-free operation. Fan guards of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel.
3. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class "F", current protected, Totally Enclosed Air-Over (TEAO) , rigid mounted, with double sealed, permanently lubricated, ball bearings.

C. Water-cooled Condenser:

1. Each condenser shall be brazed plate heat exchanger constructed of 316 stainless steel – designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure.

2.6 Insulation

A. Material: Closed-cell, flexible, UV protected, thermal insulation complying with ASTM C 534 Type 2 (Sheet) for preformed flexible elastomeric cellular thermal insulation in sheet and tubular form.

B. Thickness: minimum 1-1/2" (38mm) and in accordance with applicable energy code.

C. Thermal conductivity: 0.26 (BTU/HR-Ft2-°F/in) maximum at 75°F mean temperature.

D. Factory-applied insulation over cold surfaces of liquid chiller components including evaporator shell, water boxes, and suction line. Liquid nozzles shall be insulated by Contractor after pipe installation.

E. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface including all seams and joints.

2.7 Acoustical Data

A. Provide acoustical sound power or sound pressure level data in decibels (dB) at the scheduled eight (8) octave band center frequencies. A-weighted sound data alone is not acceptable.

B. Provide all sound power or sound pressure level data at 100%, 75%, 50%, and 25% load.

C. Supplied equipment shall not exceed scheduled sound power or sound pressure level data at any load point. The mechanical Contractor shall be responsible for any additional costs associated with equipment deviation.

D. Acoustical performance ratings shall be in accordance with AHRI Standard 370.

2.8 Controls

A. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.

B. Power/Control Enclosure: Rain and dust tight NEMA 3R powder painted steel cabinet with hinged, latched, and gasket sealed door.

C. Microprocessor Control Center:

1. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pump down at system shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from 0°F to 125°F ambient. Automatic reset to normal chiller operation after power failure.

2. Software stored in non-volatile memory, with programmed set points retained in lithium battery backed real-time-clock (RTC) memory for minimum 5 years.

3. Forty character liquid crystal display viewable in direct sunlight and LED backlit for nighttime viewing, descriptions in English (or Spanish), numeric data in English (or Metric) units. Sealed keypad with sections for Set points, Display/Print, Entry, Unit Options & clock, and On/Off Switch.

4. Programmable Set points: display language; chilled liquid temperature set point and range, remote reset temperature range, daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, low liquid temperature cutout, low suction

pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).

5. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, liquid temperature reset via a 4-20milliamp or 0-10 VDC input, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status, water pump status.
6. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. System Safeties include: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
7. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation.
8. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.
9. BAS Communications: BACnet MS/TP
10. Remote Monitoring: All on-board control points shall be discoverable on the BAS for remote monitoring, trending, and alarms.

D. Manufacturer shall provide any controls not listed above necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.9 Power Connection And Distribution

A. Power Panels:

1. NEMA 3R rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.

2. Power supply shall enter unit at a single location in bottom of panel, be 3 phase of scheduled voltage, and connect to individual terminal blocks per compressor.
3. Single Point Circuit Breaker: Single point Terminal Block with Circuit Breaker and lockable external handle (in compliance with Article 440-14 of N.E.C.) to be supplied to isolate power voltage for servicing. Incoming power wiring must comply with the National Electric Code and/or local codes.

B. Compressor, control and fan motor power wiring shall be located in an enclosed panel or routed through liquid tight conduit.

2.10 Accessories And Options

A. Control Power Transformer: Converts unit power voltage to 120-1-60 (500 VA capacity). Factory-mounting includes primary and secondary wiring between the transformer and the control panel.

B. Condenser Coil Environmental Protection *(if installed outside within 60 miles of coastal environment):*

1. Post-Coated Dipped: Dipped-cured coating on condenser coils for seashore and other corrosive applications (with the exception of strong alkalis, oxidizers, and wet bromine, chlorine and fluorine in concentrations greater than 100 ppm).

C. Protective Chiller Panels (Factory Mounted)

1. Louvered Panels (full unit): Painted steel as per remainder of unit cabinet, to protect condenser coils from incidental damage, visually screen internal components, and prevent unauthorized access to internal components.

D. Thermal Dispersion Flow Switch (Factory installed and wired in piping extension kit): Normally open, 30bar pressure rating, stainless steel 316L construction, IP67, -4°F to 158°F ambient rating.

E. Hot Gas By-Pass: Permits continuous, stable operation at capacities below the minimum step of unloading to as low as 5% capacity (depending on both the unit & operating conditions) by introducing an artificial load on the evaporator. Hot gas by-pass is installed on only one refrigerant circuit.

F. Low Temperature Process Glycol: Leaving chilled liquid set point range 10°F to 50°F.

G. Sound Reduction (Factory installed):

1. Compressor Acoustic Sound Blankets

H. Vibration Isolation (Field installed):

1. 2” Deflection Restrained Spring Isolators: Level adjustable, restrained mounts in rugged welded steel housing with vertical and horizontal

limit stops. Housings shall be designed to withstand a minimum 1.0g accelerated force in all directions to 2 inches (50.8 mm)

2.11 Modular Chiller Requirements

A. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits.

B. Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge coated steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module.

C. The compressors shall be enclosed in sound attenuating blankets. An easily-removable, internally-lined enclosure shall be provided to further attenuate sound transmission.

D. Chilled and Condenser Water Mains: Each module shall include supply and return mains for both chilled and condenser water. Cut grooved end connections shall be provided for interconnection to piping with grooved type couplings. Rolled grooved shall be unacceptable. Water Mains shall be installed such that they are beneath any power or control wiring so as to ensure for safe operation in the event of condensation or minor piping leaks.

E. Evaporators and Condensers: Evaporator and condenser shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser. Both the condenser and evaporator heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

F. Variable Flow Operation (Chilled and/or Condenser Water): Automatic butterfly type isolation valves shall incorporate appropriate accessories and controls to allow the chiller to operate efficiently in a variable primary flow system. Each valve shall modulate via a motorized actuator for return water temperature control, chiller minimum flow bypass, chiller no load bypass, or head pressure control.

G. Total Access Design: Manual isolation valves shall be installed between the heat exchangers and water supply mains for heat exchanger isolation and removal without the requirement to shut down the entire chiller allowing for total access to all serviceable components.

H. Compressor: Each module shall contain two hermetic scroll compressors independently circuited and with internal spring isolation mounted to the module with rubber-in-shear isolators. Each system shall also include high discharge pressure and low suction pressure manual reset safety cut-outs.

I. Central Control System: Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.

J. Automatic Module Partitioning: Where required by engineering design for variable heat recovery applications, automatic butterfly valves shall be provided between each chiller module. Valves shall be actuated open or closed by the chiller controller based on signal from BAS in response to heating or cooling loads.

K. The Master Controller shall monitor and report the following on each refrigeration system:

1. Discharge Pressure Fault
2. Suction Pressure Fault
3. Compressor Winding Temperature
4. Suction Temperature
5. Evaporator Leaving Chilled Water Temperature

L. The Master Controller shall be powered by the single point power connection and shall monitor and report the following system parameters:

1. Chilled Water Entering and Leaving Temperature
2. Condenser Water Entering and Leaving Temperature
3. Chilled Water and Condenser Water Flow

M. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).

N. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.

O. The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to fine tune the chiller to different existing building conditions.

P. Interoperability: The Chiller shall be capable of interfacing to the building automation system. Interface shall be accomplished using an Interoperability Web Portal and shall be capable of communication over BACNet.

Q. The chiller array shall have a single or double point power connection based on engineer requirements. Single external inputs and outputs are to be compatible with the building automation system. Inputs/Outputs required include:

1. Remote Start/Stop
2. Customer Alarm Relay
3. Customer Chilled/Load Limit Reset Signal
4. ECW to Mechanical Cooling Module
5. LCW from Mechanical Cooling Module
6. ECHW to Mechanical Cooling Module
7. LCHW from Mechanical Cooling Module
8. Power Phase Monitor
9. Chilled Water Flow Switch Input
10. Condenser Water Flow Switch Input
11. Full Load Indicator Relay
12. Condenser Pump Relay
13. Chilled Water Pump Relay

R. Single Point Power: Chiller shall be equipped with a pre-engineered genuine buss bar electrical system for single point power. Where the equipment size exceeds the amp rating of the buss bar, multiple power connections may be applied. Pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate. Individual power feeds to each module shall be unacceptable.

Part 3 - Execution

3.1 Installation

A. General: Rig and Install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.

C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Division 26).

E. Controls: Coordinate all control requirements and connections with Controls Contractor.

F. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

SECTION 23 64 24: PACKAGED, AIR-COOLED PROCESS CHILLER FOR MRI

Part 1 - General

1.1 Ratings shall be per ARI Standard 550

Part 2-Products

2.1 Acceptable Manufacturers: Filtrine, KKT Kraus, Neslab

2.2 Controls & Safeties: Electronic, micro-processor based temperature controller with high limit temperature alarm, water flow safety switch with no flow alarm; tank level monitor with low tank level alarm; manual reset high and auto reset low refrigeration pressure safeties; fan cycling, head pressure control valve, compressor anti-short-cycle delay timer, control circuit on/off switches, manual water flow bypass valve.

2.3 Indicators: Inlet and outlet water temperature indicators; pump pressure gauge; liquid filled refrigeration pressure gauges; low tank, high temperature, no flow alarm indicators. Provide an interface to share these parameters with the BAS.

2.4 Reservoirs: Stainless steel tanks with vacuum vents and pressure relief safety valves, insulated with closed cell insulation.

2.5 Pumps: All bronze or all stainless steel construction.

2.6 Changeover Panel: Manual or automatic changeover panel (see schedule) shall be furnished by process chiller manufacturer and shall include all necessary thermometers, pressure gauges, valve, flow meters, backflow preventers, check valves and 5 micron filters as required for changeover from chilled water to city water.

Part 3 - Execution

3.1 Manufacturer authorized representative shall supervise installation and startup of chiller(s).

SECTION 23 64 26 13: AIR-COOLED SCREW LIQUID CHILLERS

Part 1 - General

1.1 General Requirements

A. The requirements of this Section shall conform to the general provisions of the Contract, including General and Supplementary Conditions, Conditions of the Contract, and Contract Drawings.

1.2 Scope

A. Provide Microprocessor controlled, twin-screw compressor, air-cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:

1. Chiller package
2. Charge of refrigerant and oil
3. Electrical power and control connections
4. Chilled liquid connections
5. Manufacturer start-up

1.3 Quality Assurance

A. Products shall be Designed, Tested, Rated and Certified in accordance with, and Installed in compliance with applicable sections of the following Standards and Codes:

1. AHRI 550/590 – Water Chilling Packages Using the Vapor Compression Cycle
2. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
3. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration
4. ANSI/ASHRAE 34 – Number Designation and Safety Classification of Refrigerants
5. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
6. ANSI/NFPA 70 – National Electrical Code (N.E.C.)
7. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
8. OSHA – Occupational Safety and Health Act
9. Manufactured in facility registered to ISO 9001
10. Conform to Intertek Testing Services for construction of chillers and provide ETL/cETL Listed Mark

B. Factory Run Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

C. Chiller manufacturer shall have a factory trained and supported service organization.

D. Unit Warranty: Manufacturer shall include parts and labor warranty on all equipment and material of its manufacture against defects in workmanship and material for a period of twelve (12) months from date of substantial completion.

E. Compressor Warranty: Manufacturer shall warrant all compressors against defects in workmanship and material for a period of sixty-six (66) months from date of shipment

1.4 Delivery And Handling

A. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.

B. Provide protective covering over vulnerable components for unit protection during shipment. Fit nozzles and open ends with plastic enclosures.

C. Unit shall be stored and handled per Manufacturer's instructions.

Part 2-Products

2.1 Manufacturers

A. Johnson Controls / YORK.

2.2 General

A. Description: Furnish, Install, and Commission factory assembled, charged, and operational run tested variable speed air-cooled screw compressor chiller as specified herein and shown on the Drawings. Chiller shall include, but is not limited to: a complete system with multiple independent refrigerant circuits, variable speed semi hermetic twin screw compressors, shell and tube hybrid falling film type evaporator, air-cooled condenser, R134a refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.

B. Operating Characteristics:

1. Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 0°F to 131°F ambient temperature.
2. Cabinet: Unit panels, structural elements, control boxes and heavy gauge structural base shall be constructed of painted galvanized steel. All exposed sheet steel shall be coated with baked on powder paint to meet 1000-hour salt spray test in accordance with the ASTM B117 standard.

3. Shipping: Unit shall ship in one piece and shall require installer to provide only a single evaporator inlet and outlet pipe connection. If providing chiller model that ships in multiple pieces, bid shall include all the material and field labor costs for factory authorized personnel to install a trim kit to connect the pieces as well as all interconnecting piping and wiring.

2.3 Compressors

A. Compressor Motors: Refrigerant suction-gas cooled accessible hermetic compressor motor, maximum mesh screen, with inherent internal thermal overload protection and external current overload on all three phases.

B. Balancing Requirements: All rotating parts shall be statically and dynamically balanced.

C. Lubrication System: External oil separators with no moving parts, 450 psig (31 barg) design working pressure, and ETL listing shall be provided on the chiller. Refrigerant system differential pressure shall provide oil flow through service replaceable, full flow, cartridge type oil filter internal to compressor. Filter bypass, less restrictive media, or oil pump not acceptable.

D. Capacity Control: Variable speed drive. Compressors shall start at minimum load. Provide Microprocessor control to command compressor capacity to balance compressor capacity with cooling load down to a minimum of 10%.

2.4 Refrigerant Circuit Components

A. Refrigerant: R-134a. Classified as Safety Group A1 according to ASHRAE 34.

B. Each independent refrigerant circuit shall incorporate all components necessary for the designed operation including: liquid line shut-off valve with charging port, low side pressure relief device, removable core filter-drier and sight glass with moisture indicator.

C. Chiller manufacturer shall provide an independent circuit for each compressor to provide maximum redundancy during chiller operation. If equipment does not have independent circuits per compressor, manufacturer shall provide owner one spare compressor of each unique size.

D. Discharge lines shall be provided with manual compressor shut-off service valves.

2.5 Heat Exchangers

A. Evaporator:

1. Evaporator shall be shell and tube, hybrid falling film type with 2 pass arrangement to optimize efficiency and refrigerant charge. Tubes shall be high-efficiency, internally and externally enhanced type copper tubes. Each tube shall be individually replaceable. Independent refrigerant circuits shall be provided per compressor.

2. Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 235 psig (16 barg) refrigerant side design working pressure and 150 psig (10 barg) liquid side design working pressure.
3. Water boxes shall be removable to permit tube cleaning and replacement. Water boxes shall include liquid nozzle connections suitable for ANSI/AWWA C-606 couplings, welding, or flanges.
4. Provide vent and drain fittings, and thermo-statically controlled heaters to protect to -20°F (-28°C) ambient temperature in off-cycle. A separate power connection for evaporator heaters is required and shall be provided by the Contractor.
5. Connection location: Chilled liquid inlet and outlet nozzle connections are located at rear (opposite control panel) end of unit.

B. Air-cooled Condenser:

1. Coils shall be post-coated with an electro-deposited and baked flexible epoxy coating that is finished with a polyurethane UV resistant top-coat suitable for highly corrosive applications if installed within 60 miles of coastal environment.
2. Coils shall be designed for 350 psig (24 barg) or higher working pressure.
3. Unit shall include Louvered Panels (Full Unit): Painted steel to match unit panels, over internal components.
4. Low Sound Fans with Variable Speed Drives. All fans shall be powered by VSDs. Fans shall provide vertical air discharge. Fans shall be corrosion resistant. Fan impeller shall be dynamically balanced for vibration-free operation. Fan guards of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel.
5. Fan Motors: High efficiency, direct drive, 3-phase, insulation class “F”, current protected, Totally Enclosed Air-Over (TEAO), with double sealed, permanently-lubricated ball bearings. Open Drip Proof (ODP) fan motors will not be acceptable.

2.6 Insulation

A. Material: Closed-cell, flexible, UV protected, thermal insulation complying with ASTM C 534 Type 2 (Sheet) for preformed flexible elastomeric cellular thermal insulation in sheet and tubular form.
B. Thickness: minimum 1-1/2” (38mm) and in accordance with applicable energy code.
C. Thermal conductivity: 0.26 (BTU/HR-Ft2-°F/in) maximum at 75°F mean temperature.

D. Factory-applied insulation over cold surfaces of liquid chiller components including evaporator shell, water boxes, and suction line. Liquid nozzles shall be insulated by Contractor after pipe installation.

E. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface including all seams and joints.

2.7 Acoustical Data

A. Provide acoustical sound power or sound pressure level data in decibels (dB) at the scheduled eight (8) octave band center frequencies. A-weighted sound data alone is not acceptable.

B. Provide all sound power or sound pressure level data at 100%, 75%, 50%, and 25% load.

C. Supplied equipment shall not exceed scheduled sound power or sound pressure level data at any load point. The mechanical Contractor shall be responsible for any additional costs associated with equipment deviation.

D. Acoustical performance ratings shall be in accordance with AHRI Standard 370.

2.8 Power And Electrical Requirements

A. Power/Control Panel:

1. Factory installed and wired NEMA 3R, powder painted steel cabinets with tool lockable, hinged, latched, and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor starters and fan motor contactors, current overloads, and factory wiring.

2. Panel shall include control display access door.

B. Single Point Power:

1. Provide single point power connection to chiller, shall be 3 phase of scheduled voltage.

2. Single Point Circuit Breaker: A unit-mounted Circuit Breaker with external lockable handle shall be provided at the point of incoming single point connection for field connection, interconnecting wiring to the compressors, and isolating the power voltage for servicing. Incoming power wiring must comply with local codes. Circuit breaker shall be sized to provide the motor branch circuit protection, short circuit protection and ground fault protection for the motor branch-circuit conductors, the motor control apparatus and the motors.

C. Control Transformer: Power panel shall be supplied with a factory mounted and wired control transformer that will supply all unit control voltage from the main unit power supply. Transformer shall utilize scheduled line voltage on the primary side and provide 115V/1Ø on secondary.

D. Short Circuit Withstand Rating of the chiller electrical enclosure shall be published in accordance with UL508.

E. Power Factor:

1. Provide equipment with power factor correction capacitors as required to maintain a displacement power factor of at least 95% at all load conditions.
2. The installing contractor is responsible for additional cost to furnish and install power factor correction capacitors if they are not factory mounted and wired.

F. All exposed power wiring shall be routed through liquid-tight, UV-stabilized, non-metallic conduit.

G. Supplied equipment shall not exceed scheduled Minimum Circuit Ampacity (MCA.) The mechanical Contractor shall be responsible for any additional costs associated with equipment deviation.

2.9 Controls

A. General:

1. Provide automatic control of chiller operation including compressor start/stop and load/unload, anti-recycle timers, condenser fans, evaporator pump, evaporator heater, unit alarm contacts and run signal contacts.
2. Chiller shall automatically reset to normal chiller operation after power failure.
3. Unit operating software shall be stored in non-volatile memory. Field programmed set points shall be retained in lithium battery backed regulated time clock (RTC) memory for minimum 5 years.
4. Alarm contacts shall be provided to remote alert for any unit or system safety fault.

B. Display and Keypad:

1. Provide minimum 80 character liquid crystal display that is both viewable in direct sunlight and has LED backlighting for nighttime viewing. Provide one keypad and display panel per chiller.
2. Display and keypad shall be accessible through display access door without opening main control/electrical cabinet doors.
3. Display shall provide a minimum of unit setpoints, status, electrical data, temperature data, pressures, safety lockouts and diagnostics without the use of a coded display.
4. Descriptions in English (or Spanish), numeric data in English (or Metric) units.

5. Sealed keypad shall include unit On/Off switch.

C. Programmable Setpoints: Display language, chilled liquid cooling mode, local/remote control mode, display units mode, system lead/lag control mode, remote temperature reset, remote current limit, remote sound limit, low ambient temperature cutout enable/disable, leaving chilled liquid setpoint and range, maximum remote temperature reset.

D. Display Data: Chilled liquid leaving and entering temperatures; outside ambient air temperature; lead system; evaporator pump status; active remote control; compressor suction, discharge, and oil pressures per refrigerant circuit; compressor discharge, motor, and oil temperatures per refrigerant circuit; saturation temperatures per refrigerant circuit; compressor speed; condenser fan status; condenser subcooling temperature; condenser drain valve percentage open; compressor capacity in percentage of Full Load Amps; compressor number of starts; run time; operating hours; evaporator heater status; history data for last ten shutdown faults; history data for last 20 normal (non-fault) shutdowns.

E. Predictive Control Points: Unit controls shall avoid safety shutdown when operating outside design conditions by optimizing the chiller controls and cooling load output to stay online and avoid safety limits being reached. The system shall monitor the following parameters and maintain the maximum cooling output possible without shutdown of the equipment: motor current, suction pressure, discharge pressure, starter internal ambient temperature, and starter baseplate temperature.

F. System Safeties: Shall cause individual compressor systems to perform auto-reset shut down if: high discharge pressure or temperature, low suction pressure, low motor current, high/low differential oil pressure, low discharge superheat, high motor temperature, system control voltage.

G. Unit Safeties: Shall be automatic reset and cause compressors to shut down if: high or low ambient temperature, low leaving chilled liquid temperature, under voltage, flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.

H. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.10 Accessories And Options

Some accessories and options supersede standard product features. All options are factory-mounted unless otherwise noted.

A. Controls options:

1. Gateway: Provides communication for Building Automation Systems (BACnet, MS/TP).

2. Remote Monitoring: All on-board control points shall be discoverable on the BAS for remote monitoring, trending, and alarms.

B. General options:

1. Differential Pressure Switch: 3-45 psig (0.2-3 barg) range with 1/4" NPTE pressure connections. (Field Mounted by Contractor).

Part 3 - Execution

3.1 Installation

A. General: Rig and Install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.

C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor.

E. Controls: Coordinate all control requirements and connections with Controls Contractor.

F. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory fin

SECTION 23 65 00: COOLING TOWERS

Part 1 - General

1.1 Work Included:

A. The piping arrangement for the cooling towers shall be designed such that flow to and from the tower is hydronically balanced. This is to ensure equal flow distribution to and from each tower cell. If the piping system cannot be designed to ensure equal distribution to the towers' hot water distribution basins, automatic isolation valves shall be used.

B. Instead of using a sluice to maintain the same water level in each tower's cold water basin, use an adequately sized equalizer line with valves to permit each basin to be isolated for cleaning.

C. Cooling towers in areas with winter design temperatures of 32◦F or lower shall have steam basin heaters, if it is available and the tower is above the steam mains, electric if not. Provide water meter to measure makeup and blow down water usage to the cooling tower. Coordinate with water and sewer departments to reduce sewer charges proportional to makeup quantity to tower.

D. For each project, select at least one crossflow and one counterflow tower, each meeting the HCA Guidelines and design requirements of the project. Compare them based on performance and total cost of ownership. Submit tower selection(s) and recommendations to owner at the same time as chiller selections.

Part 2-Products

2.1 Acceptable Manufacturers: Baltimore Air Coil, Evapco, Marley

2.2 Provide cooling towers with a basin cleaning and particle separation/filtration system for the condenser water in each cooling tower basin. Refer to requirements in section 23.25.16.13 – Condenser Water Basin Cleaning and Filtration System.

~~2.3 Counterflow towers are preferred over crossflow where site conditions permit and the net cost of both styles is relatively close.~~

~~2.4~~2.3 Provide all maintenance access platforms and ladders (including platforms and ladders internal to the tower), personnel safety rails and devices, motor davits, extended lube lines, etc. for ease of maintenance. Maintenance personnel should not have to a carry a ladder or special lifting devices to the cooling tower to do regular preventive maintenance. Regular preventive maintenance includes greasing bearings, tensioning belts, and inspections of moving parts. A maintenance walkway is required around the entire cooling tower perimeter to allow access to fill material.

~~2.5~~2.4 Provide adequate platforms and coordinate locations so that no maintenance has to be done from a ladder.

~~2.6~~2.5 Specify VFDs on cooling tower fans and grounding rings on motors.

~~2.7~~2.6 Specify electronic basin level control instead of float control. Insulate and heat-trace the conductivity probe chamber to prevent freezing.

~~2.8~~2.7 Specify stainless steel hot and cold water basins for all cooling towers with galvanized steel for remaining tower construction. In locations within 60 miles of the coast, use all stainless steel construction. Stainless steel used in towers to be minimum 304 type stainless steel.

~~2.9~~2.8 All ferrous components potentially in contact with water in either basin shall be minimum 304 stainless steel.

~~2.10~~2.9 Specify CTI certification for all cooling towers.

Part 3 - Execution

3.1 Contractor shall allow adequate time for cleaning, flushing, and full passivation of galvanized towers under no-load conditions. Contractor shall coordinate all requirements and efforts with current facility chemical treatment provider.

SECTION 23 73 00: AHUs – INDOOR CENTRAL STATION

Part 1 - General

1.1 Work Included:

A. The cost/benefit of factory assembled, indoor air handling systems should be evaluated with input from the architect, and HCA Design and Construction during the project planning phase. The evaluation will include discussions for indoor mechanical rooms, penthouses or rooftop units. Evaluation should consider aesthetics, noise, first costs, future expansion, and long-term operating and maintenance costs, the utilization of fan wall or fan array technology should be part of these considerations.

B. The use of custom air handling units is discouraged unless special conditions exist such as space limitations or requirements for special equipment components.

C. Specify that at time of submission to Architect/ Design Engineer, contractor shall submit an information-only copy of the complete air handling unit submittal to HCA FacilitiGroup.

D. Due to increased maintenance requirements, diminished lifespan, air mixing issues, and aesthetic concerns, rooftop air handlers shall not be considered unless prior approval is obtained from HCA FacilitiGroup. If approved, noise and vibration problems must be addressed. Rooftop units are not desired in heavy snow areas, or in coastal regions (up to 60 miles from the coast) due to corrosion. The effect on future vertical expansion must also be considered.

~~E. Other rooftop unit concerns to be considered:~~

~~1. Provide air blender in unit if necessary to ensure proper mixing of air to minimize coil-freezing problems.~~

~~2. VFDs and controls locations in separate compartments. Do not locate in air plenum space.~~

~~3. Specify VFDs by the same manufacturer for the entire project. Manufacturer shall install at factory.~~

~~4. Roof access shall be considered and planned. Show plans and discuss access points with HCA FacilitiGroup. Do not design for access via patient room windows. Make provisions for maintenance personnel to carry tool and repair parts to roof.~~

~~5. Locate isolation valves, control valves, gauges and thermometers at the unit in accessible piping vestibules. Vestibules shall have adequate space to permit complete removal of any component inside without the need to disassemble the rest of the piping.~~

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

~~6. Schedule maximum fan sound level performance (8 octave bands) allowed on drawings. (See section 23 33 19: 1.01 B)~~

~~F.~~E. AHU design and layout shall minimize the potential of unit shut down due to low mixed air temperatures. Designer shall refer to the extreme weather data conditions recorded for the local area. Utilize air blenders if necessary to avoid nuisance freeze safety operations caused by poor mixing of return and outside air. Route the return and outside air ducts as recommended by the air blender manufacturer to promote proper mixing of these airstreams.

~~G.~~F. When DX coils are used, the handling of outside air shall be given special consideration. Humid climates and/or higher than normal percentages of outside air may require a pre-cooling coil.

~~H.~~G. The facility should be divided up into compatible zones for air handing unit sizing and selection. Consideration should be given to those areas that need to operate around the clock, and those that could be shut down and thermal zoning. Smoke compartments should also be considered when dividing between systems.

~~I.~~H. Where a pre-heat coil is required, use a hot water coil and dedicated circulator pump. Design controls to activate pump when there is a call for heating or when outside air temperature is below 40°F. Size the pump to maintain the minimum velocity of 3 feet per second in the pre-heat coil to preclude freezing. Use a differential pressure switch across the pump to indicate pump status to the BAS.

~~J.~~I. Always specify return fans on AHU's over 10,000 CFM supply or where the return fan is used for smoke evacuation required by the AHJ. Centrifugal return fans are preferred.

~~K.~~J. Schedule maximum sound power levels (8 octave bands) for both supply and return fans on the drawings.

~~L.~~K. Avoid using separate final filter sections not manufactured by the AHU supplier that require ductwork to transition from the AHU discharge to the final filter.

~~M.~~L. Avoid using blow-through units where final filters are required.

~~N.~~M. Specify return air humidity sensors in all air handling units even if they are not equipped with a humidifier.

1.2 Section Includes

A. Indoor and outdoor air handling units and components as scheduled and shown on drawings.

B. Variable frequency drives.

1.3 Related Sections

A. The requirements of the General Conditions, Supplementary Conditions, Division 1, equipment schedules, and drawings apply.

1.4 References

A. AMCA 99 – Standard Handbook

B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes

C. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters

D. AMCA 611-95 – Methods of Testing Airflow Measurement Stations for Rating

E. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings

F. ANSI/UL 900 – Test Performance of Air Filter Units

G. AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment

H. AHRI 410 – Forced-Circulation Air Cooling and Air Heating Coils

I. ANSI/AHRI 430 – Performance Rating of Central-Station Air Handling Units

J. ASHRAE 52.1/52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size

K. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality

L. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

M. ASTM-C 1338 – Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.

N. NFPA 70 – National Electric Code (conductors, equipment and raceways)

O. NFPA 90A – Installation of Air Conditioning and Ventilation Systems

P. SMACNA – HVAC Duct Construction Standards

Q. UL-181 – Mold Growth and Humidity Test

R. UL-1995 – Standard for Safety for Heating and Cooling Equipment

1.5 Quality Assurance

A. Manufacturer shall have a minimum of 25 years of experience in designing, manufacturing, and servicing air-handling units.

B. The design indicated on the schedules and shown on the drawings is based upon the products of the named manufacturer.

1.6 Coordination

A. If equipment is supplied other than as shown on plans, coordinate with the General Contractor and affected subcontractors. This coordination shall include (but is not limited to) the following:

1. Structural supports for units.

2. Size and location of concrete bases/housekeeping pads
3. Location of roof curbs, unit supports and roof penetrations
4. Ductwork sizes and connection locations
5. Piping size and connection/header locations
6. Interference with existing or planned ductwork, piping and wiring
7. Electrical power requirements and wire/conduit and over current protection sizes.
8. Trap height requirements

B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished other than as shown as basis of design.

1.7 Ratings And Certifications

A. Air Handling Unit safety: ETL or UL 1995

B. Air Handling Unit energy use: ASHRAE 90.1

C. Fans: AMCA 210

D. Air Coils: AHRI 410

E. Air Handling Unit certification program: ANSI/AHRI 430

F. Filter media: ANSI/UL 900 listed Class I or Class II

G. Control wiring: NEC codes & ETL requirements

H. Motors: Federally mandated Energy Policy Act (EPACT).

I. Airflow Monitoring Stations: AMCA 611-95

J. Units shall be seismically certified in accordance with applicable IBC 2000, 2003, 2006, 2009 or 2012 and applicable Building Code for life safety environments.

K. Units shall have secured OSHPD pre-approval of Special Seismic Certifications to be used in health facilities construction in California. Label equipment per OSHPD labeling instructions.

L. Outdoor units shall meet the Large Missile Impact Test for AHU casing (walls, roof, and doors) and base in the State of Florida. Units shall carry a Notice of Acceptance (NOA) from the Miami-Dade County Product Control Division. Label equipment per NOA labeling instructions.

1.8 Submittal Documentation Required

A. TMA asset tracking

B. Furnish fan performance ratings and fan curves with specified operating point clearly plotted.

C. Furnish drawings indicating unit dimensions, required clearances, field connection locations, wiring diagrams, shipping drawings, and curb drawings.

D. Furnish performance report showing unit level performance data including: fan(s), motor(s), coil(s) and other functional components. Performance report shall also include unit casing performance.

E. Furnish operation and maintenance data, including instructions for lubrication, filter replacement, motor and drive replacement, and condensate pan cleaning; spare parts lists, and wiring diagrams.

F. Adjust and report performance ratings for the proper altitude of operation.

G. Report air-handling unit performance ratings in accordance with ANSI/AHRI-430 (static pressure, airflow, fan speed, and fan brake horsepower).

H. Report static pressure profiles by component section.

I. Report coil ratings in accordance with AHRI-410 (capacities and pressure drops).

J. Report unweighted octave band AHU sound power for inlets and outlets rated in accordance with AHRI Standard 260. Provide eight data points, the first for the octave centered at 63 Hz, and the eighth centered at 8,000 Hz. Manufacturer shall not use sound estimates based on bare fan data (AMCA ratings), nor use calculations like the substitution method based on AHRI 260 tests of other AHU products. Provide data for inlets and outlets as scheduled. Report unweighted casing radiated sound power over the same 8 octave bands in accordance with ISO 9614 Parts 1&2 and ANSI S12.12.

K. Airflow measuring device performance shall be certified and rated in accordance with AMCA-611. Report data in accordance with AMCA-611. Provide AMCA Certified Rating Seal for Airflow Measurement Performance.

L. Report panel deflection at +/-8" w.g., stated in terms of 'L/X' where 'L' is the casing panel length and 'X' is a constant provided by the AHU manufacturer.

M. Report casing leakage rate at +/-8" w.g., specified in terms of percentage of design airflow.

N. Report weight loads and distributions by component section.

O. Report product data for filter media, filter performance data, filter assembly, and filter frames.

P. Report electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

Q. Report motor electrical characteristics.

1.9 Delivery, Storage and Handling

A. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).

B. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.

C. Follow manufacturer's recommendations for handling, unloading and storage.

D. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.

E. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.

F. Enclose and protect control panels, electronic or pneumatic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.

G. Seal openings to protect against damage during shipping, handling and storage.

H. Wrap indoor and outdoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively AHU must be tarped for shipment and storage.

I. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.

J. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

1.10 Extra Materials

A. In addition to the set of filters provided with the air handler, p~~P~~rovide one ~~additional~~ clean set ~~of filters~~ for balancing, and one additional set for final turnover to owner, for a total of 3 sets of filters provided.~~.~~

B. Provide one extra set of belts, in addition to the factory-installed set (if belt drive is needed).

1.11 Warranty

A. Provide entire unit parts and labor warranty for 12 months from date of substantial completion. Warranty shall cover manufacturer defects. Warranty work shall be performed by manufacturer's factory-trained and factory-employed technician.

B. For air handlers provided with UV lights, include service contract to replace bulbs once per year for five years after startup. Contract must include materials and labor to install new and dispose of old bulbs.

C. Parts associated with other routine maintenance, such as belts and air filter replacement shall be excluded.

1.12 System Startup

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.

Part 2-Products

2.1 Acceptable Products

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule as YORK, div. of Johnson Controls Inc.

2.2 General Description

A. The owner requirement is for modular type air handlers where possible. Custom type equipment is only to be applied where absolutely necessary.

B. Air Handling Unit (AHU) consists of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, components, and accessories; as shown on drawings, schedules, and specifications.

C. Provide AHU to meet the specified levels of performance for scheduled items including airflow, static pressure, cooling capacity, heating capacity, electrical characteristics, sound, casing leakage, panel deflection and casing thermal performance.

D. Provide internal components and accessories as specified and scheduled. Components and accessories shall be installed by the AHU manufacturer.

E. Ship units in one piece. Split units only where necessary for shipping and installation.

F. Manufacturer shall provide detailed, step-by-step instructions for disassembly and reassembly.

G. For AHU segments that must be broken down for rigging and installation: segment shall be disassembled and reassembled by manufacturer's factory-trained service personnel.

2.3 Standards Compliance

A. Comply with ratings and certifications referenced in this specification.

B. Manufacturers who do not comply with ANSI/AHRI-430 shall factory test EACH unit to verify brake horsepower rating, airflow performance and total static pressure performance.

C. Manufacturers who do not conform to requirements of AHRI 260 for ducted discharge and return air sound shall submit EACH unit to an independent sound test laboratory for AHRI 260 testing. The test laboratory shall conform to AHRI 260, Section 4.4, Test Equipment and Facilities.

2.4 Base Rail

A. Provide a structural base rail under the full perimeter of the unit

B. Provide clearance for proper external trapping of drain pans and steam condensate without the need to cut the floor.

C. Provide base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

2.5 Casing

A. Provide 2" double wall AHU casing. Exposed insulation is not acceptable.

B. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

C. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

D. Encapsulate insulation with sheet metal so that air does not contact insulation. Solid lined panels insulated with spray injected foam shall be hermetically sealed at each corner and around their entire perimeter, to eliminate airflow through the panel and to eliminate microbial growth potential within the casing wall. Foam insulation shall fully fill entire floor, all walls, and roof with no voids.

E. Provide casing with minimum thermal resistance (R-value) of 13 hr-ft^2-°F/BTU for indoor applications and 16 hr-ft^2-°F/BTU for outdoor. The casing shall incorporate thermal breaks as required so that when assembled, minimal path(s) of continuous unbroken metal to metal conduction from inner to outer surfaces exist.

F. All exterior (minimum 18 gauge) and interior (minimum 20 gauge) casing panels (roof, wall, access door) shall be made of G90 galvanized steel. Interior casing panels (walls and floor) shall be made of 304 stainless steel within wet sections – from cooling coil ~~and~~ or humidifier up to supply fan bulkhead~~sections~~. ~~Outdoor u~~Units installed within 60 miles of the coast shall also include 304 stainless steel walls in outdoor air ~~outside air intake~~ sections up to the cooling coil~~with 304 stainless steel floors~~.

~~G. Perforated panels shall be provided on intake, discharge, and fan sections.~~

~~H.~~G. Floors shall be provided with 0.125" aluminum diamond tread~~s~~ plate ~~floor~~ liner for units ~~above~~ 48" and greater in height. Units below 48" in height shall ~~be~~ have 14 gauge G90 galvanized steel floors in dry sections ~~with~~ and 14 gauge 304 stainless steel floors ~~within cooling coil and humidifier sections~~from cooling coil or humidifier to fan bulkhead. Units shorter than 48" installed within 60 miles of the coast shall also have 14 gauge 304 stainless steel floors in outdoor air sections up to the cooling coil. ~~Outdoor units shall also include outside air intake sections with 304 stainless steel floors.~~

~~I.~~H. Provide a unit frame of galvanized steel that provides the overall structure of the unit and does not rely on the casing panels for structural integrity.

~~J.~~I. Unit shall conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1.0% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. The unit leakage is the sum of the leakage in all positively and negatively pressurized sections of the air handler.

~~K.~~J. Provide wall panels and access doors that deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

~~L.~~K. Provide floors and roofs that deflect no more than L/240 when subjected to a 300 lb static load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

~~M.~~L. Provide outdoor AHUs with a roof system that deflects no more than L/240 when subjected to a static snow load of 30 lb/ft2. 'L' is defined as the panel-span length and 'L/240' is the deflection at the panel midpoint.

~~N.~~M. Provide outdoor AHUs with a roof sloped at a minimum pitch of 1/4" per foot. The roof shall overhang side and end panels by a minimum of 2."

~~O.~~N. Provide an exterior finish for outdoor AHUs that show a breakdown of less than 1/8" on either side of a scribed line when subjected to ASTM B117 500 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of '6.'

2.6 Primary Drain Pans

A. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

B. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

C. Provide floors that deflect no more than L/240 when subjected to a 300 lb load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint

D. Comply with the stated intent of ASHRAE Standard 62.

E. Provide a drain pan under each cooling coil and humidifier. Drain pans for cooling coils and humidifiers shall meet the requirements of ASHRAE 62.

F. Drain pans shall be stainless steel.

G. Provide drain connection made of same material as drain pan. Do not use dissimilar metals because of the risk of galvanic corrosion. Weld connection to the drain pan.

H. Cooling coil d~~D~~rain pan shall be double wall construction with an insulation R-value of 13~~6.25~~ hr-ft^2-°F/ (BTU-in). Low temp glycol coils shall be provided with additional 2” insulated drain pan subfloor. Drain pans shall be extended as much as possible without making the section longer.

I. Provide drain pan under the complete width and length of cooling coil and humidifier sections. Drain pan shall be full width, and completely extend to next section downstream of cooling coil and humidifier within AHU without growing section length. Pan shall extend a minimum of 12” downstream of cooling coil except where the length is limited due to the installation of UV lighting.~~.~~

J. Drain pan shall allow visual inspection and physical cleaning on 100% of the pan surface without removal of the coil or humidifier.

K. Provide a minimum of 1” clearance between the drain pan and any coil casing, coil support or any other obstruction.

L. Provide drain pan that allows the design rate of condensate drainage regardless of fan status.

M. Provide drain pan sloped in at least two planes by at least 1/8” per foot toward a single drain. Locate drain connection at the lowest point of the pan. Pan shall have no horizontal surfaces.

2.7 Access Doors

A. Provide thermal break, double wall access door(s) that meet requirements for the AHU casing.

B. Provide industrial-style stainless steel hinges that permit 180 degrees of door swing.

C. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or “paw” latches are not acceptable.

D. Provide each door with a single handle linked to multiple latching points or a separate handle for each latching point. Doors serving access segments shall have an interior latch handle.

E. Provide access doors with a locking hasp to accommodate a lockout device.

F. Where permitted by code, provide double-pane viewing windows in all fan access sections, humidifier sections and upstream of all filter sections. Windows shall be a non-condensing type consisting of a desiccant dehumidification layer. Minimum dimension shall be 8" x 8".

G. Provide VentLok 699 Test Port and gasket in all door systems and as needed to provide at least one port upstream and one port downstream of every coil and filter.

H. Access doors, where permitted by code, are always to open against positive pressure.

~~2.8 Pipe Chase Cabinet~~

~~A. Provide external pipe chases with double wall, insulated panels. Pipe chase shall have the same thermal performance as the unit casing.~~

~~B. Provide a perimeter base rail and/or roof curb under the pipe chase(s) that meets requirements for the AHU base rail and/or roof curb.~~

~~C. Manufacturer may combine the pipe chase enclosures of adjacent segments.~~

~~D. Provide an appropriate pipe chase depth and access doors as shown on drawings. Pipe chase depth is the clear inside dimension from inner pipe chase surface to outer unit surface.~~

~~E. Manufacturer may ship pipe chases separate from AHU if the chases are provided with lifting lugs for field installation per the AHU base rail requirements. Manufacturer shall provide step-by-step instructions with illustrations for proper pipe chase installation.~~

~~2.9 Roof Curbs~~

~~A. Provide insulated factory-fabricated galvanized steel roof curb for outdoor units in accordance with local codes and seismic compliance. Roof curb shall support the full perimeter of the air handling equipment, including pipe chases.~~

~~B. Match roof curb to roof slope. Curb surface shall be level in both axes.~~

~~C. Provide wood nailing strip to which roofer may nail roof flashing.~~

~~D. Ship roof curb loose for field installation prior to unit placement.~~

~~2.10~~2.8 Fans

A. Direct drive fans are preferred over belt drive. As much as is practical, p~~P~~rovide a minimum of two fans for all air handlers serving critical care or otherwise patient-facing areas. Evaluate the life cycle cost before specifying fan arrays with more than two fans.

B. Provide, at a minimum, two single width, single inlet (SWSI) plenum fans with 1800 or 1200 RPM motors for units above 12,000 CFM. For units below

12,000 CFM, 3600 RPM fan arrays may be used unless two 2400 RPM fans can meet the capacity.

C. Eighty hertz is the maximum allowed at design conditions unless approved by FacilitiGroup Engineer.

D. Unless prohibited by code, fans shall not be selected for operation within 85% of MAX Fan RPM and BHP is not to be within 85% of motor nameplate HP. Fan selections shall incorporate a total final filter pressure drop of 1.5" w.c. and a total pre-filter pressure drop of .85" w.c. along with all inlet and discharge opening static pressure drops at design CFM.

E. Maximum motor HP shall be 30 HP.

F. Airfoil fans shall comply with AMCA standard 99-2408-69 and 99-2401-82. Provide an AMCA seal on airfoil fans. Airfoil fan performance shall be based on tests made in accordance with AMCA standards 210 and comply with the requirements of the AMCA certified ratings program for air performance.

G. Provide fans with true airfoil blades unless otherwise scheduled.

H. Provide fans with the following accessories:

   1. Fan inlet screens
   2. OSHA-compliant belt guard enclosing the fan motor and drive (if belt driven)

I. Provide airfoil fans with blades formed of extruded aluminum, as scheduled. Bent sheet metal blades are not acceptable.

J. Provide fans with polished steel shafts with first critical shaft speed at least 125% of the maximum operating speed for the fan pressure class. Shaft shall have an anti-corrosion coating.

K. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame.

L. Provide adequate vibration isolation ~~springs~~ with ~~2" static deflection and~~ seismic snubbers.

M. Provide horizontal thrust restraints between AHU casing and fan housings.

N. Multiple Fans (Array of Direct-Drive Plenum Fans) shall be ~~Model SF (Stack Fan), manufactured by Lau or~~ Model MPQ centrifugal plenum type, as manufactured by Twin City Fan & Blower, or Model HPA, manufactured by Greenheck.

   1. Performance — Fans shall conform to AMCA test standards, 205 (fan efficiency grade), 210 (air performance) and 300 (sound performance) and shall bear the AMCA certified ratings seal for both sound and air,

and fan efficiency grade (FEG). Sound certification shall apply to both inlet and outlet sound power levels.

2. Construction — Fans shall be housed and incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge galvanized G90 steel frame, and front panel. The front panel shall have a removable inlet cone designed for smooth airflow transition into the wheel. The motor base shall be designed to ensure proper alignment of the fan wheel, motor and inlet cone. The design shall also ensure the structural integrity of the base to minimize vibration.
3. Wheel — Wheels shall be constructed of non-overloading extruded airfoil shaped blades. Airfoil blades shall be continuously welded. The entire wheel shall be constructed of aluminum to reduce weight and vibration. Blades shall be extruded aluminum. Wheel hubs shall be machined aluminum. Aluminum fan wheels shall not require a finish coating. Wheels shall be attached to the motor shaft using taper lock bushings. The wheel and fan inlet shall be matched and have precise running tolerances for maximum performance and operating efficiency.
4. Finish and Coating — Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.
5. Motors — Motors shall meet or exceed EISA 2007 (The Energy Independence and Security ACT of 2007) efficiencies. Motors shall be NEMA rated, 720, 900 1200, 1800 or 3600 RPM in 60 Hz, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.
6. Fan Balancing — All fans prior to shipment shall be run tested at the specified operating speed. Each fan shall be dynamically balanced as a complete unit in accordance with ANSI/AMCA 204-96 “Balance Quality and Vibration Levels for Fans” to a minimum Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken electronically in the axial, vertical and horizontal directions. Records of each fan balance shall be maintained and a written copy shall be available upon request.
7. Blank off Panels — Each Multiple Fan section to be provided with fan blank-off panels to enable manual isolation of fan for servicing. Quantity of panels shall equal number of fans on a single VFD. Backdraft dampers (barometric or controlled) shall not be permitted.
8. Fan Options — The following options shall be available for multiple fans:
    a. Piezometer Ring: Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of ± 5%. Tubing shall be field installed along with corresponding air flow

monitoring station by DDC controls contractor so that the measurement is representative of all fans in the array.

9. Fan Array Motor Control (common VFD operation with Array split into two banks)
   a. All fan motors shall be factory-wired to individual manual motor protection (MMP) device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch (one per motor) for power isolation. Field wiring of MMPs to fan motors shall not be permitted.
   b. MMPs shall be contained in a single control panel (MMP panel) and shall be mounted on the exterior wall panel of the fan array section.
   c. MMP panel shall have a single point of connection for input power wiring and shall feed power individual MMP's through a common bus bar. Independent wiring of input power to individual MMP's shall not be permitted.
   d. All VFDs shall be operated together from a single control point so that all fan motors operate together. Independent control of VFDs and fan motors shall not be permitted.

~~2.11~~2.9 Bearings And Drives

A. Provide bearings complying with ANSI/AFBMA 9 for fatigue life ratings.
B. Provide fan bearings with an average life L10 of at least 200,000 hours, as scheduled.
C. Provide re-greaseable bearings with hydraulic grease fittings and lube lines extended to the motor side of the fan.
D. Provide direct-drive plenum fans.

~~2.12~~2.10 Electrical Motors

A. Provide fan motors built in accordance with the latest standards of the NEMA and IEEE.
B. Provide AHU and fan motors in compliance with ASHRAE 90.1.
C. Provide fan motors with the following characteristics:
   1. Voltage, Frequency and Phase, as scheduled.
   2. Motor RPM, as scheduled
   3. Minimum service factor of 1.15
   4. Premium efficiency, or as required to meet ASHRAE 90.1
   5. NEMA design ball bearing type

6. Rated for continuous duty at full load in a 104°F (40°C) ambient
7. Open drip proof (ODP) or totally enclosed, fan cooled (TEFC) as scheduled.
8. Suitable for use in variable frequency application, per NEMA MG-1 Part 30
9. Shaft Grounding Rings
10. Premium Efficiency Inverter ready per NEMA STD MG1 PART 31.4.4.2

D. Where practical, provide electronically commutated motors for fractional horsepower applications.

~~2.13~~2.11 Fan-Motor Variable Frequency Drives (VFDs)

A. Variable Frequency Drives shall be provided as follows:
1. Dual Fans: One (1) VFD per fan motor with fused main disconnects.
2. Fan Arrays: One (1) VFD with motor protection panel per half of fan array with fused main disconnects.

B. Provide UL or ETL listed VFDs and associated components, as scheduled and shown on drawings. VFDs shall comply with applicable provisions of the National Electric Code.

C. Mount VFDs in a dedicated NEMA 1 compartment located on the primary access side of its associated fan section and wire VFD to motor, unless otherwise indicated on drawings.

D. Enclose outdoor VFDs in a NEMA 3R enclosure suitable for use in ambient temperatures from -20°F to 135°F:

E. After unit installation, VFD shall be started and programmed by a factory trained and employed service technician. Refer to Section Part 3 - Execution3.5.

F. Refer to 26 29 23 for complete requirements for VFDs.

G. Drives are to be provided without bypass, except in the case of a single-fan application.

~~2.14~~2.12 Factory Installed Electrical Accessories

A. In addition to motor power terminals, provide an independent power terminal for convenience receptacles and lights. Provide switches as shown on drawings.

B. Provide LED (light emitting diode) lights in segments as scheduled or shown on drawings. Provide light switches as scheduled or shown on drawings. Lights shall be constructed of safety glass and suitable for wet locations.

C. Provide a 1-hour timer on external light switches.

D. Provide a 20A 120V convenience receptacle on supply fan segment. Receptacle shall be powered separately from fan VFD so it remains energized when fan disconnect is open.

E. Disconnects and VFDs are to be installed as close as practical to the fan motor they serve. Where factory-mounted disconnects are to be provided on stacked units, they are to be installed such that they can be reached by a service technician standing beside the unit without the use of a ladder.

~~D.~~F. Where maintenance platforms are anticipated for ease of access to the upper level, disconnects are to be installed adjacent to, and on the same level as, the access door to the motor it serves.

~~2.15~~2.13 Heating and Cooling Components

A. Provide coils manufactured by AHU manufacturer, except where noted in contract documents.

B. Coils shall meet or exceed performance scheduled on drawings.

1. When applicable, provide coils with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop. Circuit coils such that the fluid velocity is within the range of certified rating conditions at design flow.

C. Provide cooling coils with a maximum face velocity of 450 FPM. Face velocity calculations shall be based on the finned area of the coil. Manufacturer shall guarantee zero carryover at 500 fpm.

D. Coils shall be provided with minimum 304 stainless steel coil casing with 304 stainless steel drain pan support structure. Heating coils shall be provided with G-90 galvanized steel coil casings except in the following situations: ~~unless in the reheat position.~~

1. heating coils in the preheat position in AHUs installed within 60 miles of the coast, and

~~D.~~2. heating coils for all AHUs installed in the reheat position ~~304 stainless steel shall be used when heating coil is reheat position~~.

E. Cooling coils shall be a maximum of 8 rows and 10 fins per inch. In ASHRAE Climate Zones 1, 2, and 3, coils shall be 8 rows deep. ***No exceptions.*** *Size cooling coils for minimum 80/67 EAT unless job specific conditions require more.*

F. Limit the water side pressure drop on water coils to 15 feet. Limit the air side pressure drop on chilled water coils to 0.90" w.c.

G. Provide at least 18" of access between coils. Provide an easily operable access panel or door, as shown on drawings.

H. Provide coil segment casing that meets or exceeds casing performance of the unit.

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I. Provide panels that are easily removable with no special tools.

J. Locate access doors to provide clearance for pipe insulation, connectors, and accessories. Space shall allow a minimum of 90 degrees of door swing.

K. Provide coils built in their own full perimeter frame. Tube sheets on each end shall have fully drawn collars to support and protect tubes. Horizontal coil casing and support members shall allow moisture to drain. Casing and support members shall not block finned area.

L. Individual coils shall be removable from the side of the AHU.

M. Provide intermediate drain pans on stacked cooling coils (one at every coil break). Intermediate drain pan shall slope in a minimum of two planes toward a single drain connection.

N. Provide a single intermediate vertical coil support on coils with a finned length greater than 62”. Provide two vertical supports on coils with a finned length greater than 100” and three vertical supports on coils with a finned length greater than 141”.

O. Provide a 1/4" FPT plugged vent/drain tap on each connection. Circuiting shall allow draining and venting when installed. Extend vent, drain, and coil connections through AHU casing.

P. When staggered coil banks are required. Provide a 1/4" FPT plugged vent/drain tap on each connection. Circuiting shall allow draining and venting when installed. Vent, drain, and coil connections shall be supplied within 10” of the header. Extend vent, drain, and coil connections through AHU casing. Insulation of internal chilled water piping shall be insulated by mechanical contractor.

Q. Insulate gap between coil stub out connection and AHU casing with a spool-shaped sleeve grommet. Adhesive rings applied the casing walls are not acceptable.

R. Water and glycol coils shall be operable at 250 psig working pressure and up to 300° F. Factory test water and glycol coils with 325 psig compressed air under water.

S. Direct expansion (DX) coils shall conform to ANSI B9.1 (Safety Code for Mechanical Refrigeration) when operating with a maximum refrigerant pressure of 250 psig. Factory test DX coils with 325 psig compressed air under water. DX coils will be dehydrated and sealed prior to installation.

T. Steam distributing coils shall be operable at 50 psig pressure and a corresponding saturated steam temperature of 298° F. Factory test steam coils with 315 psig compressed air under water. Dehydrate and seal coils prior to shipping.

U. Provide steam-distributing coils with a tube outer diameter (OD) of 1" and an inner distribution tube of 5/8" O.D. Circuit coils for gravity drain of condensate without trapping. Steam shall discharge in the direction of condensate flow to ensure even heat transfer across each tube.

V. Provide water, glycol and DX coils with a tube OD of 5/8" and material thickness of 0.025". Mechanically expand tubes to form fin bond and provide burnished, work-hardened interior surface. Turbulators shall not be permitted inside water coils.

W. Provide water, glycol and steam coil headers made of seamless copper or brass tubing. Pipe connections shall be red brass. Provide DX coils with brass distributor and lead-free solder connections. Suction and discharge connections shall be on the same end regardless of coil depth. Provide DX coils with a hot gas bypass port on distributor.

X. Provide coils with die-formed, continuous aluminum fins. Fins shall have fully drawn collars to accurately space fins and protect tubes. Fins shall be 0.008" thick.

Y. Provide coil coatings as scheduled or indicated on drawings.

~~2.16~~2.14 Filters

A. Provide filter segments with filters and frames as scheduled. Specify pre-filter racks that provide metal support on the entire perimeter of the pre-filters.

B. Provide face loading filters for all filter segment(s). Provide an 18" (minimum) access plenum and access door on the drive side through which face loading filters can be easily loaded.

C. Provide Class 2 or Class 1 filter media per U.L. 900 and as required by local codes.

D. Filter types, efficiencies, and nominal depths shall be as follows:

1. Rigid filters – 4" mini pleated with efficiencies of 60-65% (MERV 11) for all Pre-filters. 12" rigid, 90-95% (MERV 14) for final filters.
    a. Provide front loading filter tracks for all filters. Side loading racks are unacceptable.
2. HEPA filters – 12" 99.97%, or 99.99% efficient media, as scheduled.
    a. Performance of installed filtration system shall be certified via a DOP test and classified as UL Class 1 when tested in accordance with UL Standard 586.
    b. Filter frame shall be specifically developed for HEPA filters, with appropriate quantities of filter clamps.

E. Provide a flush mounted, factory installed, Magnahelic differential pressure gage on the drive side of unit to measure pressure drop across filters. Manufacturer shall provide fully functional gauges, complete with tubing.

~~2.17~~2.15 Dampers

A. Provide dampers tested in accordance with AMCA 500.
B. Provide factory-installed dampers, as shown on drawings.
C. Dampers shall have airfoil blades, extruded vinyl edge seals, and flexible metal compressible jamb seals.
D. Dampers shall have a maximum leakage rate of 4 CFM/square foot at 1" w.g., and shall comply with ASHRAE 90.1.
E. Damper blades shall be opposed acting unless otherwise indicated. Parallel blades may be required to promote air mixing.
F. Damper blades shall be aluminum.

~~2.18~~2.16 Air Blenders

A. Provide static mixing devices by Blender Products, Inc. or approved equal downstream of all outside air sections when the ASHRAE 99.6% winter design dry bulb condition is 38ºF or less to enhance the mixing of outside air with return air to an effectiveness required to eliminate freeze stat trips, minimize sensor, error and enhance outdoor air distribution.
B. The static mixer shall be capable of a minimum of 70% range mixing effectiveness when mixing 25% outside air with 75% return air at one mixer diameter downstream of mixer.
C. Multiple mixers may be utilized for OA introduced on top of air handling unit that is full casing width. All side inlet OA arrangements shall utilize single blender or minimum allowable within air handling unit casing and still provide a minimum of 70% range mixing effectiveness.

~~2.19~~2.17 Airflow Monitoring Stations

A. All fans shall be provided with factory mounted piezometer rings. Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of ± 5%.
B. BAS Contractor shall provide a field-installed transducer that sends a CFM-proportional, 4-20 mA or 0-10V signal, as specified in specification section 230913.
C. Fan array measurement – For arrays having four fans or more, provide FAATS-1000 fan array airflow totalizing system by Paragon Controls or approved equal with one remote transducer per array.

~~2.20~~2.18 Humidifier Dispersion Manifold

A. Provide Stainless Steel Short Absorption Manifold designed for atmospheric steam humidifiers or pressurized steam from a boiler, to directly inject the steam into ducted air for humidification.

1. Provide adequate vertical tube spacing to ensure absorption distance characteristic shall prevent water accumulation on any in-duct surfaces beyond 24 in downstream of the steam dispersion panel.
2. Steam inlet and condensate return located on the same side and at the bottom of the header to allow single point entry and floor mounting.
3. Provide headers of 304 stainless steel construction.
4. Provide vertical, 304 stainless steel distribution tubes to promote condensate evacuation. Horizontal distributor tubes are not accepted.
5. Stainless steel nozzle inserts shall have metered orifices, sized to provide even distribution of the discharged steam, spaced for optimum steam absorption. Systems without nozzle inserts, or other than stainless steel, are not acceptable.
6. Provide tube and header insulation constructed from 304 stainless steel shielding for increased energy efficiency and reduced airstream heat gain. Steam header insulation is to minimize heat losses to under 10%. Stainless steel shields to be isolated from distributor using plenum rated synthetic foam strips. Insulation to provide air-gap to minimize conduction and convection, as well provide reflective surface to minimize radiating heat transfer. Un-insulated headers, or simple foam insulation not accepted.

~~2.21~~2.19 UVC Fixtures

A. Provide surface decontamination UV fixtures within cooling coil sections for air handlers serving emergency departments, operating rooms, bone marrow areas, and all ICUs.
B. UV system shall be tied to a switch to kill power to the lighting system when the access door is opened. A second manual kill switch shall be provided inside the unit for safety.
C. UVC products shall be from an ISO 9001 manufacturer or the supplier shall provide proof of 100% inbound and outbound testing of equipment and have at least 10 years' experience as a manufacturer of UVC products for air handling equipment.
D. Fixtures shall be tested, listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.
E. Fixtures shall meet the "UL" drip proof design and each fixture is equipped with an electrical interlock.
F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They are constructed with UVC proof metal bases and shall not produce ozone.

G. Each lamp shall contain no more than 8 milligrams of mercury, consistent with current environmental practices, while producing the specified output at 500 fpm in temperatures of 55-135° F.

H. Lamps and fixtures shall be installed in sufficient quantity and in such a manner so as to provide even distribution of UVC energy on designated surface area (Coil, filter rack, etc.). When installed, the minimum intensity striking any point on a plane representing the surface of the coil or component shall not be less than 50 microwatts per square centimeter. Average radiation shall be 150 microwatts minimum per square centimeter.

I. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a mono-layer of mold and bacteria as typically found in HVAC systems in less than six hours.

J. Lamp fixtures shall be constructed of type 304 stainless steel to preclude corrosion. Support components shall be constructed of type 304 stainless or galvanized cold rolled steel.

K. Power supply shall be of a high efficiency, high frequency electronic type, matched to the lamp and designed to maximize UVC radiance and reliability. They shall be capable of four wire lamp operation rapid start. They shall be UL Listed and labeled, and comply with FCC 47, Part 18, non-consumer limits requirements. The ballast shall be protected from failure in the event of End of Lamp life lamp failure. The ballast shall be capable of operation indefinitely when powered with no lamp or a failed or broken lamp. Track mounted fixture ballasts shall have 120VAC or 240 VAC input. Strut mounted ballasts shall have universal input (100VAC to 277VAC). Track mounted fixtures shall be capable of producing the output as specified under Irradiation and Intensity at no more than 13 Watts of power consumption for each square foot of treated, cross sectional plane.

L. Ballast system shall not proprietary to the manufacturer of the UV bulb.

M. Provide and install a UV radiometer for monitoring bulb intensity near center of coil - tie to BAS. Set BAS to alarm operator when bulb intensity drops below manufacturer-recommended threshold.

N. Original purchase of equipment has to include a separate price for a service contract to replace bulbs once per year for five years after startup. Contract must include materials and labor to install new and dispose of old bulbs. Contract must be signed by the facility prior to submittal approval.

~~2.22~~2.20 Appurtenances

A. For motors 7.5HP and larger in the stacked position, ~~p~~Provide internal structural I-Beam motor removal rail with structural frame to distribute motor weight to unit base. Rail shall be perpendicular to centerline of access door for ease of removal.

~~B. Provide rain hoods on outdoor unit air intakes, as shown on drawings. Provide moisture screens on outdoor air inlet rain hoods.~~

~~C.~~B. Provide steel base rails suitable for rigging and lifting, as shown on product drawings.

~~D.~~C. Provide safety grates over bottom openings, as shown on drawings.

1. Safety grates shall be capable of supporting a 300 lb. center load.

~~E.~~D. Provide lifting lugs where required.

~~2.23~~2.21 Finishes

A. Manufacturer shall clean the exterior surfaces of units prior to finishing, painting, or shipment.

B. Unpainted air-handling units constructed of galvanized steel shall pass the ASTM B-117 test for 220-hour salt spray solution (5%) without any sign of red rust. (confirm)

C. Manufacturer shall paint outdoor units prior to shipment. Manufacturer shall paint indoor units, as scheduled or shown on drawings.

1. Manufacturer shall apply a primer prior to painting units.
2. Manufacturer shall apply a finish coat of acrylic polyurethane paint.
3. Finished unit shall exceed 500-hour salt spray solution (5%) test without any sign of red rust when tested in accordance with ASTM B-117.

~~2.24~~2.22 Tests and Inspections

A. Manufacturer shall dynamically balance fan/motor/base assembly.

1. Balance constant volume fan assemblies at design RPM.
2. Balance variable volume fan assemblies from 10% to 100% of design RPM.
3. Take filter-in measurements in the horizontal and vertical axes on the drive and opposite-drive sides of fan shafts.
4. Constant speed fan vibration limits: filter-in measurements shall not exceed 4 mils.
5. Variable speed fan vibration limits: filter-in measurements shall not exceed 7 mils.

B. Manufacturer shall hi-pot test wiring intended to carry voltages greater than 30VAC.

Part 3 - Execution

3.1 Installation

A. Install equipment per industry standards, applicable codes, and manufacturer's instructions.

B. Do not use AHUs for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.

~~C. Install rooftop AHUs on a roof curbs, as shown on drawings. To reduce the potential for noise complaints, retain the maximum amount of roof mass under the unit and locate rooftop units over non-sound sensitive area. Where possible, cut openings in roof for duct and pipe penetrations – do not open roof to entire area under curb. Provide sound plenums within building to reduce sound transmission. Sound plenum construction shall be thoroughly detailed.~~

~~D.~~C. Install all AHUs on elevated slabs not over a mechanical room on floating floor arrangement per HCA standard detail.

~~E.~~D. Install AHUs with manufacturer's recommended clearances for access, coil pull, and fan removal.

~~F. Provide one complete set of filters for testing, balancing, and commissioning. Provide second complete set of filters at time of transfer to owner.~~

~~G.~~E. Install AHU plumb and level. Connect piping and ductwork according to manufacturer's instructions.

~~H.~~F. Install seismic restraints and anchors per applicable local building codes. Refer to specification Section 230548 (15240 / 15070) for product and installation requirements.

~~I. Install pipe chases per manufacturer's instructions.~~

~~J.~~G. Insulate plumbing associated with drain pan drains and connections. Run condensate to nearest floor drain or roof drain.

~~K.~~H. Install insulation on all staggered coil piping connections, both internal and external to the unit.

~~L.~~I. If access to the interior of the air handler for maintenance and repair cannot be gained without a ladder, a permanent access ladder must be provided. Install platforms and access ladders to permit full maintenance of the upper level of stacked air handlers. Platform and support structure shall not obstruct door swing, coil pull, and other reasonable maintenance access to the lower level.

3.2 Field Quality Control

A. Store per AHU manufacturer's written recommendations. Store AHUs indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.

B. Rig and lift units according manufacturer's instructions.

3.3 AHU Inspection

A. Installing Contractor to perform an inspection of unit and installation prior to startup. Start-up report submitted to general contractor shall verify the following as a minimum:

1. Damage of any kind
2. Level installation of unit
3. Proper reassembly and sealing of unit segments at shipping splits.
4. Tight seal around perimeter of unit at the roof curb
5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
6. Completion and tightness of electrical, ductwork and piping
7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
8. Supply of electricity from the building's permanent source
9. Integrity of condensate trap for positive or negative pressure operation
10. Condensate traps charged with water
11. Removal of shipping bolts and shipping restraints
12. Sealing of pipe chase floor(s) at penetration locations.
13. Tightness and full motion range of damper linkages (operate manually)
14. Complete installation of control system including end devices and wiring
15. Cleanliness of AHU interior and connecting ductwork
16. Proper service and access clearances
17. Proper installation of filters
18. Filter gauge set to zero

B. Resolve any non-compliant items prior to unit start-up.

3.4 Inspection and Adjustment: AHU Fan Assembly

A. Hire the manufacturer's factory-trained and factory-employed service technician perform an inspection of the AHU fan assembly subsequent to general AHU inspection and prior to startup. Technician shall inspect and verify the following as a minimum:

1. Fan isolation base and thrust restraint alignment
2. Tight set screws on pulleys, bearings and fan
3. Tight fan bearing bolts

4. Tight fan and motor sheaves
5. Tight motor base and mounting bolts
6. Blower wheel tight and aligned to fan shaft
7. Sheave alignment and belt tension
8. Fan discharge alignment with discharge opening
9. Fan bearing lubrication
10. Free rotation of moving components (rotate manually)

3.5 Startup Service and Owner Training

A. Manufacturer's factory-trained and factory-employed service technician shall startup AHUs. Technician shall perform the following steps as a minimum:
   1. Energize the unit disconnect switch
   2. Verify correct voltage, phases and cycles
   3. Energize fan motor briefly ("bump") and verify correct direction of rotation.
   4. Re-check damper operation; verify that unit cannot and will not operate with all dampers in the closed position.
   5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.

B. Provide a minimum of 4 hours of training for owner's personnel by manufacturer's factory-trained and factory-employed service technician. Training shall include AHU controls, motor starter, VFD, and AHU.

C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

D. If AHU is provided with a factory-mounted variable frequency drive (VFD), hire the VFD manufacturer's factory-trained and factory-authorized service technician to inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.

E. If AHU is provided with a factory-mounted humidifier, hire the humidifier manufacturer's factory-trained and factory-authorized service technician to inspect, test, adjust and verify proper operation in conjunction with BAS contractor.

F. Submit a startup report summarizing any problems found and remedies performed.

G. Permanent air handling equipment shall not be started under any circumstances until dust-generating construction activities such as drywall sanding and floor grinding are complete and the space is entirely cleaned.

Until that time, the air handler shall be properly sealed to eliminate dust collecting inside the unit.

3.6 Cleaning

A. Clean unit interior prior to operating. Remove tools, debris, dust and dirt.

B. Clean exterior prior to transfer to owner.

3.7 Documentation

A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.

B. Provide six copies of Spare Parts Manual for owner's project system manual.

SECTION 23 74 00: AHUs – OUTDOOR HVAC EQUIPMENT

Part 1 - General

1.1 Work Included:

A. The preference is for air handlers to be installed inside the building envelope or in a penthouse rather than on a rooftop exposed to weather. However, some project constraints may push the design toward a roof-mounted solution. In this case, the design engineer is to contact FacilitiGroup for direction prior to proceeding with the initial project narrative or development of the design.

B. Rooftop air handlers shall be designed by manufacturer for outdoor installation. Do not use interior units modified for outdoors by adding sealant.

C. The cost/benefit of factory assembled, indoor air handling systems should be evaluated with input from the architect, and HCA Design and Construction during the project planning phase. The evaluation will include discussions for indoor mechanical rooms, penthouses or rooftop units. Evaluation should consider aesthetics, noise, first costs, future expansion, and long-term operating and maintenance costs, the utilization of fan wall or fan array technology should be part of these considerations.

D. The use of custom air handling units is discouraged unless special conditions exist such as space limitations or requirements for special equipment components.

E. Specify that at time of submission to Architect/ Design Engineer, contractor shall submit an information-only copy of the complete air handling unit submittal to HCA FacilitiGroup.

F. Due to increased maintenance requirements, diminished lifespan, air mixing issues, and aesthetic concerns, rooftop air handlers shall not be considered unless prior approval is obtained from HCA FacilitiGroup. If approved, noise and vibration problems must be addressed. Rooftop units are not desired in heavy snow areas, or in coastal regions (up to 60 miles from the coast) due to corrosion. The effect on future vertical expansion must also be considered.

G. Other rooftop unit concerns to be considered:

1. Provide air blender in unit if necessary to ensure proper mixing of air to minimize coil-freezing problems.
2. VFDs and controls locations in separate compartments. Do not locate in air plenum space.
3. Specify VFDs by the same manufacturer for the entire project. Manufacturer shall install at factory.
4. Roof access shall be considered and planned. Show plans and discuss access points with HCA FacilitiGroup. Do not design for access via patient room windows. Make provisions for maintenance personnel to carry tool and repair parts to roof.
5. Locate isolation valves, control valves, gauges and thermometers at the unit in accessible piping vestibules. Vestibules shall have adequate space to permit complete removal of any component inside without the need to disassemble the rest of the piping.
6. Schedule maximum fan sound level performance (8 octave bands) allowed on drawings. (See section 23 33 19: 1.01 B)

H. AHU design and layout shall minimize the potential of unit shut down due to low mixed air temperatures. Designer shall refer to the extreme weather data conditions recorded for the local area. Utilize air blenders if necessary to avoid nuisance freeze safety operations caused by poor mixing of return and outside air. Route the return and outside air ducts as recommended by the air blender manufacturer to promote proper mixing of these airstreams.

I. When DX coils are used, the handling of outside air shall be given special consideration. Humid climates and/or higher than normal percentages of outside air may require a pre-cooling coil.

J. The facility should be divided up into compatible zones for air handing unit sizing and selection. Consideration should be given to those areas that need to operate around the clock, and those that could be shut down and thermal zoning. Smoke compartments should also be considered when dividing between systems.

K. Where a pre-heat coil is required, use a hot water coil and dedicated circulator pump. Design controls to activate pump when there is a call for heating or when outside air temperature is below 40°F. Size the pump to maintain the minimum velocity of 3 feet per second in the pre-heat coil to preclude freezing. Use a differential pressure switch across the pump to indicate pump status to the BAS.

L. Always specify return fans on AHU's over 10,000 CFM supply or where the return fan is used for smoke evacuation required by the AHJ. Centrifugal return fans are preferred.

M. Schedule maximum sound power levels (8 octave bands) for both supply and return fans on the drawings.

N. Avoid using separate final filter sections not manufactured by the AHU supplier that require ductwork to transition from the AHU discharge to the final filter.

O. Avoid using blow-through units where final filters are required.

P. Specify return air humidity sensors in all air handling units even if they are not equipped with a humidifier.

~~B.~~

1.2 Section Includes

A. ~~Indoor and o~~Outdoor air handling units and components as scheduled and shown on drawings.

B. Variable frequency drives.

1.3 Related Sections

A. The requirements of the General Conditions, Supplementary Conditions, Division 1, equipment schedules, and drawings apply.

1.4 References

A. AMCA 99 – Standard Handbook

B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes

C. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters

D. AMCA 611-95 – Methods of Testing Airflow Measurement Stations for Rating

E. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings

F. ANSI/UL 900 – Test Performance of Air Filter Units

G. AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment

H. AHRI 410 – Forced-Circulation Air Cooling and Air Heating Coils

I. ANSI/AHRI 430 – Performance Rating of Central-Station Air Handling Units

J. ASHRAE 52.1/52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size

K. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality

L. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

M. ASTM-C 1338 – Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.

N. NFPA 70 – National Electric Code (conductors, equipment and raceways)

O. NFPA 90A – Installation of Air Conditioning and Ventilation Systems

P. SMACNA – HVAC Duct Construction Standards

Q. UL-181 – Mold Growth and Humidity Test

R. UL-1995 – Standard for Safety for Heating and Cooling Equipment

1.5 Quality Assurance

A. Manufacturer shall have a minimum of 25 years of experience in designing, manufacturing, and servicing air-handling units.

B. The design indicated on the schedules and shown on the drawings is based upon the products of the named manufacturer.

1.6 Coordination

A. If equipment is supplied other than as shown on plans, coordinate with the General Contractor and affected subcontractors. This coordination shall include (but is not limited to) the following:

1. Structural supports for units.
2. Size and location of concrete bases/housekeeping pads
3. Location of roof curbs, unit supports and roof penetrations
4. Ductwork sizes and connection locations
5. Piping size and connection/header locations
6. Interference with existing or planned ductwork, piping and wiring
7. Electrical power requirements and wire/conduit and over current protection sizes.
8. Trap height requirements

B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished other than as shown as basis of design.

1.7 Ratings And Certifications

A. Air Handling Unit safety: ETL or UL 1995

B. Air Handling Unit energy use: ASHRAE 90.1

C. Fans: AMCA 210

D. Air Coils: AHRI 410

E. Air Handling Unit certification program: ANSI/AHRI 430

F. Filter media: ANSI/UL 900 listed Class I or Class II
G. Control wiring: NEC codes & ETL requirements
H. Motors: Federally mandated Energy Policy Act (EPACT).
I. Airflow Monitoring Stations: AMCA 611-95
J. Units shall be seismically certified in accordance with applicable IBC 2000, 2003, 2006, 2009 or 2012 and applicable Building Code for life safety environments.
K. Units shall have secured OSHPD pre-approval of Special Seismic Certifications to be used in health facilities construction in California. Label equipment per OSHPD labeling instructions.
L. Outdoor units shall meet the Large Missile Impact Test for AHU casing (walls, roof, and doors) and base in the State of Florida. Units shall carry a Notice of Acceptance (NOA) from the Miami-Dade County Product Control Division. Label equipment per NOA labeling instructions.

1.8 Submittal Documentation Required

A. TMA asset tracking
B. Furnish fan performance ratings and fan curves with specified operating point clearly plotted.
C. Furnish drawings indicating unit dimensions, required clearances, field connection locations, wiring diagrams, shipping drawings, and curb drawings.
D. Furnish performance report showing unit level performance data including: fan(s), motor(s), coil(s) and other functional components. Performance report shall also include unit casing performance.
E. Furnish operation and maintenance data, including instructions for lubrication, filter replacement, motor and drive replacement, and condensate pan cleaning; spare parts lists, and wiring diagrams.
F. Adjust and report performance ratings for the proper altitude of operation.
G. Report air-handling unit performance ratings in accordance with ANSI/AHRI-430 (static pressure, airflow, fan speed, and fan brake horsepower).
H. Report static pressure profiles by component section.
I. Report coil ratings in accordance with AHRI-410 (capacities and pressure drops).
J. Report unweighted octave band AHU sound power for inlets and outlets rated in accordance with AHRI Standard 260. Provide eight data points, the first for the octave centered at 63 Hz, and the eighth centered at 8,000 Hz. Manufacturer shall not use sound estimates based on bare fan data (AMCA ratings), nor use calculations like the substitution method based on AHRI 260 tests of other AHU products. Provide data for inlets and outlets as scheduled.

Report unweighted casing radiated sound power over the same 8 octave bands in accordance with ISO 9614 Parts 1&2 and ANSI S12.12.

K. Airflow measuring device performance shall be certified and rated in accordance with AMCA-611. Report data in accordance with AMCA-611. Provide AMCA Certified Rating Seal for Airflow Measurement Performance.

L. Report panel deflection at +/-8" w.g., stated in terms of 'L/X' where 'L' is the casing panel length and 'X' is a constant provided by the AHU manufacturer.

M. Report casing leakage rate at +/-8" w.g., specified in terms of percentage of design airflow.

N. Report weight loads and distributions by component section.

O. Report product data for filter media, filter performance data, filter assembly, and filter frames.

P. Report electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

Q. Report motor electrical characteristics.

1.9 Delivery, Storage and Handling

A. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).

B. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.

C. Follow manufacturer's recommendations for handling, unloading and storage.

D. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.

E. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.

F. Enclose and protect control panels, electronic or pneumatic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.

G. Seal openings to protect against damage during shipping, handling and storage.

H. Wrap indoor and outdoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively AHU must be tarped for shipment and storage.

I. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.

J. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

1.10 Extra Materials

A. In addition to the set of filters provided with the air handler, provide one clean set for balancing, and one additional set for final turnover to owner, for a total of 3 sets of filters provided.

~~A. Provide one additional clean set of filters for balancing, and one additional set for final turnover to owner.~~

B. Provide one extra set of belts, in addition to the factory-installed set (if belt drive is needed).

1.11 Warranty

A. Provide entire unit parts and labor warranty for 12 months from date of substantial completion. Warranty shall cover manufacturer defects. Warranty work shall be performed by manufacturer's factory-trained and factory-employed technician.

B. For air handlers provided with UV lights, include service contract to replace bulbs once per year for five years after startup. Contract must include materials and labor to install new and dispose of old bulbs.

C. Parts associated with routine maintenance, such as belts and air filters shall be excluded.

1.12 System Startup

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.

Part 2-Products

2.1 Acceptable Products

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule as YORK, div. of Johnson Controls Inc.

2.2 General Description

A. The owner requirement is for modular type air handlers where possible. Custom type equipment is only to be applied where absolutely necessary.

B. Air Handling Unit (AHU) consists of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, components, and accessories; as shown on drawings, schedules, and specifications.

C. Provide AHU to meet the specified levels of performance for scheduled items including airflow, static pressure, cooling capacity, heating capacity, electrical characteristics, sound, casing leakage, panel deflection and casing thermal performance.

D. Provide internal components and accessories as specified and scheduled. Components and accessories shall be installed by the AHU manufacturer.

E. Ship units in one piece. Split units only where necessary for shipping and installation.

F. Manufacturer shall provide detailed, step-by-step instructions for disassembly and reassembly.

G. For AHU segments that must be broken down for rigging and installation: segment shall be disassembled and reassembled by manufacturer's factory-trained service personnel.

2.3 Standards Compliance

A. Comply with ratings and certifications referenced in this specification.

B. Manufacturers who do not comply with ANSI/AHRI-430 shall factory test EACH unit to verify brake horsepower rating, airflow performance and total static pressure performance.

C. Manufacturers who do not conform to requirements of AHRI 260 for ducted discharge and return air sound shall submit EACH unit to an independent sound test laboratory for AHRI 260 testing. The test laboratory shall conform to AHRI 260, Section 4.4, Test Equipment and Facilities.

2.4 Base Rail

A. Provide a structural base rail under the full perimeter of the unit

B. Provide clearance for proper external trapping of drain pans and steam condensate without the need to cut the floor.

C. Provide base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

2.5 Casing

A. Provide 2" double wall AHU casing. Exposed insulation is not acceptable.

B. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

C. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

D. Encapsulate insulation with sheet metal so that air does not contact insulation. Solid lined panels insulated with spray injected foam shall be hermetically sealed at each corner and around their entire perimeter, to eliminate airflow through the panel and to eliminate microbial growth potential within the casing wall. Foam insulation shall fully fill entire floor, all walls, and roof with no voids.

E. Provide casing with minimum thermal resistance (R-value) of 13 hr-ft^2-°F/BTU for indoor applications and 16 hr-ft^2-°F/BTU for outdoor. The casing shall incorporate thermal breaks as required so that when assembled, minimal path(s) of continuous unbroken metal to metal conduction from inner to outer surfaces exist.

F. All exterior (minimum 18 gauge) and interior (minimum 20 gauge) casing panels (roof, wall, access door) shall be made of G90 galvanized steel. Interior casing panels (walls and floor) shall be made of 304 stainless steel within wet sections – from cooling coil or humidifier up to supply fan bulkhead. Units installed within 60 miles of the coast shall also include 304 stainless steel walls in outdoor air sections up to the cooling coil.

~~F. All exterior (minimum 18 gauge) and interior (minimum 20 gauge) casing panels (roof, wall, access door) shall be made of G90 galvanized steel. Interior casing panels (walls and floor) shall be made of 304 stainless steel within cooling coil and humidifier sections. Outdoor units shall also include outside air intake sections with 304 stainless steel floors.~~

~~G. Perforated panels shall be provided on intake, discharge, and fan sections.~~

G. Floors shall be provided with 0.125" aluminum diamond tread plate liner for units 48" and greater in height. Units below 48" in height shall have 14 gauge G90 galvanized steel floors in dry sections and 14 gauge 304 stainless steel floors from cooling coil or humidifier to fan bulkhead. Units shorter than 48" installed within 60 miles of the coast shall also have 14 gauge 304 stainless steel floors in outdoor air sections up to the cooling coil.

~~H. Floors shall be provided with 0.125" aluminum diamond treads plate floor liner for units above 48" in height. Units below 48" in height shall be 14 gauge G90 galvanized steel with 304 stainless steel within cooling coil and humidifier sections. Outdoor units shall also include outside air intake sections with 304 stainless steel floors.~~

~~I.~~H. Provide a unit frame of galvanized steel that provides the overall structure of the unit and does not rely on the casing panels for structural integrity.

~~J.~~I. Unit shall conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1.0% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. The unit leakage is the sum of the leakage in all positively and negatively pressurized sections of the air handler.

~~K.~~J. Provide wall panels and access doors that deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

~~L.~~K. Provide floors and roofs that deflect no more than L/240 when subjected to a 300 lb static load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

~~M.~~L. Provide outdoor AHUs with a roof system that deflects no more than L/240 when subjected to a static snow load of 30 lb/ft2. 'L' is defined as the panel-span length and 'L/240' is the deflection at the panel midpoint.

~~N.~~M. Provide outdoor AHUs with a roof sloped at a minimum pitch of 1/4" per foot. The roof shall overhang side and end panels by a minimum of 2."

~~O.~~N. Provide an exterior finish for outdoor AHUs that show a breakdown of less than 1/8" on either side of a scribed line when subjected to ASTM B117 500 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of '6.'

2.6 Primary Drain Pans

A. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

B. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

C. Provide floors that deflect no more than L/240 when subjected to a 300 lb load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint

D. Comply with the stated intent of ASHRAE Standard 62.

E. Provide a drain pan under each cooling coil and humidifier. Drain pans for cooling coils and humidifiers shall meet the requirements of ASHRAE 62.

F. Drain pans shall be stainless steel.

G. Provide drain connection made of same material as drain pan. Do not use dissimilar metals because of the risk of galvanic corrosion. Weld connection to the drain pan.

H. Cooling coil drain pan shall be double wall construction with an insulation R-value of 13 hr-ft^2-°F/ (BTU-in). Low temp glycol coils shall be provided with additional 2" insulated drain pan subfloor. Drain pans shall be extended as much as possible without making the section longer.

~~H. Drain pan shall be double wall with an insulation R-value of 6.25 hr-ft~~$\cancel{^2}$~~-°F/ (BTU-in). Low temp glycol coils shall be provided with additional 2" insulated drain pan subfloor.~~

I. Provide drain pan under the complete width and length of cooling coil and humidifier sections. Drain pan shall be full width, and completely extend to next section downstream of cooling coil and humidifier within AHU without growing section length. Pan shall extend a minimum of 12" downstream of cooling coil except where the length is limited due to the installation of UV lighting.

~~I. Provide drain pan under the complete width and length of cooling coil and humidifier sections. Drain pan shall be full width, and completely extend to next section downstream of cooling coil and humidifier within AHU without growing section length. Pan shall extend a minimum of 12" downstream of cooling coil.~~

J. Drain pan shall allow visual inspection and physical cleaning on 100% of the pan surface without removal of the coil or humidifier.

K. Provide a minimum of 1" clearance between the drain pan and any coil casing, coil support or any other obstruction.

L. Provide drain pan that allows the design rate of condensate drainage regardless of fan status.

M. Provide drain pan sloped in at least two planes by at least 1/8" per foot toward a single drain. Locate drain connection at the lowest point of the pan. Pan shall have no horizontal surfaces.

2.7 Access Doors

A. Provide thermal break, double wall access door(s) that meet requirements for the AHU casing.

B. Provide industrial-style stainless steel hinges that permit 180 degrees of door swing.

C. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or "paw" latches are not acceptable.

D. Provide each door with a single handle linked to multiple latching points or a separate handle for each latching point. Doors serving access segments shall have an interior latch handle.

E. Provide access doors with a locking hasp to accommodate a lockout device.

F. Where permitted by code, provide double-pane viewing windows in all fan access sections, humidifier sections and upstream of all filter sections. Windows shall be a non-condensing type consisting of a desiccant dehumidification layer. Minimum dimension shall be 8" x 8".

G. Provide VentLok 699 Test Port and gasket in all door systems and as needed to provide at least one port upstream and one port downstream of every coil and filter.

H. Access doors, where permitted by code, are always to open against positive pressure.

2.8 Pipe Chase Cabinet

A. Provide external pipe chases with double wall, insulated panels. Pipe chase shall have the same thermal performance as the unit casing.

B. Provide a perimeter base rail and/or roof curb under the pipe chase(s) that meets requirements for the AHU base rail and/or roof curb.

C. Manufacturer may combine the pipe chase enclosures of adjacent segments.

D. Provide an appropriate pipe chase depth and access doors as shown on drawings. Pipe chase depth is the clear inside dimension from inner pipe chase surface to outer unit surface.

E. Manufacturer may ship pipe chases separate from AHU if the chases are provided with lifting lugs for field installation per the AHU base rail requirements. Manufacturer shall provide step-by-step instructions with illustrations for proper pipe chase installation.

2.9 Roof Curbs

A. Provide insulated factory-fabricated galvanized steel roof curb for outdoor units in accordance with local codes and seismic compliance. Roof curb shall support the full-perimeter of the air handling equipment, including pipe chases.

B. Match roof curb to roof slope. Curb surface shall be level in both axes.

C. Provide wood nailing strip to which roofer may nail roof flashing.

D. Ship roof curb loose for field installation prior to unit placement.

2.10 Fans

A. Direct drive fans are preferred over belt drive. As much as is practical, provide a minimum of two fans for all air handlers serving critical care or otherwise patient-facing areas. Evaluate the life cycle cost before specifying fan arrays with more than two fans.

~~A. Direct drive fans are preferred over belt drive. Provide a minimum of two fans for all air handlers. Evaluate the life cycle cost before specifying fan arrays with more than two fans.~~

B. Provide, at a minimum, two single width, single inlet (SWSI) plenum fans with 1800 or 1200 RPM motors for units above 12,000 CFM. For units below 12,000 CFM, 3600 RPM fan arrays may be used unless two 2400 RPM fans can meet the capacity.

C. Eighty hertz is the maximum allowed at design conditions unless approved by FacilitiGroup Engineer.

D. Unless prohibited by code, fans shall not be selected for operation within 85% of MAX Fan RPM and BHP is not to be within 85% of motor nameplate HP. Fan selections shall incorporate a total final filter pressure drop of 1.5" w.c. and a total pre-filter pressure drop of .85" w.c. along with all inlet and discharge opening static pressure drops at design CFM.

E. Maximum motor HP shall be 30 HP.

F. Airfoil fans shall comply with AMCA standard 99-2408-69 and 99-2401-82. Provide an AMCA seal on airfoil fans. Airfoil fan performance shall be based on tests made in accordance with AMCA standards 210 and comply with the requirements of the AMCA certified ratings program for air performance.

G. Provide fans with true airfoil blades unless otherwise scheduled.

H. Provide fans with the following accessories:

   1. Fan inlet screens
   2. OSHA-compliant belt guard enclosing the fan motor and drive (if belt driven)

I. Provide airfoil fans with blades formed of extruded aluminum, as scheduled. Bent sheet metal blades are not acceptable.

J. Provide fans with polished steel shafts with first critical shaft speed at least 125% of the maximum operating speed for the fan pressure class. Shaft shall have an anti-corrosion coating.

K. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame.

L. Provide adequate vibration isolation with seismic snubbers.

~~L. Provide vibration isolation springs with 2" static deflection and seismic snubbers.~~

M. Provide horizontal thrust restraints between AHU casing and fan housings.

N. Multiple Fans (Array of Direct-Drive Plenum Fans) shall be Model MPQ centrifugal plenum type, as manufactured by Twin City Fan & Blower, or Model HPA, manufactured by Greenheck.

~~N. Multiple Fans (Array of Direct-Drive Plenum Fans) shall be Model SF (Stack Fan), manufactured by Lau or Model MPQ centrifugal plenum type, as manufactured by Twin City Fan & Blower, or Model HPA, manufactured by Greenheck.~~

   1. Performance — Fans shall conform to AMCA test standards, 205 (fan efficiency grade), 210 (air performance) and 300 (sound performance) and shall bear the AMCA certified ratings seal for both sound and air,

and fan efficiency grade (FEG). Sound certification shall apply to both inlet and outlet sound power levels.

2. Construction — Fans shall be housed and incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge galvanized G90 steel frame, and front panel. The front panel shall have a removable inlet cone designed for smooth airflow transition into the wheel. The motor base shall be designed to ensure proper alignment of the fan wheel, motor and inlet cone. The design shall also ensure the structural integrity of the base to minimize vibration.
3. Wheel — Wheels shall be constructed of non-overloading extruded airfoil shaped blades. Airfoil blades shall be continuously welded. The entire wheel shall be constructed of aluminum to reduce weight and vibration. Blades shall be extruded aluminum. Wheel hubs shall be machined aluminum. Aluminum fan wheels shall not require a finish coating. Wheels shall be attached to the motor shaft using taper lock bushings. The wheel and fan inlet shall be matched and have precise running tolerances for maximum performance and operating efficiency.
4. Finish and Coating — Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.
5. Motors — Motors shall meet or exceed EISA 2007 (The Energy Independence and Security ACT of 2007) efficiencies. Motors shall be NEMA rated, 720, 900 1200, 1800 or 3600 RPM in 60 Hz, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.
6. Fan Balancing — All fans prior to shipment shall be run tested at the specified operating speed. Each fan shall be dynamically balanced as a complete unit in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to a minimum Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken electronically in the axial, vertical and horizontal directions. Records of each fan balance shall be maintained and a written copy shall be available upon request.
7. Blank off Panels — Each Multiple Fan section to be provided with fan blank-off panels to enable manual isolation of fan for servicing. Quantity of panels shall equal number of fans on a single VFD. Backdraft dampers (barometric or controlled) shall not be permitted.
8. Fan Options — The following options shall be available for multiple fans:
    a. Piezometer Ring: Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of ± 5%. Tubing shall be field installed along with corresponding air flow

monitoring station by DDC controls contractor so that the measurement is representative of all fans in the array.

9. Fan Array Motor Control (common VFD operation with Array split into two banks)
    a. All fan motors shall be factory-wired to individual manual motor protection (MMP) device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch (one per motor) for power isolation. Field wiring of MMPs to fan motors shall not be permitted.
    b. MMPs shall be contained in a single control panel (MMP panel) and shall be mounted on the exterior wall panel of the fan array section.
    c. MMP panel shall have a single point of connection for input power wiring and shall feed power individual MMP's through a common bus bar. Independent wiring of input power to individual MMP's shall not be permitted.
    d. All VFDs shall be operated together from a single control point so that all fan motors operate together. Independent control of VFDs and fan motors shall not be permitted.

2.11 Bearings and Drives

A. Provide bearings complying with ANSI/AFBMA 9 for fatigue life ratings.
B. Provide fan bearings with an average life L10 of at least 200,000 hours, as scheduled.
C. Provide re-greaseable bearings with hydraulic grease fittings and lube lines extended to the motor side of the fan.
D. Provide direct-drive plenum fans.

2.12 Electrical Motors

A. Provide fan motors built in accordance with the latest standards of the NEMA and IEEE.
B. Provide AHU and fan motors in compliance with ASHRAE 90.1.
C. Provide fan motors with the following characteristics:
    1. Voltage, Frequency and Phase, as scheduled.
    2. Motor RPM, as scheduled
    3. Minimum service factor of 1.15
    4. Premium efficiency, or as required to meet ASHRAE 90.1
    5. NEMA design ball bearing type

6. Rated for continuous duty at full load in a 104°F (40°C) ambient
7. Open drip proof (ODP) or totally enclosed, fan cooled (TEFC) as scheduled.
8. Suitable for use in variable frequency application, per NEMA MG-1 Part 30
9. Shaft Grounding Rings
10. Premium Efficiency Inverter ready per NEMA STD MG1 PART 31.4.4.2

D. Where practical, provide electronically commutated motors for fractional horsepower applications.

2.13 Fan-Motor Variable Frequency Drives (VFDs)

A. Variable Frequency Drives shall be provided as follows:
1. Dual Fans: One (1) VFD per fan motor with fused main disconnects.
2. Fan Arrays: One (1) VFD with motor protection panel per half of fan array with fused main disconnects.

B. Provide UL or ETL listed VFDs and associated components, as scheduled and shown on drawings. VFDs shall comply with applicable provisions of the National Electric Code.

C. Mount VFDs in a dedicated NEMA 1 compartment located on the primary access side of its associated fan section and wire VFD to motor, unless otherwise indicated on drawings.

D. Enclose outdoor VFDs in a NEMA 3R enclosure suitable for use in ambient temperatures from -20°F to 135°F:

E. After unit installation, VFD shall be started and programmed by a factory trained and employed service technician. Refer to Section Part 3 - Execution3.5.

F. Refer to 26 29 23 for complete requirements for VFDs.

G. Drives are to be provided without bypass, except in the case of a single-fan application.

2.14 Factory Installed Electrical Accessories

A. In addition to motor power terminals, provide an independent power terminal for convenience receptacles and lights. Provide switches as shown on drawings.

B. Provide LED (light emitting diode) lights in segments as scheduled or shown on drawings. Provide light switches as scheduled or shown on drawings. Lights shall be constructed of safety glass and suitable for wet locations.

C. Provide a 1-hour timer on external light switches.

D. Provide a 20A 120V convenience receptacle on supply fan segment. Receptacle shall be powered separately from fan VFD so it remains energized when fan disconnect is open.

E. Disconnects and VFDs are to be installed as close as practical to the fan motor they serve. Where factory-mounted disconnects are to be provided on stacked units, they are to be installed such that they can be reached by a service technician standing beside the unit without the use of a ladder.

~~D.~~F. Where maintenance platforms are anticipated for ease of access to the upper level, disconnects are to be installed adjacent to, and on the same level as, the access door to the motor it serves.

2.15 Heating and Cooling Components

A. Provide coils manufactured by AHU manufacturer, except where noted in contract documents.

B. Coils shall meet or exceed performance scheduled on drawings.

   1. When applicable, provide coils with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop. Circuit coils such that the fluid velocity is within the range of certified rating conditions at design flow.

C. Provide cooling coils with a maximum face velocity of 450 FPM. Face velocity calculations shall be based on the finned area of the coil. Manufacturer shall guarantee zero carryover at 500 fpm.

D. Coils shall be provided with minimum 304 stainless steel coil casing with 304 stainless steel drain pan support structure. Heating coils shall be provided with G-90 galvanized steel coil casings except in the following situations:

   1. heating coils in the preheat position in AHUs installed within 60 miles of the coast, and

   2. heating coils for all AHUs installed in the reheat position.

~~D. Coils shall be provided with minimum 304 stainless steel coil casing with 304 stainless steel drain pan support structure. Heating coils shall be provided with G-90 galvanized steel coil casing unless in the reheat position. 304 stainless steel shall be used when heating coil is reheat position.~~

E. Cooling coils shall be a maximum of 8 rows and 10 fins per inch. In ASHRAE Climate Zones 1, 2, and 3, coils shall be 8 rows deep. ***No exceptions.*** *Size cooling coils for minimum 80/67 EAT unless job specific conditions require more.*

F. Limit the water side pressure drop on water coils to 15 feet. Limit the air side pressure drop on chilled water coils to 0.90” w.c.

G. Provide at least 18” of access between coils. Provide an easily operable access panel or door, as shown on drawings.

H. Provide coil segment casing that meets or exceeds casing performance of the unit.

I. Provide panels that are easily removable with no special tools.

J. Locate access doors to provide clearance for pipe insulation, connectors, and accessories. Space shall allow a minimum of 90 degrees of door swing.

K. Provide coils built in their own full perimeter frame. Tube sheets on each end shall have fully drawn collars to support and protect tubes. Horizontal coil casing and support members shall allow moisture to drain. Casing and support members shall not block finned area.

L. Individual coils shall be removable from the side of the AHU.

M. Provide intermediate drain pans on stacked cooling coils (one at every coil break). Intermediate drain pan shall slope in a minimum of two planes toward a single drain connection.

N. Provide a single intermediate vertical coil support on coils with a finned length greater than 62”. Provide two vertical supports on coils with a finned length greater than 100” and three vertical supports on coils with a finned length greater than 141”.

O. Provide a 1/4" FPT plugged vent/drain tap on each connection. Circuiting shall allow draining and venting when installed. Extend vent, drain, and coil connections through AHU casing.

P. When staggered coil banks are required. Provide a 1/4" FPT plugged vent/drain tap on each connection. Circuiting shall allow draining and venting when installed. Vent, drain, and coil connections shall be supplied within 10” of the header. Extend vent, drain, and coil connections through AHU casing. Insulation of internal chilled water piping shall be insulated by mechanical contractor.

Q. Insulate gap between coil stub out connection and AHU casing with a spool-shaped sleeve grommet. Adhesive rings applied the casing walls are not acceptable.

R. Water and glycol coils shall be operable at 250 psig working pressure and up to 300° F. Factory test water and glycol coils with 325 psig compressed air under water.

S. Direct expansion (DX) coils shall conform to ANSI B9.1 (Safety Code for Mechanical Refrigeration) when operating with a maximum refrigerant pressure of 250 psig. Factory test DX coils with 325 psig compressed air under water. DX coils will be dehydrated and sealed prior to installation.

T. Steam distributing coils shall be operable at 50 psig pressure and a corresponding saturated steam temperature of 298° F. Factory test steam coils with 315 psig compressed air under water. Dehydrate and seal coils prior to shipping.

U. Provide steam-distributing coils with a tube outer diameter (OD) of 1" and an inner distribution tube of 5/8" O.D. Circuit coils for gravity drain of condensate without trapping. Steam shall discharge in the direction of condensate flow to ensure even heat transfer across each tube.

V. Provide water, glycol and DX coils with a tube OD of 5/8” and material thickness of 0.025”. Mechanically expand tubes to form fin bond and provide burnished, work-hardened interior surface. Turbulators shall not be permitted inside water coils.

W. Provide water, glycol and steam coil headers made of seamless copper or brass tubing. Pipe connections shall be red brass. Provide DX coils with brass distributor and lead-free solder connections. Suction and discharge connections shall be on the same end regardless of coil depth. Provide DX coils with a hot gas bypass port on distributor.

X. Provide coils with die-formed, continuous aluminum fins. Fins shall have fully drawn collars to accurately space fins and protect tubes. Fins shall be 0.008” thick.

Y. Provide coil coatings as scheduled or indicated on drawings.

2.16 Filters

A. Provide filter segments with filters and frames as scheduled. Specify pre-filter racks that provide metal support on the entire perimeter of the pre-filters.

B. Provide face loading filters for all filter segment(s). Provide an 18” (minimum) access plenum and access door on the drive side through which face loading filters can be easily loaded.

C. Provide Class 2 or Class 1 filter media per U.L. 900 and as required by local codes.

D. Filter types, efficiencies, and nominal depths shall be as follows:

1. Rigid filters – 4” mini pleated with efficiencies of 60-65% (MERV 11) for all Pre-filters. 12” rigid, 90-95% (MERV 14) for final filters.
    a. Provide front loading filter tracks for all filters. Side loading racks are unacceptable.
2. HEPA filters – 12” 99.97%, or 99.99% efficient media, as scheduled.
    a. Performance of installed filtration system shall be certified via a DOP test and classified as UL Class 1 when tested in accordance with UL Standard 586.
    b. Filter frame shall be specifically developed for HEPA filters, with appropriate quantities of filter clamps.

E. Provide a flush mounted, factory installed, Magnahelic differential pressure gage on the drive side of unit to measure pressure drop across filters. Manufacturer shall provide fully functional gauges, complete with tubing.

2.17 Dampers

A. Provide dampers tested in accordance with AMCA 500.

B. Provide factory-installed dampers, as shown on drawings.

C. Dampers shall have airfoil blades, extruded vinyl edge seals, and flexible metal compressible jamb seals.

D. Dampers shall have a maximum leakage rate of 4 CFM/square foot at 1" w.g., and shall comply with ASHRAE 90.1.

E. Damper blades shall be opposed acting unless otherwise indicated. Parallel blades may be required to promote air mixing.

F. Damper blades shall be aluminum.

2.18 Air Blenders

A. Provide static mixing devices by Blender Products, Inc. or approved equal downstream of all outside air sections when the ASHRAE 99.6% winter design dry bulb condition is 38ºF or less to enhance the mixing of outside air with return air to an effectiveness required to eliminate freeze stat trips, minimize sensor, error and enhance outdoor air distribution.

B. The static mixer shall be capable of a minimum of 70% range mixing effectiveness when mixing 25% outside air with 75% return air at one mixer diameter downstream of mixer.

C. Multiple mixers may be utilized for OA introduced on top of air handling unit that is full casing width. All side inlet OA arrangements shall utilize single blender or minimum allowable within air handling unit casing and still provide a minimum of 70% range mixing effectiveness.

2.19 Airflow Monitoring Stations

A. All fans shall be provided with factory mounted piezometer rings. Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of ± 5%.

B. BAS Contractor shall provide a field-installed transducer that sends a CFM-proportional, 4-20 mA or 0-10V signal, as specified in specification section 230913.

C. Fan array measurement – For arrays having four fans or more, provide FAATS-1000 fan array airflow totalizing system by Paragon Controls or approved equal with one remote transducer per array.

2.20 Humidifier Dispersion Manifold

A. Provide Stainless Steel Short Absorption Manifold designed for atmospheric steam humidifiers or pressurized steam from a boiler, to directly inject the steam into ducted air for humidification.

1. Provide adequate vertical tube spacing to ensure absorption distance characteristic shall prevent water accumulation on any in-duct surfaces beyond 24 in downstream of the steam dispersion panel.
2. Steam inlet and condensate return located on the same side and at the bottom of the header to allow single point entry and floor mounting.
3. Provide headers of 304 stainless steel construction.
4. Provide vertical, 304 stainless steel distribution tubes to promote condensate evacuation. Horizontal distributor tubes are not accepted.
5. Stainless steel nozzle inserts shall have metered orifices, sized to provide even distribution of the discharged steam, spaced for optimum steam absorption. Systems without nozzle inserts, or other than stainless steel, are not acceptable.
6. Provide tube and header insulation constructed from 304 stainless steel shielding for increased energy efficiency and reduced airstream heat gain. Steam header insulation is to minimize heat losses to under 10%. Stainless steel shields to be isolated from distributor using plenum rated synthetic foam strips. Insulation to provide air-gap to minimize conduction and convection, as well provide reflective surface to minimize radiating heat transfer. Un-insulated headers, or simple foam insulation not accepted.

2.21 UVC Fixtures

A. Provide surface decontamination UV fixtures within cooling coil sections for air handlers serving emergency departments, operating rooms, bone marrow areas, PICU, and NICUs.
B. UV system shall be tied to a switch to kill power to the lighting system when the access door is opened. A second manual kill switch shall be provided inside the unit for safety.
C. UVC products shall be from an ISO 9001 manufacturer or the supplier shall provide proof of 100% inbound and outbound testing of equipment and have at least 10 years' experience as a manufacturer of UVC products for air handling equipment.
D. Fixtures shall be tested, listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.
E. Fixtures shall meet the "UL" drip proof design and each fixture is equipped with an electrical interlock.
F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They are constructed with UVC proof metal bases and shall not produce ozone.

G. Each lamp shall contain no more than 8 milligrams of mercury, consistent with current environmental practices, while producing the specified output at 500 fpm in temperatures of 55-135° F.

H. Lamps and fixtures shall be installed in sufficient quantity and in such a manner so as to provide even distribution of UVC energy on designated surface area (Coil, filter rack, etc.). When installed, the minimum intensity striking any point on a plane representing the surface of the coil or component shall not be less than 50 microwatts per square centimeter. Average radiation shall be 150 microwatts minimum per square centimeter.

I. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a mono-layer of mold and bacteria as typically found in HVAC systems in less than six hours

J. Lamp fixtures shall be constructed of type 304 stainless steel to preclude corrosion. Support components shall be constructed of type 304 stainless or galvanized cold rolled steel.

K. Power supply shall be of a high efficiency, high frequency electronic type, matched to the lamp and designed to maximize UVC radiance and reliability. They shall be capable of four wire lamp operation rapid start. They shall be UL Listed and labeled, and comply with FCC 47, Part 18, non-consumer limits requirements. The ballast shall be protected from failure in the event of End of Lamp life lamp failure. The ballast shall be capable of operation indefinitely when powered with no lamp or a failed or broken lamp. Track mounted fixture ballasts shall have 120VAC or 240 VAC input. Strut mounted ballasts shall have universal input (100VAC to 277VAC). Track mounted fixtures shall be capable of producing the output as specified under Irradiation and Intensity at no more than 13Watts of power consumption for each square foot of treated, cross sectional plane.

L. Ballast system shall not proprietary to the manufacturer of the UV bulb.

M. Provide and install a UV radiometer for monitoring bulb intensity near center of coil - tie to BAS. Set BAS to alarm operator when bulb intensity drops below manufacturer-recommended threshold.

N. Original purchase of equipment has to include service contract to replace bulbs once per year for five years after startup. Contract must include materials and labor to install new and dispose of old bulbs.

2.22 Appurtenances

A. For motors 7.5HP and larger in the stacked position, provide internal structural I-Beam motor removal rail with structural frame to distribute motor weight to unit base. Rail shall be perpendicular to centerline of access door for ease of removal.

~~A. Provide internal structural I-Beam motor removal rail with structural frame to distribute motor weight to unit base. Rail shall be perpendicular to centerline of access door for ease of removal.~~

B. Provide rain hoods on outdoor unit air intakes, as shown on drawings. Provide moisture screens on outdoor air inlet rain hoods.

C. Provide steel base rails suitable for rigging and lifting, as shown on product drawings.

D. Provide safety grates over bottom openings, as shown on drawings.

   1. Safety grates shall be capable of supporting a 300 lb. center load.

E. Provide lifting lugs where required.

2.23 Finishes

A. Manufacturer shall clean the exterior surfaces of units prior to finishing, painting, or shipment.

B. Unpainted air-handling units constructed of galvanized steel shall pass the ASTM B-117 test for 220-hour salt spray solution (5%) without any sign of red rust. (confirm)

C. Manufacturer shall paint outdoor units prior to shipment. Manufacturer shall paint indoor units, as scheduled or shown on drawings.

   1. Manufacturer shall apply a primer prior to painting units.
   2. Manufacturer shall apply a finish coat of acrylic polyurethane paint.
   3. Finished unit shall exceed 500-hour salt spray solution (5%) test without any sign of red rust when tested in accordance with ASTM B-117.

2.24 Tests and Inspections

A. Manufacturer shall dynamically balance fan/motor/base assembly.

   1. Balance constant volume fan assemblies at design RPM.
   2. Balance variable volume fan assemblies from 10% to 100% of design RPM.
   3. Take filter-in measurements in the horizontal and vertical axes on the drive and opposite-drive sides of fan shafts.
   4. Constant speed fan vibration limits: filter-in measurements shall not exceed 4 mils.
   5. Variable speed fan vibration limits: filter-in measurements shall not exceed 7 mils.

B. Manufacturer shall hi-pot test wiring intended to carry voltages greater than 30VAC.

Part 3 - Execution

3.1 Installation

A. Install equipment per industry standards, applicable codes, and manufacturer's instructions.

B. Do not use AHUs for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.

C. Install rooftop AHUs on a roof curbs, as shown on drawings. To reduce the potential for noise complaints, retain the maximum amount of roof mass under the unit and locate rooftop units over non-sound sensitive area. Where possible, cut openings in roof for duct and pipe penetrations – do not open roof to entire area under curb. Provide sound plenums within building to reduce sound transmission. Sound plenum construction shall be thoroughly detailed.

D. Install all AHUs on elevated slabs not over a mechanical room on floating floor arrangement per HCA standard detail.

E. Install AHUs with manufacturer's recommended clearances for access, coil pull, and fan removal.

~~F. Provide one complete set of filters for testing, balancing, and commissioning. Provide second complete set of filters at time of transfer to owner.~~

~~G.~~F. Install AHU plumb and level. Connect piping and ductwork according to manufacturer's instructions.

~~H.~~G. Install seismic restraints and anchors per applicable local building codes. Refer to specification Section 230548 (15240 / 15070) for product and installation requirements.

~~I.~~H. Install pipe chases per manufacturer's instructions.

~~J.~~I. Insulate plumbing associated with drain pan drains and connections. Run condensate to nearest floor drain or roof drain.

~~K.~~J. Install insulation on all staggered coil piping connections, both internal and external to the unit.

~~L.~~K. If access to the interior of the air handler for maintenance and repair cannot be gained without a ladder, a permanent access ladder must be provided. Install platforms and access ladders to permit full maintenance of the upper level of stacked air handlers. Platform and support structure shall not obstruct door swing, coil pull, and other reasonable maintenance access to the lower level.

3.2 Field Quality Control

A. Store per AHU manufacturer's written recommendations. Store AHUs indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.

B. Rig and lift units according manufacturer's instructions.

3.3 AHU Inspection

A. Installing Contractor to perform an inspection of unit and installation prior to startup. Start-up report submitted to general contractor shall verify the following as a minimum:

1. Damage of any kind
2. Level installation of unit
3. Proper reassembly and sealing of unit segments at shipping splits.
4. Tight seal around perimeter of unit at the roof curb
5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
6. Completion and tightness of electrical, ductwork and piping
7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
8. Supply of electricity from the building's permanent source
9. Integrity of condensate trap for positive or negative pressure operation
10. Condensate traps charged with water
11. Removal of shipping bolts and shipping restraints
12. Sealing of pipe chase floor(s) at penetration locations.
13. Tightness and full motion range of damper linkages (operate manually)
14. Complete installation of control system including end devices and wiring
15. Cleanliness of AHU interior and connecting ductwork
16. Proper service and access clearances
17. Proper installation of filters
18. Filter gauge set to zero

B. Resolve any non-compliant items prior to unit start-up.

3.4 Inspection and Adjustment: AHU Fan Assembly

A. Hire the manufacturer's factory-trained and factory-employed service technician perform an inspection of the AHU fan assembly subsequent to general AHU inspection and prior to startup. Technician shall inspect and verify the following as a minimum:

1. Fan isolation base and thrust restraint alignment
2. Tight set screws on pulleys, bearings and fan
3. Tight fan bearing bolts
4. Tight fan and motor sheaves
5. Tight motor base and mounting bolts
6. Blower wheel tight and aligned to fan shaft
7. Sheave alignment and belt tension
8. Fan discharge alignment with discharge opening
9. Fan bearing lubrication
10. Free rotation of moving components (rotate manually)

3.5 Startup Service and Owner Training

A. Manufacturer's factory-trained and factory-employed service technician shall startup AHUs. Technician shall perform the following steps as a minimum:
   1. Energize the unit disconnect switch
   2. Verify correct voltage, phases and cycles
   3. Energize fan motor briefly ("bump") and verify correct direction of rotation.
   4. Re-check damper operation; verify that unit cannot and will not operate with all dampers in the closed position.
   5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.

B. Provide a minimum of 4 hours of training for owner's personnel by manufacturer's factory-trained and factory-employed service technician. Training shall include AHU controls, motor starter, VFD, and AHU.

C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

D. If AHU is provided with a factory-mounted variable frequency drive (VFD), hire the VFD manufacturer's factory-trained and factory-authorized service technician to inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.

E. If AHU is provided with a factory-mounted humidifier, hire the humidifier manufacturer's factory-trained and factory-authorized service technician to inspect, test, adjust and verify proper operation in conjunction with BAS contractor.

F. Submit a startup report summarizing any problems found and remedies performed.

G. Permanent air handling equipment shall not be started under any circumstances until dust-generating construction activities such as drywall sanding and floor grinding are complete and the space is entirely cleaned. Until that time, the air handler shall be properly sealed to eliminate dust collecting inside the unit.

3.6 Cleaning

A. Clean unit interior prior to operating. Remove tools, debris, dust and dirt.

B. Clean exterior prior to transfer to owner.

3.7 Documentation

A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.

B. Provide six copies of Spare Parts Manual for owner’s project system manual.

SECTION 23 75 13: PACKAGED OUTDOOR DX EQUIPMENT

Part 1 - General

1.1 Scope

A. Provide microprocessor controlled, multiple-scroll compressor, air-cooled double-wall outdoor single packaged air conditioning units, and components of the scheduled capacities and performance as shown and indicated on Engineer documents, including but not limited to: factory-single packaged air conditioner, charge of refrigerant and oil, roof curb, power and control connections, and utility connections.

1.2 Quality Assurance

A. Products will be designed, tested, and rated in accordance with ARI, and installed in compliance with applicable sections of the following Standards and Codes:

1. ANSI/ASHRAE Standard 15 – Safety Code for Mechanical Refrigeration
2. ARI Standard 340/360
3. ETL/cETL
4. Manufactured in facility registered to ISO 9002
5. ASHRAE 62 – Ventilation for acceptable indoor air quality
6. ASHRAE 90.1 – Energy standard for buildings except low rise residential buildings (affix compliance label to machine)

B. Sound rating of outdoor unitary equipment shall be certified in accordance with latest version of ARI Standard 270.

C. Manufacturers: York by Johnson Controls

D. Factory Test: The refrigerant circuit will be pressure-tested, evacuated and fully charged with refrigerant and oil. The refrigerant circuit will undergo a factory test and undergo an automated operational run test and quality inspection prior to shipment. The unit controller will be configured and run tested at the factory to minimize field setup time. If the unit is not configured and tested, then the manufacturer will provide field start up and testing to ensure that the controller is functioning properly.

E. Warranty: Manufacturer will warrant all equipment and material of its manufacture against defects in workmanship and material for a period of 12 months from the date of owner acceptance.

    1. The warranty will include parts and labor required to remedy defects in materials or workmanship for entire machine during this period.

    2. The warranty will not include parts associated with routine maintenance, such as belts, air filters, etc.

1.3 Delivery and Handling

A. Unit will be delivered to the job site fully assembled, wired, and charged with refrigerant and oil by the manufacturer.

B. Unit will be stored and handled per Manufacturer’s instructions.

1.4 Submittals

A. Shop drawing submittals will include the following at minimum: drawings indicating components, dimensions, weights, required clearances, and location, type and size of field connections, and power and control wiring connections.

B. Product data will include dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials. All cooling and heating capacities will be provided as net capacities and take into account heat gain from all motors in the air stream.

    1. Fan curves with specified operating point clearly plotted will be provided.

    2. Product data of filter media, filter performance data, filter assembly, and filter frames will be provided.

    3. Electrical requirements for power supply wiring; including wiring diagrams for interlock and control wiring will be supplied. Factory and field-installed wiring will be clearly indicated.

4. Manufacturer's standard published installation instructions will be provided.

C. Manufacturer's standard operating and maintenance instructions will be supplied, including, but not limited to instructions for lubrication, filter replacement, compressor, motor and drive replacement, coil cleaning, filter maintenance, spare parts lists, and wiring diagrams.

Part 2-Products

2.1 Product Specification

A. Summary: Completely factory assembled unitized construction single packaged air conditioning unit including a factory-mounted and wired unit controller and sensors, outdoor air handling section with return and supply openings, discharge plenum, direct-expansion refrigerant condensing section.

B. Provide extruded aluminum outside air dampers and coated condenser coils in coastal applications (up to 60 miles from the coast.)

C. Where required by code, select unit with 100% outdoor air economizer and relief fan.

D. Unit Construction

1. Manufacturers' standard double-wall galvanized sheet metal construction with insulated walls. Wall thickness and insulation R-value is to be in accordance with applicable energy code. Hinged access doors with gaskets are located on both sides for inspection and access to internal parts.
2. The roof will be double-wall construction sloped on both sides and with a drip lip to provide proper drainage of water without staining sides of unit. Roof sections are connected together via integral channels and gasketing. Each fastened seam is to be protected by a sheet metal channel covering the full length of the gasket surface.
3. Floor construction will be double-wall and provide sufficient structural integrity for servicing.
4. Exterior surfaces are to be coated with a minimum 1.5 mil powder paint, capable of withstanding a minimum 1000-hour salt spray hours in accordance with ASTM B-117.
5. Control and power panel includes knockouts for electrical and piping connections. An exterior drain is provided for elimination of condensate. A condensate trap will be provided by others in the field. A 120V/1ph/60Hz GFCI outlet is provided to power hand tools and lights. The outlet is to remain powered when unit power is locked out for servicing.
6. Lifting lugs are provided on both sides to facilitate unit rigging.

E. Supply Fan Section

1. The supply fan is a single Airfoil fan Class I or II construction as required by the fan rating point, with belt-driven fixed motor sheaves, self-aligning pillow-block re-greasable ball bearings, and 25 HP TEFC - Premium Efficiency motor. Fan and motor are assembled on a fan skid with 2" Spring Isolation and will be dynamically balanced in the factory prior to shipment.
2. VAV and Single Zone supply fan control shall be accomplished by using a variable-frequency drive matched to the supply-fan motor HP. The VFD shall include an integral DC link choke to reduce harmonic distortion in the incoming and outgoing power feeds. If a DC link choke is not provided, an AC line reactor must be provided. Inlet guide vanes shall not be acceptable. VFD control keypads shall be located in the control cabinet for accessibility and servicing while the unit is operating.

F. Evaporator Section

1. Evaporator coils will be direct expansion type with intertwined circuiting to assure complete coil face activity during part load operation. Coil tubes will be copper. Fins will be aluminum mechanically expanded to bond with the copper tubes. Coil casing will be fabricated from heavy gauge galvanized steel. All coils will be pressure tested at a minimum of 450 PSIG.
2. A stainless steel double-sloped drain pan will be provided under the entire width of the evaporator coil. The main drain pan will be sloped a total of 1/8” per foot towards the drainage point. Main drain pan will be accessible and easily cleanable in the field. The condensate drain opening will be flush with the bottom of the drain pan to allow complete drainage. Coils in excess of 48” high will have an intermediate drain pan extending the entire finned length of the coil to provide better water drainage. Drainage from the intermediate drain pan will be to the primary drain pan.
3. A modulating hot gas reheat coil shall be provided where indicated on engineer drawings as required for humidity control and discharge air temperature reset.

G. Condenser Section

1. Propeller type, directly driven by permanently lubricated motor. Condenser fans will be matched up with compressors to optimize system control.
2. Condenser coils are seamless copper, arranged in staggered rows, mechanically expanded into aluminum fins with epoxy coating. Condensing coils will have an integral subcooler for more efficient, stable operation. The condenser section shall be enclosed by a louvered panel condenser enclosure on the three exposed sides. Paint

finish shall match the color and salt spray specifications of the unit exterior.

3. Units will use industrial-duty hermetic scroll compressors, piped and charged with oil and HFC-410A refrigerant. Compressors include a solid state protection module, designed to protect the compressor from over-temperature and over-current conditions. Each compressor will include the following safety and convenience devices: discharge line check valve and oil sight glass. Compressors will be vibration-isolated from the unit, and installed in an easily accessible area of the unit. All compressor-to-pipe connections will be brazed. Compressor sound blankets are provided to attenuate radiated sound.
4. Refrigerant piping includes check valves, thermal expansion valves with replaceable thermostatic elements, replaceable core drier, high and low pressure switches, antirecycling timing device to prevent compressor restart for five minutes after shutdown. Shut-off isolation valves are located on the suction and discharge lines of the compressor circuit for compressor servicing. Hot gas bypass piping is provided for optimal unit control at low loads.
5. Low-ambient, head-pressure control designed to operate at temperatures as low as 0°F by controlling speed of last fan of circuit one.
6. Pressure transducers with readout capability through the single packaged unit control display unit are provided on each circuit.

H. Filter Section

1. All filter holding frames will be of heavy duty extruded aluminum construction. All filters will be either side accessible or front loading with access doors provided on both sides of the filter section. Filter efficiencies will be rated in accordance with ASHRAE Standard 52-76.
2. A differential pressure switch provides a signal to the rooftup unit controller when filter become dirty and require cleaning.

I. Outside Air Section

1. Outside Air inlet openings are covered by a factory installed rainhood permanently attached to the cabinet to prevent windblown precipitation from entering the unit. The rain hoods on the left and right sides of the unit folded flat against the cabinet and secured for shipment so that upon installation they can be unfolded and rotated upwards and screwed into place. The outside air hood contains a removable and cleanable filter with an efficiency rating of 50% based on ASHRAE 52-76.
2. All damper assemblies are low-leak design. Damper blades are fabricated from a minimum of 16 gauge galvanized steel. Blade edges

are covered with vinyl seals. Damper shafts are fabricated from solid steel and mounted in the frame with bronze bearings.

3. Fresh air will be introduced into the unit via an outside airflow measurement station for full airflow measurement from 0-100% outside airflow. The airflow measurement station is designed into the unit and includes all controls, dampers, air straighteners, and components to monitor airflow accurately.

J. Indoor Air Quality

1. Unit(s) specified for air handling applications shall be required to provide a protective covering membrane for such equipment being shipped by truck, rail, or ship. The membrane shall be fully formed around the equipment exterior. The membrane shall cover the entire top, side and end panel surface as to protect the product effectively during shipping & storage including "Long Term Storage". Storing on job-site shall no longer require the unit(s) to be covered with a tarp as long as the covering membrane has not been removed or cut open.
2. Equipment including electrical components shall be effectively covered for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust, & corrosion during shipping cycle. Equipment shall remain clean and dry.
3. Manufacturers of units not having a protective membrane, fully formed around the equipment exterior, covering the entire top, side and end panel surface area shall be required to ship equipment covered with a tarp, in crating or in a closed truck as is necessary to ensure product protection from sun fading, road salt/chemicals, rust, corrosion, moisture and dirt infiltration. Arrangements for short term and/or long term storage at the job site shall be required.

2.2 Controls

A. Enclosure: Unit shall be shipped complete with factory configured, installed, wired and tested single packaged unit controller housed in a rain and dust tight NEMA 3R/12 (IP55) powder painted steel cabinet with hinged, latched, and gasket sealed door.

B. Basic Controls: Control shall include automatic start, stop, operating, protection sequences across the range of scheduled conditions and transients. The single packaged unit controller shall provide automatic control of compressor start/stop, energy saver delay and anti-recycle timers, condenser fans, and unit alarms. Automatic reset to normal operation after power failure. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real time clock (RTC) memory for minimum 5 years. Eighty character liquid crystal display, descriptions and numeric data in English (or Metric) units. Sealed keypad with sections for Setpoints, Display, Entry, Unit Options & clock, and an On/Off Switch.

C. Diagnostics: Upon startup of the controller, it shall run through a self-diagnostic check to verify proper operation and sequence loading. The single packaged unit controller shall continually monitor all input and output points on the controller to maintain proper operation. The unit shall continue to operate in a trouble mode or shut down as necessary to prevent an unsafe condition for the building occupants, or to prevent damage to the equipment. In the event of a unit shutdown or alarm, the operating conditions, date and time shall be stored in the shutdown history to facilitate service and troubleshooting.

D. BAS Communications

1. BACnet MSTP (RS-485): The unit shall include BACnet communications directly from the unit controller. Equipment that is not native BACnet at the unit control board shall include any necessary interface or translator device factory-mounted and wired within the unit. A control points list, BIBBs and PICS statement shall be provided by the manufacturer to facilitate communications programming with the building automation system. Programming, establishing communications and commissioning shall be the responsibility of the installing controls contractor. Start-up assistance and support may be purchased from the manufacturer.

2. BAS Interface: At a minimum, the interface shall provide the following inputs and outputs:

   a. Inputs: supply air reset, duct static pressure reset, building static pressure reset, smoke purge operating mode, ventilation override, morning warm-up and demand limiting

   b. Outputs: fault alarms for sensors, cooling or heating failure, supply fan faults, and dirty filter faults

2.3 Air Handler Variable Speed Drives

A. Variable Speed Drive: The microprocessor-based, variable-speed AC drive has control functions and software designed specifically for fan applications. The VSD uses voltage vector control to supply full-rated motor voltage at rated frequency, full motor performance without derating, and high efficiency for both drive and motor.

B. VSD Keypad: The keypad features an alphanumeric display with seven indicators for the Run status (Run, Counterclockwise, Clockwise, Ready, Stop, Alarm, Fault) and three indicators for the control place (I/O term, Keypad, BusComm).The control information is represented with numeric symbols. The drive is operable through the pushbuttons of the keypad. The buttons can be used in setting parameters and monitoring values. The keypad is detachable and isolated from the input line potential.

C. Operation: VFD shall be fully configured, tested at the factory and set to run from the unit controller. If manual operation is required, control of the VFD can be switched from unit control (auto) to manual (hand) directly from the keypad. In addition, any trip level fault can be reset from the keypad.

D. Drive Features: The VSD includes a DC link choke, power line protection, sleep mode, run permissive circuit, two analog inputs, one analog output, adjustable carrier frequencies, lockout capability for up to six critical frequencies, and broken belt setting.

1. DC Link Choke: An input DC link choke is standard equipment on the VSD. This filter reduces the level of harmonics reflected back into the building power system without causing a voltage loss at the drives input and reducing efficiency as an external AC link choke would. This filter also improves input power factor.
2. Power Line Protection: power line voltage surge protection is provided. The DC link choke also acts to slow input power surges.
3. Sleep Mode: automatically stops drive when speed drops below set "sleep" level for specified time. Automatically restarts when speed command exceeds set "wake" level. Saves energy and reduces wear on driven equipment.
4. Run Permissive Circuit: ability to accept a "system ready" signal assures that dampers or other auxiliary equipment are in the proper state for drive operation.
5. Acceleration / Deceleration Rates: the VSD can provide one individually controlled set of acceleration/deceleration rates each from 0.1 to 3600 seconds. The shape of these curves may be automatically contoured to prevent tripping.
6. Plenum Rated: the VSD is recognized by UL for installation inside any air conditioning duct or plenum.
7. Analog Inputs: the VSD is equipped with two analog inputs as standard (1) 0 to 10 VDC, (1) 0 to 20 mA). In addition, a built-in PID controller can be used to control the drive and perform the functions of a set point controller.
8. Analog Outputs: the VSD is equipped with one analog output as standard that can be configured for 0 to 20 mA or 0 to 10 VDC (with pull-down resistor). The analog output can be configured proportional to output frequency, frequency reference, motor speed, output current, motor torque, motor power, motor voltage and DC link voltage.
9. Auto Restarts: the VSD can be automatically restarted up to 3 times per 5 seconds. If the application causes the drive to trip more than the number of trials set, the drive will stop operating and display the fault

on the display screen. A manual reset will be required by means of the reset key, a digital input, or BAS command. In cases of severe trips, as a safety feature, the drive's input power may have to be cycled to restart a fault.

10. Carrier Frequency: the VSD drive can employ high switching frequencies, so the motor current is practically sinusoidal. Audible motor noise can also be minimized by adjusting the frequency. These frequencies can be set or adjust themselves on the fly to fit the application.
11. Input Power: the VSD is equipped with an automatic sustained power or phase loss circuit. The VSD will provide a full rated output with an input voltage as low as 90% of the nominal. The drive will continue to operate with reduced output with an input voltage as low as 164 volts for 208/230 volt units, and 342 volts for 460 volt units.
12. Critical Frequency Lockouts: for applications where it may be necessary to avoid specific frequencies due to mechanical resonance problems in the driven equipment, the VSD makes it possible to set up to four different frequency ranges which will be avoided during operation of the drive. Each critical frequency setting can be up to +/- 50% of the center frequency speed. If the reference signal defines that the VSD is to operate within this critical frequency range, the critical frequency lockout function will keep the drive operating below the critical frequency limit. When the frequency reference signal rises above the critical frequency maximum limit, the VSD will allow the motor to accelerate through the critical frequency at the time set by the acceleration rate.

Part 3 - Execution

3.1 Installation

A. General: Installing contractor will install single packaged unit(s), including components and controls required for operation, in accordance with single packaged unit manufacturer’s written instructions and recommendations. Single packaged units will be installed as specified.
   1. Single packaged unit(s) will be stored and protected in accordance with manufacturer’s recommendations.
   2. Single packaged unit(s) will be stored only in a clean, dry place, protected from weather and construction traffic.
   3. Single packaged unit will be handled such that damage to components, enclosure, and finish is avoided.
B. Location: Locate the single packaged unit as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level the single packaged unit on support structure.

C. Mount unit on spring vibration isolation rails/curb assembly, where required by engineer.

3.2 Startup Services

A. Manufacturer's Supervision: A factory-trained service representative of the manufacturer will supervise the unit startup and application specific calibration of control components.

1. The single packaged unit will not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation.
2. After the single packaged unit is installed, the variable speed drive (if supplied) will be field commissioned by a factory trained and employed service technician.

B. Permanent air handling equipment shall not be started under any circumstances until dust-generating construction activities such as drywall sanding and floor grinding are complete and the space is entirely cleaned. Until that time, the air handler shall be properly sealed to eliminate dust collecting inside the unit.

3.3 Roof Mounting

A. Provide insulated roof curb, flashed in accordance with roof system manufacturer instructions.

B. Roof opening is to be minimized to area required for duct and conduit penetrations only. Roof openings inside the full perimeter of the roof curb will not be permitted.

SECTION 23 81 23: COMPUTER ROOM AIR CONDITIONERS

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Acceptable Manufacturers: Liebert, Airedale, HiRoss, DataAire, Compu-Aire, Stultz & Schneider Electric.

2.2 Provide head pressure controls to allow for stable unit operation at low load conditions.

2.3 Unit shall be equipped with hot gas bypass.

2.4 Unit shall be equipped with anti-short-cycle timer.

2.5 Unit is to be equipped with humidifier if required to maintain minimum humidity levels.

2.6 Unit shall be equipped with DDC controls with logic for controlling cooling, reheat and humidifier with interface to BAS for trending, monitoring and recording space temperature and humidity and alarms conditions.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 81 26 13: SPLIT SYSTEM (<10 TONS) A/C UNITS

Part 1 - General
1.1 Avoid if possible. See DX discussion in Section I: General, above.

Part 2-Products
2.1 Acceptable Manufacturers: Carrier, Trane, York

2.2 Provide head pressure controls to allow for stable unit operation at low load conditions.

2.3 Provide anti-short-cycle timer.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 82 16: AHU COILS

Part 1 - General
HCA is electing at this time not to provide guidelines.

Part 2-Products
2.1 Heating coils: Performance per ARI 410. Minimum 0.020″ tube wall thickness and minimum fin thickness of 0.0075″.

2.2 Hot water is the preferred heating medium. Use the highest practical temperature difference to reduce piping sizes and pump requirements. Select heating coils with 140° EWT.

2.3 Provide inlet strainer, PT plugs, and air vent in the connection piping. Do not provide balancing valve at individual space reheat coils.

2.4 Hot water preheat coils shall have a minimum tube velocity of 3 FPS maintained through each tube by the use of a local circulating pump, controlled to operate at outside air temperatures below 40°F.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 23 82 17: ELECTRIC DUCT HEATERS

Part 1 - General

1.1 Avoid use of electric duct heaters.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 23 82 19: FAN COIL UNITS

Part 1 - General

1.1 Work Included:

A. Do not use fan coil units with through wall fresh air intakes. Use separate make-up air unit to provide ventilation air.

B. Do not use the space above the ceiling as a return plenum.

C. Heating and cooling coils shall be certified in accordance with ARI Standard 410.

D. Where practical, provide electronically commutated motors for fractional horsepower applications.

Part 2-Products

2.1 Acceptable Manufacturers: JCI

Part 3 - Execution

3.1 Where permitted by AHJ and/or plumbing inspector, pipe condensate drains to entering side of lavatory p-trap.

3.2 Minimum condensate drain pipe shall be ¾″

3.3 Design condensate drainage piping for cleaning at trap.

3.4 Provide auxiliary drain pans with overflow drain piped to visible location through chrome plated escutcheon.

SECTION 23 84 00: HUMIDITY CONTROL EQUIPMENT

Part 1 - General

1.1 Work Included:

A. Do not use humidifiers except where specifically called for by the AHJ or where Vendor drawings require minimum humidity requirements.

B. Do not use local individual humidifiers at each space unless required by the AHJ. Where possible place the space humidity sensor at a location that will serve for multiple spaces, such as a return duct. Where possible, provide humidification in the main supply duct or within the air handling units. Provide a controlling high limit humidity sensor in supply duct to override the signal to the humidifier valve and limit supply air humidity at its duct location to a maximum 80% RH. Locate a high limit humidity switch adjacent to the controlling high limit humidity sensor that will disable the humidifier controls (manual reset) in the event the supply air humidity exceeds 95% RH.

C. Avoid humidifiers that require a heated manifold in the air stream in order to eliminate wetting problems.

D. Size humidifiers to provide required humidification at all conditions including 100% economizer mode.

Part 2-Products

2.1 Acceptable Manufacturers: Armstrong, Hermiddifier Co., DriSteam, Pure Steam, Nortec

Part 3 - Execution

3.1 Where possible, locate humidifiers in air handlers, upstream of cooling coils.

3.2 Provide Plexiglas view ports and a light in AHU/ductwork at humidifiers to observe operation.

DIVISION 26 – ELECTRICAL

DESIGN GUIDELINES - ELECTRICAL

SECTION I: GENERAL

1.1 Design Engineer shall prepare a front-end report documenting interviews with representatives from the local electrical utility company, Telephone Company, and local cable TV provider (as applicable), obtaining specific utility information, including historical peak transformer loads, for the facility/project. Items to be coordinated should include:

A. Quantity, size, and routing of primary entrance conduits,

B. Method of installation for entrance conduits, (e.g., man/hand hole requirements, encasements, etc.),

C. Contractor's responsibilities relative to transformer installation, including furnishing and installing equipment, concrete pads, supplemental enclosures, etc.,

D. Limitations or other specific requirements of the local utilities,

E. System fault current,

F. Metering provisions required,

G. Confirm connection of fire pump to transformer is permissible along with metering requirements for fire pump,

H. Historical peak demand from utility bills, or obtain data from facility from power monitoring equipment if it exists,

I. Power factor penalties,

J. Redundant service power sources.

K. Interview staff and other facilities in the area to document if there are power quality issues.

1.2 Design Engineer shall discuss with the electric utility opportunities for providing electric service from two separate utility sources for the facility. These opportunities, supplemental costs, benefits, and reliability issues shall be discussed with HCA Design and Construction prior to inclusion. Contact HCA National Energy Programs, for support in the evaluation of the cost of alternative utility rate schedules, delivery voltages, and utility appurtenances

1.3 Design Engineer shall determine opportunities for reduced electric contract rates available through negotiating with competing utilities or through the direct purchase of deregulated non-utility power. Information shall be passed on to HCA Corporate National Energy Programs at 615-344-1116 for action.

1.4 Utility rates and rebates shall be researched. For new facilities or major additions use this and other information to complete an energy analyses for the project. HCA has a National Energy Program and the design team shall review current purchasing practices in respective regions with HCA Corporate National Energy Programs, 615-344-1116. Determine opportunities for negotiating interruptible utility rates and/or instituting peak shaving programs. Design Engineer shall present to HCA National Energy Programs and HCA Design and Construction a simple payback comparing primary vs. secondary metering.

1.5 Design Engineer shall determine estimated costs, if any, from local telephone, CATV, and electric utility companies to provide service to the site and forward these to HCA Design and Construction. Underground feeds are preferred, but evaluate the cost compared to overhead and review these with the HCA Construction Manager.

1.6 For new facilities and major additions, copies of front-end report information and supplemental interview information shall be forwarded to the utilities for confirmation and to HCA Design and Construction.

1.7 Applicable codes shall be determined by the Architect and Design Engineer The front-end report shall include applicable editions, along with state and local modifications, of national codes.

1.8 Code requirements shall be considered minimum standards. Various written interpretations of codes adopted by local AHJ shall be obtained by the engineer. It is understood that the most stringent requirements must be adhered to. Specific cautions shall be taken in states known to have developed certain strict interpretations that exceed standard accepted practice elsewhere, (e.g., California, Florida, etc.). In the case of unreasonable interpretation of the code by a local AHJ, HCA Design and Construction is to be consulted.

1.9 Facilities with contiguous medical office areas or non-institutionally classified occupancy should be closely coordinated with the local authorities to avoid excessive institutional type design requirements for non-institutional areas.

1.10 For new construction and replacements of main switchgear, design for the ability to quick connect a 2000 kVA portable generator set to the normal switchgear using an assembly similar to the Emergency Generator Quick Connection Assembly by Eaton Electrical. The dead front quick connectors shall be female equal to Crouse Hinds E1016 Series.

1.11 Pre-Design Testing:

A. When expanding existing systems, engineers shall obtain from the facility actual operating load of electrical systems and branches affected by area renovation and expansion. Additionally, verification of panelboard directories and areas served from affected panels should be obtained from the facility for use in preparation of the design.

B. Actual utility load information should be obtained by the Design Engineer identifying peak demand period for the previous twelve months in order to verify present service entrance capacity. If this information is not available from the utility or the facility, contact the HCA FacilitiGroup Energy Service Center.

C. Load readings should be obtained from the facility for each transfer switch to similarly determine load capacity information for the emergency distribution system. The Design Engineer's project file shall contain a record of the dates and time of day the readings were recorded.

D. Provide at least 1 week of Power Quality metering of the Main Service that measures at 5-minute intervals:

1. Volts, LN, LL, LG
2. Amps
3. kVA
4. kW
5. kVar
6. Harmonics down to the 40th

E. Copies of all the above information should be returned to the facility for their records.

1.12 Standard warranty period for major systems and equipment shall be specified in the standard agreements. On each project the project engineer shall coordinate with the HCA Construction Manager to establish initiation dates for the warranty and warranty periods. Instruct the contractor to provide phone numbers and contact persons for each warranty included in the scope of the project.

1.13 HCA Emergency Power System Design Guideline shall be consulted in the design of the distribution system for the Essential Power System.

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
This guideline is intended as an aid in the design of HCA acute care hospitals. While this guideline is intended to exceed the requirements of the NEC Art. 517 & NFPA 99, it should not be substituted for the requirements of NEC Art. 517 and NFPA 99. The intent of these documents should be adhered to in the design of all HCA projects. Refer to the HCA Design Standard and Model Room Guidelines (obtain these from the architect) for more detail regarding the distribution of emergency power and lighting in interior spaces. Also consult applicable state health regulations for any state specific requirements.			

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
Site	selected ltg/rec	selected ltg	egress lighting, parking lot lighting adjacent to hospital (more extensive site lighting is required by some local AHJ's), ER signage at ER canopy
Site	sump/lift stations	sump/lift stations	for water and waste systems
Admin., Admit., Bus. Offices	selected ltg/rec	selected ltg/rec	selected task lighting and receptacles to allow for limited continued services within limited distribution
Dietary	coolers/ freezers	coolers/ freezers	
Dietary	consider appliances	selected cooking appliances	place controls for all natural gas cooking equipment on EP, if electric kitchen, only connect grill to EP
Dietary		selected ltg/rec	while not required by code, place limited task ltg in kitchen and dining on EP
Dietary	ventilation	ventilation	kitchen hoods exhaust and make-up air provisions
Hskpg	selected ltg/rec	selected ltg/rec	to allow continued access to supplies, equipment
Surgery / Rec	selected ltg/rec	majority of ltg/rec	all lighting fixtures and receptacles in each OR, nurses station, clean utilities, soiled utilities, sterile storage, anesthesia workroom, sub-sterile should be on EP, except two lighting fixtures and a receptacle in each OR should be on normal power (see note 1), include battery backup lighting capability in each OR florescent lighting fixture fed by the EP.
Surgery / Rec	htg & ventilation systems	htg & ventilation systems	some local AHJ's require cooling on EP; for major additions and in hurricane prone areas consider connecting cooling to the EP, discuss with HCA Manager, Engineer Services. Put any dedicated chiller on EP if the

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
			generator is capable of handling the additional load.
Surgery / Rec	selected ltg/rec	in-suite radiology	EP receptacle for portable x-ray equipment in each O.R. Discuss need for separate EP receptacle for laser equipment. Place on isolated power separate from general room isolated power.
E.R.	selected ltg/rec	majority of ltg/rec	majority of lighting and all rec should be on EP, except two rec at the patient head wall in each treatment, exam, and trauma room should be on normal power (see note 1), sufficient ltg should be on normal power to serve patients in case of a critical branch failure
E.R.	htg & ventilation systems	htg & ventilation systems	for major additions and in hurricane prone areas consider connecting cooling to the EP, discuss with HCA Manager, Engineer Services
E.R.		in-suite radiology	provide all ER suite radiology equipment with EP
Lab	selected ltg/rec	majority of ltg/rec	provide EP at work areas and for selected equipment to allow continued service
Lab		coolers/ freezers	refrigerators/freezers are provided with EP,
Lab	exhaust & hoods	htg & ventilation	in addition to exhaust & hoods, add htg & ventilation to EP
Central Sterile	ventilation	selected task ltg, equip, & ventilation	selected task lighting, all sterilizers fed by fossil fueled steam boilers (a single sterilizer if only electrically generated steam is available), exhaust for ethylene oxide should be on EP

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
Pharmacy	selected ltg/rec	majority of ltg/rec	EP ltg & power should be provided to allow continued service, includes coolers / freezers, blood bank, and storage security systems and dispensing equipment
Cardiac	selected task ltg/rec	selected task ltg/rec & Cath lab equipment	Cath lab equipment (including equipment cooling unit) should be on EP, all lighting and receptacles should be on EP except two lighting fixtures and one receptacle should be on normal power (see note 1). Typically only one cath lab per facility needs to be on EP where the remaining cath labs are served by a UPS. Consult with HCA Equipment Manager if the facility has multiple rooms.
Vascular	selected task ltg/rec	selected task ltg/rec & equipment	Vascular , special procedures, & angio equipment (including equipment cooling unit) should be on EP, all lighting and receptacles should be on EP except two light fixtures and one receptacle should be on normal power (see note 1). Typically only one vascular lab per facility needs to be on EP where the remaining vascular, special procedures, & angio equipment are served by a UPS. Consult with HCA Equipment Manager if the facility has multiple rooms.
Radiology	selected ltg/rec	processors/selected viewers	all processors and selected viewers should be on EP
Radiology	selected ltg/rec	selected ltg/rec	most spaces provided with some EP ltg; selected MRI and CT procedure room lighting fixtures should be on EP for patient comfort in a confined environment

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
Radiology	selected ltg/rec	radiology and R&F equipment	at least one radiology or one R&F room in the facility should be on EP. If ER has radiology unit on EP, do not add any radiology or R&F units to EP without confirmation from the HCA Equipment Manager.
Radiology	selected ltg/rec	CT	at least one CT (including cooling unit) in a facility should be on EP, check with HCA Equipment Manager prior to adding additional CT to EP. .
Radiology	selected ltg/rec	MRI cryogen	cryogen cooling unit only should be on EP
Radiology		htg & ventilation	supply, return, exhaust, & heating should be on EP
Nuclear Med	exhaust	selected task ltg/rec & exhaust	exhaust for radioactive material & selected task ltg and receptacles on EP
Endoscopy		selected task ltg/rec & equipment	selected receptacles for endo equipment and selected task ltg on EP.
O.B.	selected ltg/rec	majority of ltg/rec	treat traditional delivery & c-sect. areas like surgery (see note 1) ; most support spaces in O.B. suite should have some EP ltg & power to allow continued service; LDRPs should have extensive ltg and rec on EP, with a couple of normal powered ltg fixtures and rec as well.
O.B. - nursery	selected ltg/rec	majority of ltg/rec	provide all ltg on EP. Provide 50% of receptacles in Level 1 nursery and 75 % of rec in Level 2 or NICU nursery on EP.
O.B. - nursery	selected ltg/rec	security systems	while not specifically mentioned in the code, it is important for security systems and equipment to be provided with EP

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
O.B.	htg & ventilation systems	htg & ventilation systems	for major additions and in hurricane prime areas, consider placing OB cooling on EP, discuss with Manager, Engineering Services
Gen. Patient Rms	selected ltg/rec	selected ltg/rec	place patient headwall fixture, night light and bathroom light on EP. Two receptacles, minimum, at the head of the patient bed should be on EP. For major additions and in hurricane prime areas, consider placing cooling on EP, discuss with Manager, Engineering Services
ICU/CCU	selected ltg/rec	majority of ltg/rec	all ICU/CCU lighting should be on EP except if more than one fixture is in the patient room, one should be on normal. All receptacles should be on emergency power except two receptacles at the head of the bed should be on normal power. (see note 1).
ICU/CCU	htg & ventilation systems	htg & ventilation systems	for major additions and in hurricane prime areas, consider placing ICU/CCU cooling on EP, discuss with Manager, Engineering Services
Patient Care Nursing Stations & Support Areas	selected ltg/rec	selected ltg/rec	selected ltg and rec should be placed on EP at nursing station, medication prep area, nourishment stations, clean utility and soiled utility
Outpatient Holding		selected rec	place one receptacle in each holding space on EP
Misc Eqp.	vacuum	vacuum	pump assembly & controls
Misc Eqp.	clinical air	clinical air	compressor assembly & controls
Misc Eqp.	HVAC controls	HVAC controls	all HVAC controls equipment, place on equipment branch
Misc Eqp.	med gas systems	med gas systems	all alarms and control equipment should be on EP

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
Misc Eqp.		domestic hot & cold water systems	domestic water booster pumps, hot water heater controls, etc.
Misc Eqp.		freeze protection	for water systems (clg twrs, sprnklrs, dom water in unheated soffits, etc.)
Misc Eqp.	elevator	elevators & equipment room cooling	design should provide for any elevator in a bank to be selected to run on emergency power. Place unitary cooling equipment serving elevator equip on EP
Misc Eqp.	sterilizer	sterilizer	see note under Central Sterile Suite/Area above.
Misc Eqp.	nurse call systems	nurse call systems	
Misc Eqp.	IT/Telephone/comm systems	IT/Telephone/comm systems	telephone switch, any dedicated cooling unit for switch, ITS routers, servers, hubs, etc., public address systems, radio paging, pagers, etc. to be on EP.
Misc Eqp.		security systems and CCTV equipment	
Misc Eqp.	heating equip	heating equip	place all heating equipment on EP (ignore code exceptions, except when heat source is electric). If electric heat, check with Manager, Engineering Services.
Misc Eqp.		cooling equip	for new facilities, consider putting one chiller and associated equipment on emergency power. Discuss number of chillers with Manager, Engineering Services. For chillers added to an existing facility, discuss with Manager, Engineering Services. See Surgery/Rec notes above for additional information
Misc Eqp.		air handlers	all air handlers are to be on emergency power
Misc Eqp.		terminal HVAC equipment serving critical spaces	Includes VAVs and fan coils

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	**Emergency Power - per Code**	**Emergency Power - for HCA**	**Notes**
Misc Eqp.		dialysis	place dialysis equipment and selected ltg on EP
Misc Eqp.	automatic doors	automatic doors	place all on EP
Misc Eqp.		refrig/ice makers	refrigerators/ice makers at nourishment stations should be on EP
Fire Protection	fire & sprinkler alarm systems	fire & sprinkler alarm systems	these systems should be provided with internal batteries as well as EP. On preaction sprinkler systems, place controls for valve on EP. For dry type sprinkler systems, put air compressor on EP.
Fire Protection	smoke control equipment & systems	smoke control equipment & systems	both passive and active systems are required to be supplied with EP which includes all necessary control equipment
Fire Protection		fire pump/jockey pump	fire pump should be placed on EP, discuss with Manager, Engineering Services if doing so necessitates a larger generator set size. Jockey pump is always on EP.
Main Electrical Distr. Room		Lighting	Place selected ltg & rec on emergency power (maintenance space, see below)
Maintenance	selected ltg/rec	selected ltg/rec	ltg & rec on EP to allow repair work as required during an emergency
Powerhouse, Mechanical, and Electrical spaces	selected ltg/rec	selected ltg/rec	provide lighting and power for emergency access and repairs .
		Notes:	**1. All lighting and receptacles may be on EP in critical care patient treatment rooms if two transfer switches are available to serve each patient treatment room. In**

HCA Emergency Power (EP) System Design Guideline			
Suite / Area	Emergency Power - per Code	Emergency Power - for HCA	Notes
			OR's and delivery rooms, limited light fixtures need not be on normal power or served by a separate transfer switch if the AHJ will accept as equivalency the standby battery operated light fixtures around the table.
		Last Reviewed and/or Revised By HCA:	April 8, 2013

1.14 Consult the HCA Room Design Standard and the Model Room Guidelines in the design of the interior space lighting and power distribution. (Ask the architect for these documents.)

1.15 Consult with architect on elevators to ensure a selector switch is provided to return all elevators to the designated floor and operate one elevator in each bank on the essential system after a normal power outage. Provide control connections between ATS and elevator equipment.

1.16 Design engineer must refer manufacturers and installers to the entirety of Appendix F - Energy and Resource Metering ~~Section 26.99.00 - Energy and Resource Metering for Electrical~~ to obtain full scope of work. Omissions will not be at the owner’s expense.

1.17 It is the responsibility of the Design Engineer to properly coordinate, select, and apply metering equipment in accordance with the manufacturer requirements and HCA Guidelines to fulfil the owner requirements. The design documents must clearly show the locations of components. Additionally, design documents must clearly show scopes of work between all trades, including commissioning, and purchased equipment to avoid overlap or gaps in scope.

SECTION II: PATIENT ROOMS

1.1 Refer to HCA Design Standards.

1.2 Patient room design shall incorporate minimum standards for receptacle quantities per HCA Model Room Guidelines and branch circuit requirements dictated by NEC.

1.3 Provide adequate lighting in the toilet for ample visibility in the shower/tub (if provided). Supplement with specific shower light, appropriately listed, as required.

1.4 Provide adequate lighting for standalone sinks with-in patient rooms.

SECTION III: OPERATING, OBSTETRICS, DELIVERY, LDRP SUITES

1.1 Refer to HCA Design Standards.

1.2 Coordinate the use of supplemental exam/delivery task lighting for LDR and LDRP.

1.3 Specify full spectrum color fluorescent lamps throughout the C-section/Operating suites.

1.4 Provide design to accommodate an infant security system. Coordinate with HCA Design and Construction and/or the HCA Equipment Manager for system design requirements.

1.5 Supplement OR/C-section lighting, critical branch fixtures with internal battery backup in the event of interruption of the critical power to the lighting in the space. Provide limited, "normal power" lighting in ORs/C-Section and throughout these suite in the event of loss of the critical ATS. Do not provide internal battery packs for these procedure rooms' lighting fixtures connected to the normal power distribution.

1.6 Lighting fixtures in the operating/C-section rooms installed flush mounted in the ceiling shall not be connected to the isolation panel but rather be served from the local critical and normal branch panels for the area.

SECTION IV: DIETARY

1.1 Refer to vendor drawings for specific equipment layouts and loads.

1.2 Shunt trip or interlock the power and gas supplies for grease laden equipment located beneath the exhaust hood with the operation of the hood fire extinguishing system.

1.3 Additionally, coordinate fire alarm system interface requirements for the operation of the kitchen hood ventilation system and the kitchen hood extinguishing system with the local AHJ.

1.4 Discuss with Vendor coordination of single point connection breaker and distribution breakers within hood equipment for both Normal Branch and Equipment Branch Supplies. Discuss separation of different branches within equipment.

SECTION V: EQUIPMENT ROOMS

1.1 Maintain adequate access to and working clearance for starters, disconnect switches, and control panels operating in mechanical equipment spaces.

1.2 Minimum access and clearance as dictated by the NEC shall be strictly adhered to. Additionally, adequate floor space shall be provided with access and working clearance necessary for future equipment identified for planned expansions.

1.3 Provide adequate but not excessive free space for future equipment to accommodate reasonable growth in main electrical equipment room and key electrical distribution spaces. Closely coordinate future growth requirements with architect and HCA Design and Construction.

1.4 In general, coordinate location of electrical equipment closets close to the area to be served. Specifically, do not serve branch circuits from equipment located on different floors, except life safety branch and roof mounted equipment.

EQUIPMENT AND SYSTEMS GUIDELINES - ELECTRICAL

NOTE: Where CSI MF04 sections are not listed, HCA is electing at this time not to provide guidelines.

SECTION 26 05 00: COMMON WORK RESULTS FOR ELECTRICAL

Part 1 - General

1.1 Submittals~~.~~

A. Follow the shop drawing submittal procedures outlined in HCA's standard contract with the architect and the contractor.

B. Contractor is responsible for submitting dimensioned layouts of electrical equipment locations within electrical rooms, generator room and fire pump room with equipment drawn to scale and identified therein. Working clearance and access shall be clearly identified on the drawings. Rooms shall be designed, including door openings, and clearance shall be provided to allow for the future removal of each generator, unit substation transformer or other large piece of equipment independently without having to remove non-related equipment first.

C. Electrical contractor shall coordinate with general contractor to provide at least one path to outside with 8'-0" tall door in main electrical rooms and generator rooms that contain switchgear, motor control centers, generators and other electrical equipment taller than 6'-6".

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Record Drawings: Record drawings shall be specified per the HCA standard contract with the architect and with the general contractor. The contractor shall maintain record drawings during course of project and give to Design Engineer for recording on CADD. Engineer shall periodically monitor status of record drawings to ensure Contractor is consistently annotating drawings as construction progresses.

~~3.1~~3.2 Infrared scanning: Within 60 days of substantial completion, perform an infrared scan of each termination and splice in conductors #3 AWG and larger. Infrared scan reports shall be provided to HCA FacilitiGroup engineer.

~~3.2~~3.3 Tests

A. Balance circuits so that feeders to panels are not more than 10% out of balance between phases with all available load energized and operating. All ampere readings should be made with a true RMS reading meter.

B. Perform megger tests of all feeders and provide a report of results including values measured.

C. Project close out manuals shall include copies of the following test results/certifications:

1. Service ground resistance test.
2. Switchboard/panelboard ampere readings, including all major circuit breakers.
3. Generator test. (load bank, warning lights, ground fault indication)
4. Ground fault test. (at what the engineer's coordination study indicates)
5. Patient care area grounding test. (leakage current for fixed equipment including beds)
6. Fire alarm certification.
7. Nurse call certification.
8. Lightning protection certification.

SECTION 26 05 13: MEDIUM VOLTAGE CABLES – 5KV THROUGH 35~~46~~KV

Part 1 - General

1.1 Applicable Publications:

A. American Society for Testing and Materials (ASTM): B3-01 (2007) Standard Specification for Soft or Annealed Copper Wire.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 48-09: Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated

Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

2. 386-95: Separable Insulated Connector Systems for Power Distribution Systems above 600 V
3. 400-01: Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
4. 400.2-04: Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
5. 400.3-06: Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment
6. 404-00: Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V

C. National Electrical Manufacturers Association (NEMA):

1. WC 71-99 Non-Shielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy
2. WC 74-06 5-46 KV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

D. National Fire Protection Association (NFPA): 70-11 National Electrical Code (NEC)

E. Underwriters Laboratories (UL):1072-06 Medium Voltage Power Cables

Part 2-Products

2.1 Cable Descriptions: Cable shall be single conductor, ethylene propylene rubber (EPR) insulated to 133% level, PVC jacketed, shielded power cable suitable for wet and dry locations and for installation in conduit or underground duct banks.

Part 3 - Execution

3.1 General

A. Installation shall be in accordance with the NEC, as shown on the drawings, and per manufacturer’s instructions.

B. Cable shall be installed in conduit above grade and duct bank below grade.

C. All cables of a feeder shall be pulled simultaneously.

D. Conductors of different systems (e.g., 5kV and 15kV) shall not be installed in the same raceway.

E. Splice the cables only in manholes and pullboxes.

F. Cable maximum pull length, maximum pulling tension, and minimum bend radius shall conform to the recommendations of the manufacturer.

G. Use suitable lubricating compounds on the cables to prevent pulling damage. Provide compounds that are not injurious to the cable jacket and do not harden or become adhesive.

H. Seal the cable ends prior to pulling, to prevent the entry of moisture or lubricant.

3.2 Pulling Cables In Ducts And Manholes

A. Cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winches, cable-feeding flexible tube guides, cable grips, pulling eyes, and lubricants. A sufficient number of qualified workers and equipment shall be employed to ensure the careful and proper installation of the cable.

B. Cable reels shall be set up at the side of the manhole opening and above the duct or hatch level, allowing cables to enter through the opening without reverse bending. Flexible tube guides shall be installed through the opening in a manner that will prevent cables from rubbing on the edges of any structural member.

C. Cable shall be unreeled from the top of the reel. Pay-out shall be carefully controlled. Cables to be pulled shall be attached through a swivel to the main pulling wire by means of a suitable cable grip and pulling eye.

D. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.

E. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.

F. Cables shall be liberally coated with a suitable lubricant as they enter the tube guide or duct. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.

G. Cables shall be pulled into ducts at a reasonable speed. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately at any indication of binding or obstruction, and shall not be resumed until the potential for damage to the cable is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

H. Splices in manholes shall be firmly supported on cable racks. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing.

I. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

3.3 Splices And Terminations

A. Install the materials as recommended by the manufacturer, including precautions pertaining to air temperature and humidity during installation.

B. Installation shall be accomplished by qualified workers trained to perform medium-voltage equipment installations. Use tools as recommended or provided by the manufacturer. All manufacturer's instructions shall be followed.

C. Splices in manholes shall be located midway between cable racks on walls of manholes, and supported with cable arms at approximately the same elevation as the enclosing duct.

D. Where the HCA engineer determines that unsatisfactory splices and terminations have been installed, the Contractor shall replace the unsatisfactory splices and terminations with approved material at no additional cost to HCA.

3.4 Circuit Identification Of Feeders

A. In each manhole and pullbox, install permanent identification tags on each circuit's cables to clearly designate the circuit identification and voltage. The tags shall be the embossed brass type, 40 mm (1.5 inches) in diameter and 40 mils thick. Attach tags with plastic ties. Position the tags so they will be easy to read.

3.5 Acceptance Checks And Tests

A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and electrical inspections.

B. Test equipment, labor, and technical personnel shall be provided as necessary to perform the acceptance tests. Provide minimum of one week notification to the HCA engineer of when the tests shall take place.

C. Visual Inspection:

1. Inspect exposed sections of cables for physical damage.
2. Inspect shield grounding, cable supports, splices, and terminations.
3. Verify that visible cable bends meet manufacturer's minimum bending radius requirement.
4. Verify installation of fireproofing tape and identification tags.

D. Electrical Tests:

1. Acceptance tests shall be performed on new and service-aged cables as specified herein.
2. Test new cable after installation, splices, and terminations have been made, but before connection to equipment and existing cable.

E. Insulation-Resistance Test: Test all new respect to ground and adjacent conductors.

1. Test data shall include megohm readings and leakage current readings. Test voltages and minimum acceptable resistance values shall be:

Voltage Class	Test Voltage	Min. Insulation Resistance
5kV	2,500 VDC	1,000 megohms
15kV	2,500 VDC	5,000 megohms
25kV	5,000 VDC	20,000 megohms
35kV	15,000 VDC	100,000 megohms

2. Submit a field test report to the HCA engineer that describes the identification and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and identifies the insulation resistance and leakage current results for each cable section tested. The report shall provide conclusions and recommendations for corrective action.

F. Final Acceptance: Final acceptance shall depend upon the satisfactory performance of the cables under test. No cable shall be put into service until all tests are successfully passed, and field test reports have been approved by the HCA engineer.

SECTION 26 05 19: LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES – 600 VOLT AND BELOW

Part 1 - General

1.1 Work Included:

A. Branch wiring shall be copper.

B. Service and feeder wiring under 200 amps shall be copper.

C. Normal power s~~S~~ervice and feeder wiring 200 amps and over shall be designed as aluminum alloy unless prohibited ~~elsewhere in this document~~below. Contractor may substitute copper at no additional cost.

~~C.~~D. Exceptions:

~~D.~~1. All feeders connecting directly to motors including, but not limited to, chillers and fire pumps shall be copper to minimize loosening of connectors due to cyclical thermal expansion.

~~E.~~2. All essential power systems circuits shall be copper.

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Part 2-Products

2.1 Where aluminum conductors are used, Stabiloy or Southwire brands shall be used.

2.2 HCF Cable

A. Multi-conductor Cables: Comply with NEMA WC 70; Exterior sheath color coded to differentiate cable voltages and quantity of phase conductors. Heath Care Facilities armored cable, Type HCF; Comply with UL 4 and UL 1479; with green grounding conductor(s) in addition to Armor/Bond Wire ground combination; with exterior sheath colored green or appropriately marked and identified.

B. Stranded cable is acceptable ~~only~~ for conductors #14~~8~~ AWG and larger~~ unless specifically allowed by FacilitiGroup in writing~~.

Part 3 - Execution

3.1 Installation

A. Equipment grounding conductors should be specified in all power conduits, including feeders, branch circuits, and switch legs.

B. Wiring in a homerun conduit should be limited to ~~one~~two, 3-phase (3-circuit) homeruns. Homeruns with more than ~~three~~ six circuits generally should be avoided. Each circuit shall have a separate neutral conductor.

C. Low voltage, e.g. communications wiring, when not required to be in conduit, shall be plenum rated where used in air plenums.

D. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway and Type HCF in limited locations where indicated. Type HCF is acceptable for the following applications.

1. Feeders for lighting fixture whips and for branch circuits concealed in walls and partitions only. Locate junction box and convert to single conductors in rigid raceway within the same room as where the cable enters/exits the wall.
2. Use only for single-circuit cable (i.e. two wire plus ground). For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
3. The HCF length for power circuits shall be limited to 30' from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit must immediately transition to conduit.
4. The HCF length for lighting circuits shall be limited to 30' from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by this HCF circuit.

F. Type HCF is not acceptable for the following applications; instead provide single conductors in non-flexible raceway.

1. Homeruns to Panelboard.
2. Branch circuits serving Essential Electrical System (Emergency & Standby) loads; including Life Safety branch, Critical branch and equipment emergency system.
3. Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
4. Within mechanical, electrical or telecommunication equipment rooms.
5. Exposed Branch Circuits within areas that do not have a ceiling (i.e. open to structure).
6. Wet locations.

SECTION 26 05 26: GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

Part 1 - General

1.1 Work Included:

A. Design for standard service grounding will consist of made electrodes via a grounding electrode conductor connected to a minimum length of 20 feet of reinforcing steel in the building footing <u>and</u> lengths of conductors laid in the foundation or three ground rods in a tripod arrangement. Bond to facility steel and water lines as required.

B. All Radiology grounding systems shall be provided as directed by the equipment manufacturers. No variation shall be made from the manufacturer's requirements. Consult the manufacturer's power and grounding requirements for the imaging modality being served.

C. Where a facility ground loop is provided for the lightning protection system, the service shall be bonded to the ground loop. If sufficient grounding is not achieved by one of those methods, additional electrodes shall be provided. Specialty grounding systems should be used only where dictated by local conditions.

D. New facilities shall have a ground grid (loop) installed around the building with the ground bonded to each corner column and every other column from the corner column. Interior columns may be bonded as indicated on the drawings determined by the Design Engineer.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Installation: Grounding electrode conductors shall be installed without conduit. Where exposed to potential physical damage, conductors shall be installed in Schedule 80 PVC.

SECTION 26 05 29: HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

Part 1 - General

Work Included: J-hooks shall be used for communication and other low voltage wiring not in conduit

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Installation: Avoid cable tray use unless approved by HCA Design and Construction.

SECTION 26 05 33: RACEWAYS AND CONDUIT SYSTEMS

Part 1 - General

1.1 Work Included: Provide minimum ½″ conduit for power and controls wiring. ½″ conduit may be used for 5 #12AWG wires or 3 #10AWG wires. 3/8″ flexible conduit may be used for light fixture whips.

1.2 Keep different electrical branches in separate pull and junction boxes.

Part 2-Products

2.1 Conduit and raceways are to be color coded for ease of identification. Where a facility standard already exists, that shall be followed.~~Conduit is to be color-coded from factory in accordance with current facility standard.~~ Where no standard exists for color-coding, provide in accordance with HCA Conduit Color Table. ~~(Junction boxes, fittings, and connectors are not required to be painted to match.)~~

2.2 As the HCA standard, conduit is to be color-coded from the factory. ~~(~~Junction boxes, fittings, and connectors are not required to be painted to match.~~)~~

~~2.1~~2.3 As an alternative, contractor may submit deduct to omit use of factory-painted conduit. Tape or paint are to be used to indentify conduits and junction boxes and/or fittings are to be painted in accordance with facility standard or color table.

HCA Conduit Color Table	
Conduit Service	Color Description
Building Automation and Controls	Blue
Fire Alarm	Red
Life Safety Power Branch	Yellow
Critical Power Branch	Orange
Equipment Branch	Green
Emergency Power Distribution Not Listed Above	Purple

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Part 3 - Execution

3.1 Raceway application

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Above Ground: RSC or IMC
2. Within Crawl Spaces: RSC or IMC
3. Emergency Feeders: RSC or IMC
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, unless otherwise indicated.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
    a. Mechanical rooms.
2. Exposed and Subject to Physical Damage: RSC, or IMC. Includes, but is not limited to, raceways in the following locations:
    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet handling units.
    ~~c.a. Mechanical rooms.~~
    ~~d.~~c. Parking Garages, where exposed to vehicular traffic.
3. Conductors over 600 volts: RSC, or IMC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Concealed within Masonry Walls: RSC, or IMC.
6. Concealed under Raised Floors: EMT or LFMC.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
8. Flexible Connection to Luminaires: FMC, maximum of 72 inches (1830 mm).
9. Damp or Wet Locations: RSC, or IMC.
10. Elevator Pits: RSC, IMC, or LFMC.
11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
12. Emergency feeders and branch circuits: EMT
13. Corrosive Locations: PVC-Coated RSC, PVC-Coated Steel Conduit.

~~C. Minimum Raceway Size:~~

~~1. Individual Branch Circuits: 1/2-inch (16-mm)~~

~~2. For feeder circuits and multiple branch circuits: 3/4-inch (21-mm)~~

~~D.~~C. Provide minimum 1/2”-inch (16-mm) conduit for controls circuiting.

~~E.~~D. Use the shortest path possible to the intended load or receptacle for raceways of ungrounded circuits which are electrically monitored by ground detector system; this is intended to minimize leakage current to ground. In ceiling space, utilize paths that deviate from that perpendicular to structure where these paths will not interfere with other overhead systems.

~~F.~~E. Junction and Pull Boxes: Sheet steel boxes, unless noted or required otherwise.

1. Provide boxes no smaller than 4 inches square and 2-1/8 inches deep.
2. Size all junction and pull boxes in accordance with the NFPA 70, unless project conditions dictate use of larger boxes.
3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.

~~G.~~F. Outlet and Device Boxes: Sheet steel boxes, unless noted or required otherwise.

1. For Lighting Fixture Outlets: 4 inch square with raised fixture ring.
2. For Wall Switches, Receptacles, and Communication Use: 4 inch square, one-piece. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use boxes 1-1/2 inch deep only in locations where deep boxes cannot be accommodated by construction.
3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.

~~H.~~G. Boxes used outdoors or in Damp/Wet Locations: Cast metal boxes with gasketed covers and threaded hubs.

~~I.~~H. Couplings for EMT shall be steel with set-screw. Die-cast fittings will not be allowed.

SECTION 26 05 36: CABLE TRAYS FOR ELECTRICAL SYSTEMS

Part 1 - General

1.1 Work Included:

A. Generally cable tray shall only be used in Telecom/MDF type spaces as may be required by the I.S. designers.

B. Use of cable tray throughout the facility shall be approved by HCA Design and Construction before specifying.

Part 2-Products

2.1 Components:

A. Tray shall be 24″ wide x 6″ deep.

B. Cable tray shall be center support ladder type or wall mounted ladder type.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 26 05 39: UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

Part 1 - General

1.1 Work Included: Trench duct shall be used only as may be required by owner's equipment vendors (i.e. Radiology).

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Installation Requirements: Maintain integrity of compartments separating power and signal wiring at all crosses, tees, and junctions.

SECTION 26 05 48: VIBRATION AND SEISMIC CONTROL FOR ELECTRICAL SYSTEMS

Part 1 - General

1.1 Work Included:

A. Provide housekeeping pads under all floor mounted equipment.

B. Seismic isolation and protection shall be specified on a performance basis by the Design Engineer as required by Code. All materials including equipment anchoring and pipe hangers shall be designed by a registered professional engineer in the State of the project. Isolation vendor shall include design costs with the equipment costs. Submittals shall include details on all isolators, anchorage, hangers, sway bracing, etc. for a complete system that is approved by State and local AHJ. Design Engineer shall include a performance specification and sufficient seismic details to convey scope of the seismic requirements to the contractor. The scope of work shall include a Certified Seismic Inspection Report prior to acceptance of the work.

Part 2-Products

2.1 Acceptable Manufacturers: Mason Industries, Kinetics Noise Control, Vibration Eliminator Co., Vibration Mountings & Controls, Inc., Korfund Co., Amber Booth, Vibro-Acoustics, or Hyspan.

Part 3 - Execution

3.1 Application

A. Provide vibration isolation for floor-mounted and rack mounted transformers as follows:

1. 45 kVA and below: provide nothing.
2. 75 kVA to 150 kVA: provide isolation pad.
3. 225 kVA and above: provide spring isolators.

~~B. Provide spring isolators for suspended transformers.~~

SECTION 26 05 53: IDENTIFICATION FOR ELECTRICAL SYSTEMS

Part 1 - General

1.1 Equipment and materials shall be listed by U.L. or other nationally accredited testing laboratory.

Part 2-Products

2.1 Provide wall and ceiling access panels (minimum size 16″ x 16″) wherever required for access for electrical equipment.

Part 3 - Execution

3.1 Identification of Equipment

A. Identify electrical equipment with permanently attached phenolic plates with ¼″ white, engraved lettering on the face attached to the equipment with two sheet metal screws. Coordinate color of the phenolic plates with the facility to identify the electrical distribution branches. Typically, the following color scheme shall be used:

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

1. Normal - Black with white letters.
2. Essential Systems – Red with white letters
3. If existing equipment identification nameplates are a different color, request a preference from the hospital to determine what color scheme to follow.

B. In addition to equipment identification purposes, the plates attached to individually mounted circuit breakers, all panel boards, safety switches and disconnects shall contain the following information: "Fed From (name of panel, circuit breaker, or switch feeding power to the device)".

C. Provide warning signs and Arc flash labels required by NFPA 70, NFPA 70E, and by OSHA ~~equal to engraved, pressure sensitive~~adhesive vinyl signs for indoor use and ~~30 gauge baked enamel~~engraved plastic for outdoor use.

SECTION 26 05 73: POWER SYSTEM ANALYSIS

Part 1 - General

1.1 Scope of Work

A. Provide short-circuit, and protective device coordination and arc flash studies as prepared by the electrical equipment manufacturer or a professional electrical engineering firm.

1.2 Submittals for Review/Approval

A. Submit a preliminary short-circuit and protective device coordination study to the design engineer prior to receiving final approval of the shop drawings and/or prior to release of equipment drawings for manufacturing. The preliminary study shall provide sufficient data to ensure that the selection of equipment will have adequate ratings and the protective device trip characteristics will be satisfactory.

B. Perform a final short-circuit, protective device coordination, and arc flash hazard analysis at the end of the construction cycle when circuits are installed and all equipment is on site and/or installed such that complete and accurate data may be obtained.

1.3 Submittals for Construction

A. The single-line diagram and results of the final short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data shall be provided on CD in PDF format.

B. The engineer is required to provide the SKM single-line diagram, short-circuit, coordination, and arc flash project files to the Owner in electronic format including all project files, libraries, etc to allow the owner to update and to print additional copies, labels, etc.

C. A copy of the computer analysis software viewer program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, one line diagrams, etc.

D. The report shall include the following sections:

1. Executive Summary,
2. descriptions, purpose, basis and scope of the study,
3. tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties,
4. protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, and fuse selection,
5. fault current calculations including a definition of terms and guide for interpretation of the computer printout,
6. details of the incident energy and flash protection boundary calculations,
7. recommendations for system improvements, where needed,
8. one line diagram,
9. equipment specific arc flash labels.

E. Qualifications

1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer licensed in the state for which the work is being performed.

F. Computer Analysis Software

1. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program. Other commercially available products may be considered under certain circumstances.

Part 2-Products

2.1 Data Collection

A. Source contributions shall include actual utility data as well as present and future motors and generators. The engineer shall obtain required existing data, if necessary, to satisfy the study requirements.

2.2 Short-Circuit Study

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141. Estimated conductor lengths, typical generator, transformer, motor, and utility data may be used for the preliminary study.

B. Actual installed conductor lengths, test and/or nameplate data for all generators, transformers, motors 50 HP and larger, capacitors, reactors, or other equipment that may affect the study must be used for the final study.

C. Provide the following:
   1. One line diagram of the system being evaluated.
   2. Utility impedance data, including the maximum and minimum 3 phase and line-to-ground fault current available, nominal, maximum, and minimum voltage, 3 phase X/R ratio line-to-ground X/R ratio.
   3. Utility protective device settings including re-closer if used.
   4. Motor fault contribution characteristics.
   5. Generator fault contribution characteristics.
   6. Tabulations of calculated quantities.
   7. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and line-to-ground faults at each:
   1. Electric utility's supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear.
   5. Motor control centers.
   6. Standby generators and automatic transfer switches.
   7. Branch circuit panelboards.
   8. Other significant locations throughout the system.

E. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings.
   2. Evaluate adequacy of switchgear, switchboards, disconnects, transfer switches, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
   3. Notify Owner, in writing, of any existing circuit protective devices improperly rated for the calculated available fault current.

2.3 Protective Device Coordination Study

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. No more than 5 devices shall be shown on any plot.

B. Include on each TCC graph, a complete title, applicable notes, and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device.
2. Medium voltage equipment overcurrent relays.
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves. The frequent fault portion of the damage curve should not be shown unless the transformer feeds overhead lines. The shifted curve for line-to-ground faults on the secondary side shall be shown on the ground fault plot.
6. Conductor damage curves.
7. Ground fault protective devices shall be shown on separate TCC plots. The first phase overcurrent relay and any negative sequence relays on the primary side of a delta-wye transformer shall be shown.
8. Pertinent motor starting characteristics, motor damage points, and overload relay. Motors larger than 500 HP shall have a thermal damage curve.
9. Pertinent generator short-circuit decrement curve and generator damage point. Generators larger than 1250 kW shall have a thermal damage curve.
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.4 Arc Flash Hazard Analysis

A. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

B. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

C. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

   1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

D. Incident energy and flash protection boundary calculations

   1. Arcing fault magnitude
   2. Protective device clearing time
   3. Duration of arc
   4. Arc flash boundary
   5. Working distance
   6. Incident energy
   7. Hazard Risk Category
   8. Recommendations for arc flash energy reduction

Part 3 - Execution

3.1 Field Adjustment

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion. Where the engineering consultant has performed the studies, protective device settings shall be provided by the engineer of record to the electrical contractor prior to the equipment being energized and commissioned.

B. Notify Owner in writing of any required major equipment modifications.

3.2 Arc Flash Warning Labels

A. Furnish and install a 3.5 in. x 5 in., unless otherwise by Owner, thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided to owner after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

~~E.~~ Arc flash labels shall be provided on all serviceable equipment in accordance with NFPA 70E. ~~in the following manner and all labels shall be based on recommended overcurrent device settings.~~

~~1. For each 600, 480 and applicable 208 volt panelboard, provide one arc flash label.~~

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~~2. For each motor control center, provide one arc flash label.~~

~~3. For each low voltage switchboard, provide one arc flash label.~~

~~4. For each switchgear, provide one flash label.~~

~~5.~~E. ~~For medium voltage switches, provide one arc flash label.~~

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.3 Arc Flash Training

A. Provide training for the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

SECTION 26 12 00: MEDIUM VOLTAGE TRANSFORMERS

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Acceptable Manufacturers: Square D, Cutler-Hammer/Westinghouse.

2.2 Equipment Requirements:

A. Transformer shall be ventilated 150°C rise, complying with DOE-2016 efficiency levels.

B. Provide two 5% FCBN taps for ratings through 10kVA and two above and four below, for ratings 15kVA and above.

C. Transformer cores shall be visibly grounded by the manufacturer to the enclosure by means of a flexible grounding conductor sized in accordance with UL and NEC.

D. Transformers shall have infrared windows installed. Quantities and locations shall be determined by the transformer manufacturer.

Part 3 - Execution

3.1 Installation Requirements:

A. Floor mounted transformers shall be securely anchored to a 4″ reinforced concrete housekeeping pad.

B. Design electrical equipment rooms to avoid hanging or stacking transformers greater than 15 kVA.

C. Provide cost payback for low loss transformers that promise additional savings to the HCA Design and Construction for review.

SECTION 26 12 19: LOW VOLTAGE ELECTRICAL SERVICE ENTRANCE

Part 1 - General

1.1 Design Engineer shall obtain information and prepare a front-end report documenting interviews with representatives from the local electrical utility relating to specific utility information for the project. Items to be coordinated include the following:

A. Quantity, size and routing of primary entrance conduits,

B. Method of installation for entrance conduits, (e.g., man/hand hole requirements, encasements, etc.),

C. Limitations or other specific requirements of the local utilities,

D. System fault current.

1.2 Metering shall be provided per HCA metering guidelines.

1.3 Confirm connection of fire pump to transformer is permissible along with metering of fire pump. Where fire pump feed from utility transformer is permissible and used, route grounded conductor (neutral) with phase conductors between utility transformer and service entrance rated fire pump controller.

1.4 Underground service laterals shall use minimum 4" PVC in concrete encasement.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
3.1 Installation Requirements:

A. Contractor's responsibilities relative to transformer installation, including furnishing and installing equipment, concrete pads, supplemental enclosures, etc.

B. Provide three spare conduits in duct bank.

SECTION 26 13 00: MEDIUM VOLTAGE SWITCHGEAR

Part 1 - General
1.1 HCA is electing at this time not to provide guidelines.

Part 2-Products
2.1 Manufacturers:

A. Eaton Electrical Inc.; Cutler-Hammer Products.

B. Square D; Schneider Electric.

2.2 Options:

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A. Phase barriers are to be included.

Infrared windows shall be installed in medium voltage switchgear in quantities and locations to provide line-of-sight viewing of all line side and load side cable terminations.

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B.

Part 3 - Execution
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~~3.1 Infrared windows shall be installed in medium voltage switchgear in quantities and locations to provide line-of-sight viewing of all line side and load side cable terminations.~~

SECTION 26 17 00: ROLL-UP GENERATOR TERMINATION CABINET

Part 1 - General

1.1 HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Manufacturers:

A. Eaton Electrical Inc.; Cutler-Hammer Products.

B. Square D; Schneider Electric.

Part 3 - Execution

3.1 Clear, detailed, written instruction are to be permanently attached to the quick connect and electrical gear being served by it for staff reference. In addition, a laminated, color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room.

SECTION 26 22 00: LOW-VOLTAGE TRANSFORMERS

Part 1 - General

1.1 HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Manufacturers.

A. Eaton Electrical Inc.; Cutler-Hammer Products.

B. Square D; Schneider Electric.

2.2 General Transformer Requirements

A. Energy Efficiency for Transformers Rated 15 kVA and Larger: Complying with DOE-2016 efficiency levels.

B. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

C. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91, unless otherwise indicated.

1. 9 kVA and below: 37 dBA
2. 10 kVA to 50 kVA: 42 dBA
3. 51 kVA to 150 kVA: 47 dBA
4. 151 kVA to 300 kVA: 52 dBA
5. 301 kVA to 500 kVA: 57 dBA
6. 501 kVA to 700 kVA: 59 dBA

7. 701 kVA to 1000 kVA: 61 dBA

Part 3 - Execution

3.1 Installation.

A. Transformer mounting
   1. 15 kVA or less: Floor mounted or suspended, as indicated.
   2. 30 kVA and 45kVA: floor mounted or suspended, as indicated.
   3. 75 kVA: Floor mounted or rack mounted, as indicated.
   4. Greater than 75 kVA: Floor mounted, unless otherwise indicated.

B. Install and anchor floor-mounted transformers level on concrete bases, 4-inch (100-mm) nominal thickness according to manufacturer's written instructions. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

C. Construct steel channel support system for rack-mounted or suspended transformers according to manufacturer's written instruction and requirements of Division 26 Section "Hangers and Supports for Electrical Systems." Comply with vibration isolation for transformers per requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems"

SECTION 26 23 00: LOW-VOLTAGE SWITCHGEAR

Part 1 - General

1.1 HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Manufacturers.

A. Eaton Electrical Inc.; Cutler-Hammer Products.

B. Square D; Schneider Electric.

2.2 Main switchgear used as service entrance equipment shall be provided with infrared windows in quantities and locations to provide line-of-sight viewing of all cable terminations on the line side of the main overcurrent protective device.

SECTION 26 23 13: PARALLELING LOW VOLTAGE SWITCHGEAR

Part 1 - General

1.1 Work Included:

A. Consideration shall be given to designing multiple generators in lieu of a single unit above approximately 1000kW to 1200kW total system capacity.

B. When designing systems employing multiple generators, simplified automatic paralleling systems shall be designed to provide the greatest reliability. Limit system options and accessories to avoid over-complication of the system operation. Alternative consideration may be given to main-tie-main type designs connecting both generators with key switch protection to common bussing operating with the tie switch normally open. Manual load shedding and breaker lock-out would allow a single unit to serve critical loads in the event of a unit failure.

C. Emergency systems with single or multiple non-paralleled generators shall be provided with a circuit breaker in the emergency switchgear to be used for connection of temporary load banks and/or a single temporary emergency generator with no parallel operation capabilities.

D. In general, multiple generators serving dedicated transfer switches with no means for backup operation should be avoided.

E. Provide separate batteries for paralleling gear control. The generator start batteries shall not be used for this purpose.

F. Specify advanced metering for all generator as specified in the Appendix F: Energy and Resource Metering.

Part 2-Products

2.1 See Section 26 32 13 requirements.

2.2 Acceptable Manufacturers: ASCO, Russ Electric and Cummins.

2.3 Paralleling switchgear shall be provided with infrared windows in quantities and locations to provide line-of-sight viewing of all cable terminations on incoming and outgoing overcurrent protective devices.

Part 3 - Execution

3.1 See Section 26 32 13 for requirements.

SECTION 26 24 13: SWITCHBOARDS

Part 1 - General

1.1 Work Included:

A. Metering to be as specified in the Appendix F: Energy and Resource Metering.

B. Facilities will be designed with a single main electronic trip circuit breaker. Designing smaller facilities using the "six-disconnect rule" will not be allowed.

C. The main service shall be switchboard style construction reserved for the installation of large frame circuit breakers serving the larger loads. Installation of smaller circuit breakers or smaller loads served from the main switchboard (approximately under 400 amps) should be limited. Instead, the distribution should be arranged to accommodate smaller loads served from less expensive distribution panels or panelboards. The future capacity design for the project shall be closely coordinated with, and approved by, HCA Design and Construction.

D. Design a means of facilitating the safe and quick connection of a temporary portable emergency generator to the main switchgear. Provide a separate compartment and circuit breaker in the switchgear that is cabled to an external tap box sized for the rating of the main switchgear. The external tap box shall have female CamLock connectors installed inside. The box shall contain sufficient access doors and clearances designed to protect the mated connectors/cables from adverse weather conditions. The Design Engineer is to coordinate concrete pad with architect.

Part 2-Products

2.1 Acceptable Manufacturers: Eaton (Cutler Hammer) or Schneider (Square D).

Part 3 - Execution

3.1 Installation:

A. Require the switchboard manufacturer to submit his own engineered fault study and coordination study for the electrical system

B. Surge Protection Devices shall be installed by the manufacturer in the main switchboard assembly. Third party devices may be used if factory installed by the main switchboard manufacturer.

C. Verify with local utility any power factor penalties for the system. Provide local power factor correction capacitors for chillers and motors over 50 hp, when not employing power factor correcting drives if required to avoid penalties.

3.2 Main switchboards used as service entrance equipment shall be provided with infrared windows in quantities and locations to provide line-of-sight viewing of all cable terminations on the line side of the main overcurrent protective device.

3.3 Clear, detailed, written instruction are to be permanently attached to the quick connect and electrical gear being served by it for staff reference. In addition, a laminated, color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room.

SECTION 26 24 16: PANELBOARDS

Part 1 - General

1.1 Work Included:

A. Bussing in switchboard, panelboards, and motor control centers shall be designed using aluminum unless written permission is given by HCA. Copper may be substituted by contractor at no additional cost.

B. Panelboard and distribution panel circuit breakers should be bolt-on. Group mounted switchboard devices, not tandem breakers, are acceptable where appropriate.

C. Provide fully rated circuit breakers adequate for the available fault current at each bus in the system. Do not rely on series rated devices for the “let-through” value for determining circuit breaker AIC ratings.

D. All panelboard doors shall be hinged type.

Part 2-Products

2.1 Circuit breakers are preferred over current protection devices for the distribution system for protection of branch circuits and feeders. Fuses may be used in disconnect switches and other limited applications where appropriate. Thermal-magnetic circuit breakers type shall be used wherever possible and practical as overcurrent devices.

Part 3 - Execution

3.1 Installation

A. Provide minimum 20% future capacity for bus and feeder ratings of distribution equipment with associated available space for breakers. Spare capacity shall not be excessive. Future capacity will be provided for planned expansions as directed by HCA Design and Construction.

B. Panel directories shall match the graphic design package. Contractor documents shall be noted accordingly.

C. New typewritten directories shall be provided for existing panelboards where changes occur resulting from renovation or remodeling work.

SECTION 26 24 17: ISOLATION PANELBOARDS

Part 1 - General

1.1 Work Included:

A. Isolated power systems shall continue to be installed as minimum standard design practice for operating rooms and treatment spaces involving invasive procedures using line operated electro-medical devices in wet locations. The majority of operating rooms~~, cath labs~~, C-section rooms, open heart, and orthopedic surgery spaces are generally considered wet locations.

B. Isolated power systems should only be deleted from projects when directed in writing by facility administration and approved by the HCA Corporate Construction Manager.

C. Closely coordinate portable radiology, other diagnostic equipment, lasers, and other portable treatment equipment to be used in ORs. Provide appropriate connections and power provisions.

D. Consideration shall be given to providing adequate size and/or quantities of isolated power panels to accommodate all treatment equipment to be utilized in each OR. Typically one isolation panel is adequate to serve a single OR. Occasionally, the intended use of certain lasers or equipment necessitates increasing the isolation transformer size, or consideration of a second isolation panel, or a dual voltage panel.

E. When providing two sources of power (normal and critical or two independent critical sources) in the same operating room, provide an isolated power panel for each power source.

F. The use of more than twelve circuits on any one panel should not be considered due to additive leakage capacitance.

G. Isolation power system branch circuit wiring shall have XHHW or XHHW-2 insulation.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 26 24 19: MOTOR CONTROL CENTERS

Part 1 - General

1.1 HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Manufacturers:

A. Eaton Electrical Inc.; Cutler-Hammer Products.

B. Square D; Schneider Electric.

Part 3 - Execution

3.1 HCA is electing at this time not to provide guidelines.

SECTION 26 27 26: WIRING DEVICES

Part 1 - General

1.1 Work Included:

A. Hospital grade receptacles shall be used throughout.

B. Tamper proof receptacles shall be specified in all pediatric areas including pediatric waiting rooms.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 26 27 27: WIRING DEVICE PLATES

Part 1 - General

1.1 Work Included: Plates for switches, receptacles, telephone outlets and miscellaneous devices to be specification grade nylon, except alloy or stamped metal plates should be used on exposed devices. For renovations or small additions, existing types and colors should be matched. Coordinate type and color with facility.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Installation Requirements:

A. Provide permanent, laminated, engraved labels for receptacles in critical patient care locations, identifying the branch and panel circuit.

B. All other device plates throughout the facility shall be labeled to identify panel and branch circuit using an adhesive tape method similar to "P-touch" by Brothers or Laser Etched.

SECTION 26 28 16: ENCLOSED SWITCHES AND CIRCUIT BREAKERS

Part 1 - General

1.1 Work Included:

A. Switches shall have arc shields, be heavy duty, enclosed construction and fusible or non-fusible as indicated. Switches shall be rated for either 240-volt AC or 600-volt AC service as required.

B. Switches shall have UL listed lugs suitable for 75° C copper or aluminum conductors.

C. Switches shall be pad lockable in the open (off) position.

D. Fusible switches shall have a UL listed short circuit rating of 100,000 amps rms with fuses applied.

Part 2-Products

2.1 Acceptable Manufacturers: Square D, G.E., or Cutler-Hammer/Westinghouse.

Part 3 - Execution

3.1 Installation Requirements:

A. Provide non-fusible switches at all motor locations.

B. Identify safety switches with bakelite name-plates in accordance with Section 26 05 53.

C. Use NEMA 1 for interior use and NEMA-3R for exterior use.

D. Where installed on either side of a VFD, provide one normally open and one normally closed auxiliary contacts for disconnect switches for all fans and pumps.

SECTION 26 29 13: ENCLOSED CONTROLLERS

Part 1 - General

1.1 Work Included: Starters shall be motor circuit protector type (OCP) with melting alloy type thermal units.

Part 2-Products

2.1 Starters:

A. Starters shall be NEMA classification, sized as recommended by NEMA.

B. UL listed and CSA approved.

C. Provide Hand-Off-Automatic selector switch, one red and one green pilot light and two normally-open, two normally closed auxiliary contacts in each starter.

D. Reduced voltage starters shall be Auto Transformer, closed transition; or Wye-Delta starters, closed transition type.

E. Starters shall include 120 volt control transformers in each starter, individually fused from the line side of the starter using two cartridge fuses and one fuse in the secondary. Size transformers to carry the holding coil circuit and other connected devices.

F. Provide built-in power factor correction capacitors on load side of contactor in starters for motors 50 horsepower and larger to correct the power factor to 95%. Connect capacitors between the contactor and overload relays.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 26 29 23: VARIABLE FREQUENCY MOTOR CONTROLLERS

Part 1 - General

1.1 Work Included: VFDs shall be used on:

A. Chilled water, condenser water, and heating hot water pumps in excess of 5 hp.

B. Supply and return fans on variable volume systems, and considered for constant volume supply fans >5 hp

C. Supply fans on systems with significantly varying static pressures (e.g. to account for pre- and final filter loading) to maintain constant volume.

D. Boiler burner blowers 15 hp and greater. Boiler feed pumps 15 hp and greater.

Part 2-Products

2.1 Acceptable Manufacturers: ABB, Danfoss, York/Toshiba, SquareD/Schneider, Yaskawa, JCI.

2.2 VFDs shall be provided with interface for Building Automation System (BAS). VFDs shall not be installed on owner IT network.

2.3 VFDs motor transfer circuit shall include three contacts for bypass switching from line to VFD and vice versa.

2.4 Motors 50 hp and under shall be specified with minimum 6-pulse drives. Motors larger than 50 hp require minimum 18-pulse drives or 6-pulse drives with passive filters.

2.5 VFDs shall meet IEEE 519-1992 at the input terminals of the VFD, and TDD level should correspond to Isc/Il <20.

2.6 Harmonic Performance: THiD shall be 5% or less at loads greater than 60%, THvD shall be <2% with <5% line voltage imbalance.

2.7 At the owner's request, provide calculations, specific to this installation, showing total harmonic voltage distortion meeting IEEE 519.

2.8 Total Power Factor = (Displacement pf [cos phi] +Distortion pf) shall be >.98 at loads greater than 50%.

2.9 VFDs serving fans and pumps (e.g. AHU's, chilled water, & cooling towers) shall have the ability to lock out critical speeds.

2.10 Each VFD over 50Hp shall be provided with a passive harmonic filter or 18 pulse phase shifting transformer to limit the total harmonic current distortion and voltage distortion as noted herein.

2.11 The filter transformer shall be compatible with the 6 pulse invertor. All components must be installed in a single contiguous enclosure.

2.12 All VFDs shall be identical regardless of harmonic filtering.

2.13 The harmonic filter/transformer shall treat all characteristic low frequency harmonics generated by a three phase full wave converter (5th, 7th, 11th, 13th, etc.).

2.14 To ensure generator compatibility, the harmonic filter must never introduce a capacitive reactive power (KVAR), which is greater than 20% of its KVA rating.

2.15 Filter/transformer to be disconnected from circuit when operating in bypass mode.

2.16 VFDs with active front end units and regenerative VFDs are not allowed.

Part 3 - Execution

3.1 All VFDs on a project shall be provided by a single manufacturer.

3.2 All VFDs shall be provided with a warranty of not less than 24 months from startup.

3.3 VFDs serving cooling towers equipped with gear boxes shall be programmed to not operate below the minimum speed required for proper lubrication. Where VFDs serve belt-driven equipment, they shall be provided with broken belt sensing feature.

3.4 When a VFD is mounted remotely from the motor it serves, the disconnect switch mounted adjacent to the driven motor shall include an auxiliary set of contacts to de-energize the drive. Coordinate with Division 26.

3.5 Wiring distance shall not exceed manufacturer's maximum recommended distance.

3.6 VFDs shall be installed and started up by the manufacturer or his designated, trained representative.

3.7 Installation of VFD load conduit and conductors are to follow manufacturer's instructions on recommended spacing between loads served by other drives to avoid signal interferences.

SECTION 26 32 13: ENGINE GENERATORS

Part 1 - General

1.1 Work Included:

A. Generators will be located inside the facility. Outdoor generators may be considered when space and budget limitations are significantly impacted, but only in moderate temperature climates.

B. Obtain approval from HCA Design and Construction prior to the design of an outdoor generator.

C. In extreme weather areas, outdoor generators will be unacceptable.

D. Avoid the use of remote radiators.

E. Gen Set Engine Controllers shall be specified with electronic engine monitoring control panels capable of local display and remote communications for all NFPA110 required generator and engine parameters and alarms. Remote communications to energy management systems shall be provided using Modbus TCP Ethernet

F. Design Engineer shall adhere to HCA Design & Construction Guidelines when determining loads to be placed on emergency power. Refer to Tab 11 for requirements. Excess capacity shall not be included for future construction unless specifically instructed by HCA.

G. A field inspection must be done by the engineer prior to installation to ensure engine exhaust is routed in a way to avoid fumes from entering the building through outdoor air intakes.

Part 2-Products

2.1 Manufacturers: Generators shall be by Cummins/Onan or Generac

2.2 Provide manufacturer's warranty for 18 months from date of shipment from the factory or 12 months from startup (which ever date is later), covering parts and labor required to remedy defects in materials or workmanship for the entire generator. Perform warranty work with manufacturer's factory-trained and factory-employed service technician.

Part 3 - Execution

3.1 Installation Requirements:

A. Loads described in Article 517 of the NEC shall be served from the appropriate branch of the essential system as required. Additional "selected" loads added to the essential system should be limited to that equipment deemed necessary for effective operation of the facility. (Refer to Tab 11 – emergency Power Guidelines for the recommended essential system loads.) Consideration should be given to environmental conditions that could impact the frequency of outages.

B. Avoid oversized generators resulting from inappropriate sizing methods or calculations not specifically supported by the code. (Certain states have specific sizing methods dictated for emergency generator calculations, e.g., California, Washington, etc.)

C. Every effort should be made to select a generator size close to the actual expected system demands to avoid operating and testing of the generator without adequate load.

D. Provide future capacity in the automatic transfer switches and associated electrical distribution switchgear for planned expansions.

E. Unless otherwise noted, allow for sufficient spare capacity to accommodate future load. Coordinate percentage with the HCA Corporate Construction Manager.

F. Review these future capacities specifically with the HCA Corporate Construction Manager.

G. A single generator design serving the entire essential system should be used up to approximately 1000-1200kW total system capacity. System requirements exceeding 1200kW shall consider multiple units operating in parallel. Consideration may be given when designing two generator systems to main-tie-main type designs when budget constraints are significant. Preference shall be to design paralleled systems in this capacity range.

H. Generators shall be specified with provisions on the load side of the generator main breaker for quick connection of a load bank or temporary generator. This includes appropriate sleeves through walls for installation of cabling from exterior of building. Coordinate concrete pad for load bank or temporary generator with Architect.

I. Generator day tank should not be installed in the skid of the generator for indoor generators, unless specifically requested by the facility and approved by HCA Design and Construction. Provide a minimum of 2 hours for each day tank. Maximum inside the building must not total more than 660-gallons.

J. Outdoor generators within 60 miles of a coastline shall have an aluminum weatherproof housing.

K. Where an outdoor generator has a remotely mounted electrical panel to serve auxiliary loads on essential power branch, this is to be shown on the one-line diagram.

SECTION 26 33 53: STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS)

Part 1 - General

1.1 Work Included: Coordinate with hospital staff and the HCA Corporate Construction Manager to employ existing UPS, when possible. Coordinate with Equipment Manager and IT Manager for power requirements of any new UPS furnished by the owner.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 Provide a UPS for all BAS field-level controllers.

SECTION 26 36 00: TRANSFER SWITCHES

Part 1 - General
HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Manufacturers: Transfer switches shall be manufactured by ASCO, Cummins or Zenith.

2.2 Switches shall have provisions for metering from the factory.

Part 3 - Execution

3.1 Transfer switches shall have in-phase monitoring to allow transfer only when the two sources are synchronized within fifteen (15) electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

3.2 Typically, design the emergency distribution system with 4-pole, open transition, single drive motor, automatic transfer switches (ATS's). Equipment branch transfer switches shall be delayed-transition with a programmed delay from 0.5-30 seconds. Do not provide isolation bypass type switches unless required by AHJ, (e.g., California). All Automatic Transfer Switches (ATS's) shall have provisions for manual transfer with the cabinet door closed.

3.3 When using 4-pole ATS's, generator neutrals shall be bonded to ground at the generator. Four-pole ATS's shall also be used when applying ground fault protection schemes on the normal system to avoid the potential for nuisance trip. Carefully coordinate the system grounding methods for the utility services and the emergency generators.

3.4 ATS's shall be specified with metering as in the Appendix F: Energy and Resource Metering.

SECTION 26 41 13: LIGHTNING PROTECTION SYSTEMS

Part 1 - General

1.1 Work Included: Lightning risk assessment analysis as prescribed in NFPA-780 should be calculated for each project. From this data a recommendation shall be made to the HCA Corporate Construction Manager as to the use or expansion of lightning protection.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

SECTION 26 43 13: (TVSS) TRANSIENT VOLTAGE SURGE SUPPRESSION

Part 1 - General

1.1 Specify Surge Protection Devices (SPD) for the following as a minimum:

A. Service entrance switch or distribution panel.

B. Panelboards serving laboratory, radiology/ imaging and data processing equipment.

1.2 For new installations, provide bus-connected SPDs. Panelboards or switchboards assemblies with integral bus-connected SPDs shall be U.L. listed.

1.3 On renovation projects, discuss with HCA Corporate Engineering and Facility Management Services the cost and feasibility of adding SPDs to the existing equipment.

1.4 Where it is not feasible to provide bus-connected SPD, the leads shall be as short as possible. Under no circumstances shall the impedance exceed the impedance of 18" of #8 copper conductor. (U.L. test SPDs let-through using a 6" lead length.)

1.5 SPDs at switchboards and distribution panels shall be protected by circuit breakers.

1.6 Ratings shall be:

A. Per Phase: 250 kA for service entrance equipment; 160 kA for distribution panelboards; and 120 kA for branch circuit panelboards.

B. Per mode: 125 kA for service entrance equipment; 80 kA for distribution panelboards; and 60 kA for branch circuit panelboards.

C. ANSI/IEEE C3 wave repetitive surge withstand capabilities: 12,000 strikes for service entrance equipment; 10,000 strikes for distribution panelboards; and 9,000 strikes for branch circuit panelboards.

1.7 SPDs shall meet the requirements of U.L. 1449, 2nd Edition. Provide independently tested let-through voltage test data in the form of oscillograph results for the ANSI/IEE C62.41 Category C3 & C1 (combination wave) and B3 (ringwave). Testing shall be in accordance with ANSI/IEEE C62.45 with 10 modes of protection.

1.8 Provide a remote monitor for three phase surge suppression devices (SPD), to enable monitoring of a device failure.

Part 2-Products

2.1 Acceptable Manufacturers: Eaton/Cutler Hammer; Square D, Current Technologies & Surge Suppression, Inc.

Part 3 - Execution

3.1 Installation Requirements:

A. Mount all three phase SPD units adjacent to the panelboards served. Cabinets for devices serving flush mounted panelboards shall be provided for flush mounting.

B. Provide Owner with two spare module units for each type of 277/480 volt or 120/208 volt SPD employed.

SECTION 26 51 00: INTERIOR LIGHTING

Part 1 - General

1.1 Work Included:

A. Refer to HCA Design Standard and Model Room Guidelines available from the HCA Director of Architecture and Design Services.

B. Employ motion sensor switching or timers in non-occupied areas such as storage spaces.

C. Automatic lighting controls including occupant sensors are not allowed in electrical rooms or mechanical rooms.

Part 2-Products

Refer to Tab 17 for sole sourcing of lighting through Acuity Brand Lighting/Graybar.

2.1 Material:

A. LED lighting is preferred for interior lighting due to energy and maintenance costs.

B. Specify backlit style LED exit signs.

C. Do not specify incandescent type fixtures except in imaging areas. In these areas use incandescent fixtures only where required or recommended by the equipment manufacturer.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 26 56 00: EXTERIOR LIGHTING

Part 1 - General

1.1 Work Included:

A. LED lighting is preferred for exterior lighting due to energy and maintenance costs.
B. The use of 250-watt, 400-watt, and 1000-watt metal halide fixtures on 30, 40, or 50-foot poles may be considered on a per-project basis after careful comparison of total cost of ownership including maintenance and replacement costs.
C. Match existing lighting source for renovation/ addition projects.
D. Standard lighting levels for site parking shall be a minimum maintained level of one foot-candle. Attempt to limit the variation of the lighting level to a 10 to 1 ratio. At the property line, limit the lighting level to ½ foot-candle.
E. Increase these minimums where required by the AHJ or deemed necessary for increased security as directed by the facility.
F. Provide contactors controlled by photocell-on, time clock-off controls for parking lighting except where not allowed by local or state codes.
G. Florida poles shall be listed for 146-mph wind loads. Provide pole base calculation with structural engineer. Have pole manufacturer provide wind load calculations in coastal (up to 60 miles from the coast) regions. Provide pole base calculation to pole vendor.

Part 2-Products

Refer to Tab 17 for sole sourcing of lighting through Acuity Brand Lighting/Graybar.

Part 3 - Execution

3.1 Provide photocell-on, time clock-off controls for parking lighting except where not allowed by local or state codes.

SECTION 26 90 10: WIRED MASTER TIME SYSTEM

Part 1 - General

1.1 Master Clock systems are not to be used without prior approval from HCA Design and Construction. Include provisions for hospital provided, battery operated clocks in all areas except where interval timers are required. In these areas, 120V clocks/I.T.'s shall be specified.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

SECTION 26 90 11: MODULAR HEADWALLS - CRITICAL/INTENSIVE CARE UNITS

Part 1 - General

1.1 Work Included: Headwalls are to be specified by the ~~Design Engineer~~design team and provided by the Contractor. These items are to be competitively bid. The extent and sophistication of headwalls or power columns in critical care areas shall be coordinated with the facility staff and approved by HCA Design and Construction.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

SECTION 26 90 12: PATIENT CONSOLES

Part 1 - General

1.1 Work Included:

A. Consoles should typically be provided only in patient rooms, recovery rooms, and in ER treatment areas.

B. Consoles to be competitively bid.

C. Consoles that are not indicated on HCA Design Standard and Room Design Guidelines should not be specified unless requested by the facility and approved by HCA Design and Construction.

Part 2-Products

HCA is electing at this time not to provide guidelines.

Part 3 - Execution

HCA is electing at this time not to provide guidelines.

DIVISION 27: TELECOMMUNICATIONS

DESIGN GUIDELINES – TELECOMMUNICATIONS

Part 1 - General

1.1 All applicable codes and standards shall be determined by the architect including adopted editions, along with state and local modifications, of:

A. TIA -568-B.1: Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements

B. TIA -569-B: Commercial Building Standards for Telecommunications Pathways and Spaces

C. TIA-606-A: Administration Standard for Commercial Telecommunications Infrastructure

D. TSB-67: Transmission Performance Specifications for field testing of Unshielded Twisted-Pair Cabling Systems

E. TIA-1179: Healthcare Facility Telecommunications Infrastructure Standard

F. BICSI: Telecommunications Distribution Methods Manual (TDMM)

G. BICSI: Information Technology Systems Installation Methods Manual (ITSIMM)

H. ANSI/NECA/BICSI 568-2006: Standard for installing Commercial Building Telecommunications Cabling

I. ANSI/BICSI 004-2012: Information Technology System Design and Implementation Best Practices for Healthcare Institutions and Facilities

J. NFPA 70: National Electric Code (NEC)

K. NFPA 99: Healthcare Facilities Code

L. NECA 1-2015: Standard for Good Workmanship in Electrical Contracting

M. IBC or other applicable building codes

1.2 Healthcare Corporation of America (HCA) technology & low voltage design contact. For all questions related to Division 27 guidelines within please contact:

A. Matt Dunaway 615.344.2768, matt.dunaway@hcahealthcare.com.

1.3 Telecommunications Designer Qualifications

A. Telecommunication designer shall be registered with BICSI as a Registered Communications Distribution Designer (RCDD) or under direct supervision of an RCDD.

B. Must have experience with healthcare telecommunication design including applying all applicable standards, codes and guidelines.

1.4 Telecommunications Contractor Qualifications

A. General qualifications:

1. Contractor shall be a current Belden certified partner. Current status of contractor can be confirmed by contacting HCA's Belden representative:

    a. Scott Fencik

    b. Scott.Fencik@belden.com

    678.450.8090 or 404.431.8230

2. Contractor shall be familiar with working in operational healthcare facilities and be familiar with ICRA guidelines and installation methods.

B. Project manager & estimator qualifications:

1. Shall be registered with BICSI as a Registered Communications Distribution Designer (RCDD) or under direct supervision of an RCDD.

2. Shall have knowledge all applicable standards, codes and guidelines as required by the local AHJ.

C. Onsite supervisor/lead technician qualifications:

1. At a minimum shall be registered with BICSI as a Technician.

1.5 Structured cable material procurement:

A. Healthcare Corporation of America (HCA), has a group pricing arrangement for all low voltage and structured cabling materials and other solutions through HealthTrust Group Purchasing (HPG), with vendor Accu-Tech (http://www.accu-tech.com/).

B. The Contractor shall utilize Accu-Tech for all pricing of materials. Accu-Tech's HPG Contract #6715. Only when previous approvals have been made should you purchase outside of HPG pricing.

C. Accu-Tech contact:

1. Tim Flannagan, Director of Healthcare, 615.585.3972; tim.flannagan@accu-tech.com

2. Buddy Strader, Account Executive, 615.804.9697; Buddy.Strader@accu-tech.com

Part 2-Products

Telecommunication Spaces and Pathway Design Guidelines:

2.1 General:

A. Room or Enclosure dedicated to serving telecommunication equipment and infrastructure. Telecommunication Room (TR/IDF), Telecommunication Equipment Room (TER/MDF), Telecommunication Entrance Facility

(EF/DEMARC), and Telecommunication Enclosure (TE) are all considered Telecommunication Spaces.

B. Telecommunication drawings shall include an enlarged detail plan of the telecommunication space. Plan to include:

1. All equipment that is to be located within the telecommunication space. Layout to include, at a minimum: equipment racks, wire management, overhead cable supports, backboards, thermostat, light switch, electrical outlets, TVJ, telemetry backboard, fire alarm panel, nurse call, overhead paging amplifier, ground buss bar, floor/wall sleeves, and DAS.
2. Dimensions to show exact location of equipment within the space.
3. Elevations of all walls and equipment racks/cabinets. Exact placement of equipment mounted within the equipment racks/cabinets shall be coordinated with the facility IT director.

2.2 Existing Telecommunication Spaces:

A. It shall be the responsibility of the architect and telecommunication engineer to apply the guidelines listed within as applicable to existing telecommunication spaces.

B. A survey shall be conducted of the existing spaces with the coordination of IT&S. It shall be determined if:

1. There is adequate physical space for added equipment/cable.
2. Existing mechanical system will be sufficient for added equipment heat load.
3. Electrical is available for any added equipment such as an UPS.

2.3 Telecommunications Room (TR/IDF) Design Guidelines:

A. General:

1. TR is a room within the facility housing telecommunication systems and horizontal cabling termination hardware.
2. TR allowed to house low voltage systems including: data/telephone networks, nurse Call, CCTV, intercom, overhead paging, distributed antenna system (DAS), wireless networks, CATV, infant protection, access control, RFID/RTLS, physiological/fetal/telemetry monitoring and fire alarm.

B. Location and construction requirements:

1. Room size shall be a minimum of 130 ft^2 (10’x13’) measured from interior walls of the room. It must be noted however some states have adopted NFPA 99 and FGI guidelines which require a minimum room size of 168 ft^2 (12’x14’).

2. Room walls shall be a minimum 2 hour fire rated.
3. There shall be a minimum of one TR serving each floor within the facility.
4. Room shall be located central to the area it is to serve to maintain the cable distance limitations of 295 feet. Rooms shall be stacked where applicable.
5. TR's shall serve a maximum usable floor space of 20,000 ft^2.
6. TR's shall be located a minimum of 12 feet from any permanent source of electromagnetic interference (transformers, elevator equipment rooms, electric motors, x-rays, etc).
7. TR shall be located where access is gained from a main corridor or hallway. Access through another room shall not be permitted.
8. TR shall be served by a minimum door width of 36". Door shall include electronic access control reader.
9. TR shall not include a lay-in or false ceiling. Room shall be open to deck.
    a. If ceiling is absolutely necessary the minimum height shall be 10 feet from finished floor to allow for cable and pathways to be installed below ceiling.
10. All interior walls within the TR shall be covered with ¾" thick AC grade fire retardant plywood from finished floor to 8 feet above finished floor.
    a. Plywood shall be installed with "A" side facing out using flush hardware attaching to wall framing studs.
    b. Manufacturer's fire rating stamp shall be located on the "A" side.
    c. If painted, plywood shall be covered with two coats of fire retardant paint. Paint shall be light in color to enhance room lighting.
        i. Leave a minimum of one manufacturer's fire rating stamp unpainted per sheet of plywood for easy inspection identification.
11. Flooring within TR's shall be a minimum of sealed concrete to prevent creation of dust. Carpet shall never be used.
12. No other system, pipe, cable, conduit, duct, etc. not directly related to the function of the TR shall be located in or pass through the TR.
13. Care shall be taken to insure water piping is not installed within walls of the TR that may serve a plumbing fixture within an adjoining room.

14. Wet Sprinkler piping serving the TR shall not be routed over equipment racks or other electronic equipment.
    a. Where applicable fire sprinkler heads shall be wall mounted, side discharge type.
    b. Sprinkler heads shall include wire cage guards to prevent accidental discharge.

C. TR Power Requirements:

1. General: Communication enlarged drawings and elevations shall show location of all power outlets within TR for coordination in the field. Electrical power plans shall have reference to communication enlarged drawings for exact locations of power outlets located with the TR.
2. A minimum of (3) 208V 30A (L6-30R) dedicated critical circuits shall be provided for rack mounted Uninterruptable Power Source (UPS).
    a. Twist lock receptacles shall be mounted to back side of cable tray, centered above vertical cable managers.
3. A minimum of (2) 120V duplex outlets shall be provided for rack mounted vendor equipment.
    a. Duplex outlets shall be mounted to back side of cable tray, centered above vertical cable managers.
    b. Duplex outlets shall be on critical circuit and allowed to share the same circuit.
4. All interior walls of the TR shall include a minimum of (1) 120V duplex outlet for convenience purposes 18” above finished floor.
5. Convenience outlets are not required to be on critical circuit.
6. There will be additional power requirements for additional vendor equipment and other systems mounted on the walls of the TR. Designers shall work with vendors to plan correct power for non IT&S related equipment (e.g. fire alarm panel, access control, nurse call, CATV amplifier, DAS, etc.).

D. TR Lighting Requirements:

1. General: Communication enlarged drawings and elevations shall show location of lighting fixtures within TR for coordination in the field. Electrical lighting plans shall have reference to communication enlarged drawings for exact locations
2. Lighting shall be designed for a minimum of 500 lux in the horizontal plane and a minimum of 200 lux in the vertical plane when measured 3 feet above finished floor.
3. Lighting fixtures shall be mounted a minimum of 8’-6” above finished floor and be located within the aisles of the room.

4. Lighting shall be supplied from a different distribution panel than all the other power outlets within the TR.
5. Emergency lighting shall be provided per the AHJ.

E. TR Environmental:

1. Room temperature shall be maintained between $41^0 – 95^0$ F dry bulb with a relative humidity range of 8-80%.
2. Mechanical unit shall be sized based on a BTU count of 45,000 BTU.
3. Mechanical unit shall be powered from the ~~critical~~ equipment branch to provide 24/7/365 cooling.
4. Mechanical unit shall be dedicated to the TR served.
5. Thermostat shall be located on the wall in front of the equipment racks, centered.
6. Equipment racks will be laid out so that cool air is pulled from the front of the rack mounted equipment and hot air discharged out the rear of the equipment.
    a. Supply duct design shall be that the supply discharges in front of the equipment racks.
    b. Return duct design shall be that the return grill/intake is located behind the equipment racks.

F. TR Equipment Racks:

1. Each TR shall include a minimum of (3) 2 post equipment racks and (1) 4 post equipment rack. Additional racks may be required depending on the function of the room.
2. Each equipment rack shall be secured to the floor structure per manufacturer and AHJ requirements.
3. Equipment racks shall be located so that there is a minimum of 3 feet of clearances in front of the equipment racks and a minimum of 5 feet in the rear of the equipment racks measured from the covers of the vertical wire managers.
4. Equipment racks shall include double sided vertical wire managers. Six inch wide vertical managers shall be located between equipment racks. Three inch wide vertical managers shall be used at the end of the equipment rack row.

G. TR Cable Pathway and Supports:

1. TR's located on a floor where there are floor(s) below shall include cores and sleeves through floor for backbone cable vertical pathway.

a. A minimum of (2) 4” cores and EMT sleeves shall be provided. Additional sleeves may be required if room is used for vertical backbone pathway for multiple rooms.

2. There shall be a combination of 2” and 4” fire rated pathway devices (Hilti speed sleeves or STI EZPath) wall mounted for cable pathway into the room. It’s the responsibility of the telecommunications engineer to determine the size and quantity based on the system separation.

3. TR shall include 18” wide x 2” tall basket style cable tray routed overhead for cable support within TR. Tray shall be routed around the perimeter of the TR and over equipment rack row. Tray shall be mounted a minimum of 4 inches above equipment racks.

H. TR Backbone Cable Connection

1. Each TR is shall be connected to the TER with a minimum of (1) ~~24~~ 48 strand single mode fiber and (1) 100 pair copper backbone cables.

2. Other backbone cables may be required for other telecommunication systems. These include, but not limited to, Telemetry, DAS, and CATV systems. It shall be the responsibility of the architect and telecommunication engineer to coordinate exact requirements and include within the project plans and specifications.

2.4 Telecommunications Equipment Room (TER/MDF) Design Guidelines:

A. General:

1. TER is the main telecommunication space within the facility housing system servers and other telecommunication systems. Each TR is connected to the TER via a combination of fiber and copper backbone connections.

2. Horizontal cable connections shall not be supported from the TER.

3. Telecommunication Entrance Facility (EF/DEMARC) shall be allowed to be located within the TER.

B. Location and construction requirements:

1. Room size shall be based on project requirements. It’s the responsibility of the architect and telecommunication engineer to coordinate room requirements and size with IT&S.

2. In an area that is in risk of flooding the TER shall be located on an upper level.

3. Room walls shall be a minimum 2 hour fire rated.

4. TER’s shall be located a minimum of 12 feet from any permanent source of electromagnetic interference (transformers, elevator equipment rooms, electric motors, x-rays, etc).

5. TER shall be served by a minimum door width of 48". Door shall include electronic access control reader.
6. TER shall not include a lay-in or false ceiling. Room shall be open to deck.
    a. If ceiling is absolutely necessary the minimum height shall be 10 feet from finished floor to allow for cable and pathways to be installed below ceiling.
7. All interior walls within the TER shall be covered with ¾" thick AC grade fire retardant plywood from finished floor to 8 feet above finished floor.
8. Flooring within TER shall be a minimum of sealed concrete to prevent creation of dust. Carpet shall never be used.
9. No other system, pipe, cable, conduit, duct, etc. not directly related to the function of the TER shall be located in or pass through the TER.
10. Care shall be taken to insure water piping is not installed within walls of the TER that may serve a plumbing fixture within an adjoining room.
11. Fire suppression sprinkler system shall be double interlock pre-action dry-pipe system within the TER.
    a. Sprinkler piping serving the TER shall not be routed over equipment racks or other electronic equipment.
    b. Sprinkler heads shall include wire cage guards to prevent accidental discharge.

C. TER Power Requirements:

1. General: Communication enlarged drawings and elevations shall show location of all power outlets within TER for coordination in the field. Electrical power plans shall have reference to communication enlarged drawings for exact locations of power outlets located with the TER.
2. Majority of all network equipment within the TER shall be powered by a large (15-60Kva) UPS. Electrical and telecommunication engineer shall coordinate with IT&S and UPS vendor to determine requirements for the project.
    a. UPS vendor will provide and install UPS equipment, network cabinets, PDU's, power whips between UPS and cabinets/PDU's, and support for power whips. Contractor is responsible for providing input power connection.
3. A minimum of (3) 120V duplex outlets shall be provided for service provider equipment if located within the TER.

a. Duplex outlets shall be located as near as possible to service provider equipment. This could be wall or rack mounted. Exact requirements shall be coordinated with service provider and IT&S.

b. Duplex outlets shall be on critical circuit and shall not share the same circuit.

4. All interior walls of the TER shall include a minimum of (2) 120V duplex outlet for convenience purposes 18" above finished floor.

    a. Convenience outlets are not required to be on critical circuit.

5. There will be additional power requirements for additional equipment and other systems within the TER. It shall be the responsibility of the architect and engineers to coordinate all requirements with system vendors and IT&S.

D. TER Lighting Requirements:

1. General: Communication enlarged drawings and elevations shall show location of lighting fixtures within TR for coordination in the field. Electrical lighting plans shall have reference to communication enlarged drawings for exact locations
2. Lighting shall be designed for a minimum of 500 lux in the horizontal plane and a minimum of 200 lux in the vertical plane when measured 3 feet above finished floor.
3. Lighting fixtures shall be mounted a minimum of 9'-6" above finished floor and be located within the cabinet aisles of the room.
4. Lighting shall be supplied from a different distribution panel than all the other power outlets within the TER.
5. Emergency lighting shall be provided per the AHJ.

E. TER Environmental:

1. General: The TER shall utilize two dedicated computer room air handler (CRAH) units to condition the room. The units shall be sized and designed so that during normal operation both units are operating at 50% load for redundancy. Any failure of one unit would allow the second unit to condition the room until the issue is fixed. It shall be the responsibility of the MEP engineers and architect to work with IT&S on sizing the units based on the equipment being provided.
2. Room temperature shall be maintained between 41^0 - 95^0 F dry bulb with a relative humidity range of 8-80%.
3. Mechanical unit shall be powered from the ~~critical~~ equipment branch to provide 24/7/365 cooling.

4. Equipment cabinets/racks will be laid out so that cool air is pulled from the front of the rack mounted equipment and hot air discharged out the rear of the equipment.
    a. Supply duct design shall be that the supply discharges in front of the equipment racks.
    b. Return duct design shall be that the return grill/intake is located behind the equipment racks

F. TER Equipment Racks:
1. Majority of the equipment within the TER will be located within enclosed network cabinets. It shall be the responsibility of the telecommunication engineer to coordinate with IT&S for exact requirements and layout of the TER.
2. Front and rear clearances between cabinets/racks and walls and other equipment shall be a minimum of 4 feet.

G. TER Cable Pathway and Supports:
1. TER's located on a floor where there are floor(s) below shall include cores and sleeves through floor for backbone cable vertical pathway.
    a. A minimum of (4) 4" cores and EMT sleeves shall be provided. Additional sleeves may be required if room is used for vertical backbone pathway for multiple rooms.
2. There shall be 4" fire rated pathway devices (Hilti speed sleeves or STI EZPath) wall mounted for cable pathway into the room. It's the responsibility of the telecommunications engineer to determine the size and quantity based on the system separation.
3. TER shall include 18" wide x 2" tall basket style cable tray routed overhead for cable support within TR. Tray shall be routed around the perimeter of the TR and over equipment rack row. Tray shall be mounted a minimum of 8 inches above UPS power whip support.

2.5 Telecommunications Enclosure (TE/IDF) Design Guidelines:

A. General: TE is a metal enclosure housing telecommunication systems and horizontal cabling termination hardware.
1. TE shall be allowed where the only telecommunication systems that are to be supported are telephone, network data, and CCTV data.
2. Typical scenarios that would require a TE include, but not limited to:
    a. Parking garages where security cameras and emergency call boxes require connectivity.
    b. Central utility plant where network connection are required for energy use metering/usage.

c. Remote parking lot where security cameras and emergency call boxes require connectivity.

3. Door shall be lockable.
4. Enclosure shall be rated for the environment it is to be placed.

B. TE Power Requirements:

1. A minimum of (1) 120V duplex outlets shall be provided for rack mounted equipment within the TE.
   a. Duplex outlets shall be mounted within the enclosure.

C. TE Backbone Cable Connection

1. Each TE is shall be connected to the TER with a minimum of (1) ~~12~~ 48 strand single mode fiber.
2. If the TE supports analog or digital telephony needs (1) 25 pair copper backbone cable shall be provided between the TE and TER.

2.6 Design guidelines for Underground Duct Bank Pathway for Telecommunications Cables

A. General:

1. Underground nonmetallic conduits in a duct configuration including all handholes/manholes/vaults. Used for pathway between facility and service providers or between buildings on the same campus.
2. Telecommunications engineer shall coordinate exact requirements for underground duct bank with IT&S, service providers, AHJ and civil engineers. All requirements shall be shown on site plan and specifications.

B. Conduit Design Guidelines:

1. Unless directed otherwise minimum conduit size shall be 4 inch trade size.
2. Unless directed otherwise the minimum number of conduits within a duct bank connecting two buildings on the same campus shall be (two) four inch.
3. Unless directed otherwise the underground duct bank used for service provider (telco, internet, CATV Company) into the building shall be (four) four inch.
   a. Duct Bank shall be split into two diverse routed pathways into the building. At no point shall the two pathways share the same trench and must be separated by a minimum distance of 10 feet at all times.
4. At least one of the conduits within the duct bank shall include a minimum of 3 color coded inner ducts.

5. Conduits shall be encased in concrete when located within an area used for vehicular traffic.
6. Warning tape and locate wire shall be installed above duct bank.
7. Duct bank shall slope away from the building to prevent water infiltrating into the building.
8. Underground conduits shall terminate within the telecommunication space.

C. Handhole, Manhole, and/or Vault Design Guidelines
1. Comply with TIA-758-B.
2. Size shall be based on pathway served.
3. Shall be listed for the area it is located.
4. Any covers and/or lids shall be labeled "Telecommunications".

Part 3 - Execution
Telecommunication Systems Design Guidelines
3.1 General:

A. Section includes general design guidelines for telecommunication systems most likely included in the project. It shall be the responsibility of the architect and engineers to coordinate all system requirements for the project.
B. Telecommunication plans and specifications shall include all requirements for all required systems. Any vendor drawings and specifications used for the purpose of gathering information and placing on architectural/engineer plans shall not be issued to the contractor.

3.2 Existing Telecommunication System Cabling Infrastructure

A. Telecommunication plans shall include demo plans showing the removal and/or protection of existing cabling infrastructure and devices as applicable. Telecommunication engineer shall coordinate all affected systems with the IT&S director and/or associated system vendor.
1. Existing cabling to be demolished shall be completely removed back to the point of origin. Abandoned cabling shall include any cable, with associated pathways/supports, that is not currently used or will not be used at the time of project completion. Marking of abandoned cable as "future" or "spare" is not acceptable.
2. Existing cabling that is to remain shall be supported and protected to current standards.

3.3 IT&S Data/Unified Communication/Telephone Networks.

A. General:

1. Devices including, but not limited to: PC's, network printers, network scanners, point of care devices, tracker monitors, Telephones, faxes, copiers, and proximity cabinets.

B. Cable Infrastructure Design Guidelines:

1. The intent is to provide a universal Cat 6 cable infrastructure that will support Voice Over IP (VOIP) protocol. Cabling for telephony devices such as: phones, fax machines/lines, etc. shall be the same cabling as the Data Network/Data Cable Infrastructure.
    a. There may be circumstances due to system support agreements within certain facilities that require a stand-alone infrastructure for telephony devices that includes traditional wall punch blocks and dedicated cable/jack color. These circumstances shall be confirmed with HCA low voltage engineer:
        i. Matt Dunaway matt.dunaway@hcahealthcare.com
2. Cable jacket and jacks shall be black.
3. Cable shall be supported using wall mount or suspended snake tray. Cable shall only be allowed share supports and sleeves with Cat 6a wireless cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
4. Within the telecommunication space cabling shall be terminated on 24 or 48 port rack mounted dedicated patch panels. Telecommunications engineer shall coordinate exact configuration of rack mounted equipment with IT&S director.
5. Device Outlet Design Guidelines:
    a. Typical outlet for PC, printer, kiosk, etc. For typical outlet location where outlet is easily accessed in the future the minimum number of cables/ports per outlet shall be two. The intent is to provide enough connections for the required equipment plus one additional port/cable.
    b. Wallphone outlet: One port/cable required.
    c. Wall mounted computer enclosure (i.e. proximity cabinet): One port/cable required.
    d. Wall mounted monitor: One port/cable required.
    e. Employee time clock: One port/cable required.
    f. Floor mounted copier: Two ports/cables required.
6. Rough in box for standard outlets shall be a standard dual gang, 2 ½ inch deep, rough in electrical box equipped with a single gang finish ring.

7. Rough in box for wall mounted monitors (tracker and/or Information) shall be recessed flat panel rough in box (Hubbell Part Number NSAV62M).
8. Minimum conduit size shall be 1 inch trade size.

3.4 IT&S Wireless Data Networks.

A. General:
   1. There will be a wireless data network throughout the facility that includes wireless access points and associated cabling infrastructure.

B. Cable Infrastructure Design Guidelines:
   1. Cabling infrastructure shall be Cat 6a.
   2. Cable jacket shall be yellow. Jack color shall be black.
   3. Cable shall be supported using wall mount or suspended snake tray. Cable shall only be allowed share supports and sleeves with Cat 6 IT&S data/voice network cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
   4. Within the telecommunication space cabling shall be terminated on 24 or 48 port rack mounted dedicated patch panels. Telecommunications engineer shall coordinate exact configuration of rack mounted equipment with IT&S director.
   5. Device Outlet Design Guidelines:
      a. Wireless survey to determine exact placement of wireless access points shall be conducted after the ceilings and doors have been installed. Telecommunication engineer shall show two wireless ports/cables, with a minimum of 30 feet coiled up, every 25 feet within the main corridors as a staging location for the cables. Once wireless survey is completed by IT&S the cabling contractor is responsible for relocating each cable from the staging location to the final access point location.
      b. Majority of final wireless access points will be located within lay-in accessible ceiling type where a rough in box and conduit are not required. If an access point is located within a hard lid inaccessible ceiling area or on the exterior a rough in box will be required. Rough in box shall be a standard dual gang, 2 ½ inch deep, rough in electrical box equipped with a single gang finish ring.
      c. Minimum conduit size shall be 1 inch trade size.

3.5 Physiological/Fetal/Telemetry Monitoring Networks.

A. General:
   1. Devices including, but not limited to: Bedside physiological/fetal monitors, central stations, slave monitors, mirror monitors, etc.
   2. It shall be the responsibility of the telecommunication engineer to coordinate requirements with medical equipment and system vendor for all requirements required for the project. All requirements shall be shown on telecommunication plans and specifications. Any vendor created drawings used for the purpose of gathering information shall not be issued to the contractor.

B. Cable Infrastructure Design Guidelines:
   1. Cat 6 Cabling Infrastructure:
      a. Cabling infrastructure shall be Cat 6 for all physiological and fetal monitoring outlets.
      b. Cat 6 Cable Jacket and jacks shall be orange.
      c. Cat 6 Cable shall be supported using J-hook style cable supports. Monitoring cable shall not share supports and sleeves with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
      d. Within the telecommunication space cabling shall be terminated on 24 or 48 port rack mounted dedicated patch panels. Telecommunications engineer shall coordinate exact configuration of rack mounted equipment with IT&S director.
      e. Device Outlet Design Guidelines:
         i. Typical Outlet for Central monitor or workstation: Four ports/cables required
         ii. Bedside Monitor Outlet: Two ports/cables required.
         iii. Fetal Monitor Outlet: Two ports/cables required.
         iv. Monitoring network jacks shall be allowed to share outlet faceplate with IT&S data network jacks.
         v. Rough in box shall be a standard dual gang, 2 ½ inch deep, rough in electrical box equipped with a single gang finish ring.
         vi. Minimum conduit size shall be 1 inch trade size.
   2. Coax Cabling Infrastructure:
      a. Majority of telemetry cabling will be RG6/RG11/Hardline coax cable. It shall be the responsibility of the telecommunications

engineer to coordinate exact requirements with telemetry vendor.

b. Majority of the telemetry coax cable will be provided by the vendor to be installed by the contractor. Telemetry vendor shall terminate and test all telemetry coax cables.

c. Coax Cable shall be supported using J-hook style cable supports. Telemetry coax cable shall not share supports with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable shall be installed within dedicated supports.

d. Within the telecommunication space cabling shall be terminated on the wall of the telecommunication space by the monitoring vendor.

3.6 CATV Networks.

A. General:

1. Devices including: TV sets, mounts, signal amplifiers, signal splitters/combiners, associated cabling, etc.

2. It shall be the responsibility of the telecommunication engineer to coordinate requirements with medical equipment and system vendor for all requirements required for the project. All requirements shall be shown on telecommunication plans and specifications. Any vendor created drawings used for the purpose of gathering information shall not be issued to the contractor.

B. Cable Infrastructure Design Guidelines:

1. General: CATV network cabling infrastructure shall consist of RG6/RG11 coax cable and Cat 6 cable.

2. Cat 6 Cabling Infrastructure:

a. Cabling infrastructure shall be Cat 6 for all CATV data outlets.

b. Cat 6 Cable jacket and jacks shall be blue.

c. Cat 6 Cable shall be supported using J-hook style cable supports. CATV cable shall only be allowed to share supports with CATV coax cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.

d. Within the telecommunication space cabling shall be terminated on 24 or 48 port rack mounted dedicated patch panels. Telecommunications engineer shall coordinate exact configuration of rack mounted equipment with IT&S director.

3. Coax Cabling Infrastructure:
    a. CATV coax horizontal cabling shall be RG6. Coax cable shall originate from the telecommunication space and end at the TV outlet without any splices or taps in between.
    b. Majority of CATV backbone cable shall be RG11. There will be circumstances that require single mode fiber to be used as the CATV backbone. It is the responsibility of the telecommunications engineer to determine the exact requirement.
    c. Coax Cable shall be supported using J-hook style cable supports. CATV cable shall only be allowed to share supports with CATV data cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
    d. Within the telecommunication space cabling shall be terminated on the wall of the telecommunication space by the CATV vendor.
4. Device Outlet Design Guidelines:
    a. Typical Outlet for CATV outlet located outside patient care areas: One Cat 6 data and one RG6 coax cable.
    b. Anywhere TV will be controlled by nurse call controls CATV outlet shall include a nurse call control outlet/cable along with Cat 6 data and coax cables.
    c. Contractor shall be responsible for terminating and testing all Cat 6 cabling. Contractor is responsible for terminating RG6 coax cable at the TV outlet only. CATV vendor will terminate the coax cable within the telecommunication space and perform all test. Contractor responsible for terminating Nurse Call to TV control cable at the TV outlet. Nurse call vendor will terminate control cable at the nurse call device.
    d. Rough in box for wall mounted TV's shall be recessed flat panel rough in box (Hubbell Part Number NSAV62M).
    e. Minimum conduit size shall be 1 inch trade size.

3.7 CCTV Data Networks.

A. General:

1. Security and observation cameras and associated cabling infrastructure.

2. It is the responsibility of the architect and telecommunication engineer to coordinate camera locations based on the latest HCA Healthy Work Environment (HWE) guidelines and coordination with facility security personnel and/or safety officer.
3. System shall utilize CISCO IP camera solution.
4. HCA IT&S will contract directly with a vendor that will install all cameras, mounts, and other associated active equipment.

B. Cable Infrastructure Design Guidelines:

1. Cabling infrastructure shall be Cat 6.
2. Cable jacket and jack shall be black.
3. Cable shall be supported using wall mount or suspended snake tray. Cable shall only be allowed to share supports and sleeves with Cat 6 IT&S data/voice network cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
4. Within the telecommunication space cabling shall be terminated on 24 or 48 port rack mounted dedicated patch panels. Telecommunications engineer shall coordinate exact configuration of rack mounted equipment with IT&S director.
5. Device Outlet Design Guidelines:
    a. Majority of final interior camera locations will be located within lay-in accessible ceiling type where a rough in box and conduit are not required. If a camera is located within a hard lid inaccessible ceiling area a rough in box will be required. Rough in box shall be a standard dual gang, 2 ½ inch deep, rough in electrical box equipped with a single gang finish ring.
    b. Rough in for standard exterior cameras shall be dual gang, 2 ½ inch deep, rough in weatherproof electrical box equipped with a single gang finish ring. Conduit shall be ran from box to interior of the building and stub above accessible ceiling space. Box opening shall be flush with the surface. Camera vendor will install camera and weatherproof seal over box opening.
    c. Rough in for exterior cameras within a parking garage or central utility plant shall be dual gang, 2 ½ inch deep, rough in weatherproof electrical box equipped with a single gang finish ring. Conduit shall be ran from box to telecommunication space or enclosure within the parking garage. Box and conduit allowed to be surface mounted within the garage.
        i. For exterior cameras that will have cabling that exceeds 300 feet there shall be an 8 inch square by 4 inch deep NEMA 3R

box included in the rough in for the camera. Box will house POE extender device provided by camera vendor. Box needs to be located a close as possible to final camera location.

d. Rough in for pole mounted cameras, such as exterior parking lots, shall be roughed in using an 8 inch square by 4 inch deep NEMA 3R box mounted to the pole. One inch conduit shall be routed from the NEMA 3R box to the nearest TR/IDF/TE located within the interior of the building. Cable will be terminated within NEMA 3R box. Camera vendor will provide all cameras, mounts and patch cord between camera and NEMA 3R box.

   i. There may be a circumstance where parking lot is remote and cameras cannot be connected to an existing building. in these situations the use of an exterior telecommunication enclosure may be needed. It's the responsibility of the telecommunications engineer to determine exact requirement based on project conditions.

e. Minimum conduit size shall be 1 inch trade size.

3.8 Nurse Call Networks

A. General:

1. It shall be the responsibility of the telecommunication engineer to coordinate requirements with medical equipment and system vendor for all requirements required for the project. All requirements shall be shown on telecommunication plans and specifications. Any vendor created drawings used for the purpose of gathering information shall not be issued to the contractor.
   a. Telecommunication drawings to include all rough in requirements, cable types and wiring schematic information.
2. Contractor is responsible for providing and installing all cabling for the nurse call system. Nurse call vendor shall terminate all cables, provide/install devices and conduct functional test.
3. Nurse call within overnight patient rooms shall include control connection between the nurse call system and over bed lights. This includes a low voltage control relay provided by the lighting contractor. Landing of the nurse call control cable to the light control relay shall be the responsibility of the lighting contractor. Nurse call vendor shall land the other end of cable to the nurse call device.
4. In patient exam, holding and overnight rooms that include TV's there shall be a control connection between the nurse call system and TV outlet. Landing of the nurse call control cable to the TV outlet shall be

the responsibility of the cabling contractor. Nurse call vendor shall land the other end of cable to the nurse call device.

B. Cable Infrastructure Design Guidelines:

1. Cabling Infrastructure:

   a. Majority of cabling infrastructure for nurse call shall be Cat 5e. There will be some other low voltage control cables used for power and other controls. Telecommunication floor plans shall show all cable types and schematics.

   b. Cable jacket shall be green.

   c. Cable shall be supported using J-hook style cable supports. Nurse call cable shall not share supports and sleeves with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.

   d. Within the telecommunication space some nurse call systems will be terminated on rack mounted patch panels and others will use a wall mounted cabinet. Telecommunications engineer shall coordinate exact requirement with nurse call vendor and show direction on telecommunication plans and specifications.

2. Device Outlet Design Guidelines:

   a. Rough in boxes used for nurse call vary depending on the device being installed. It's the responsibility of the telecommunication engineer to coordinate rough in requirements with nurse call vendor and show on the telecommunication plans.

   b. Nurse call cables are terminated and tested by the nurse call vendor.

   c. Minimum conduit size shall be ¾ inch trade size.

3.9 RTLS/RFID Networks.

A. General:

1. Staff and/or equipment tracking system that that includes a variety of ceiling mounted devices and associated cabling infrastructure.

2. It is the responsibility of the architect and telecommunication engineer to coordinate system requirements with system vendor and cover all requirements on the telecommunication plans and specifications.

3. HCA will contract directly with a vendor that will install all associated active equipment. Cabling shall be installed by the contractor.

Termination responsibility shall be coordinated with the system vendor and covered on the telecommunication plans and specifications.

B. Cable Infrastructure Design Guidelines:

1. Majority of cabling infrastructure for RTLS/RFID shall be Cat 6. There will be some other low voltage control cables used for power and other controls. Telecommunication floor plans shall show all cable types and schematics.
2. Cable Jacket and jack shall be purple/violet.
3. Cable shall be supported using J-hook style cable supports. RTLS/RFID cable shall not share supports and sleeves with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
4. Within the telecommunication space the telecommunication engineer shall coordinate the exact termination requirements with the system vendor and cover within the telecommunication plans and specifications.
5. Device Outlet Design Guidelines:
    a. Majority of final RTLS/RFID locations will be located within lay-in accessible ceiling type where a rough in box and conduit are not required. If a device is located within a hard lid inaccessible ceiling area a rough in box will be required. Rough in box shall be a standard dual gang, 2 ½ inch deep, rough in electrical box equipped with a single gang finish ring.
    b. Telecommunication engineer shall coordinate required scope for contractor with system vendor and cover requirements on telecommunication plans and specifications.
    c. Minimum conduit size shall be ¾ inch trade size.

3.10 Distributed Antenna System (DAS/Cell Boosting) Design Guidelines:

A. General:

1. System used to amplify cell phone coverage within the interior of the building consisting of ceiling mounted antennas, amplifiers and associated cabling infrastructure.
2. It's the responsibility of the architect and telecommunication engineer to coordinate system requirements with system vendor and cover all requirements on the telecommunication plans and specifications.
3. HCA IT&S will contract directly with a vendor that will install all associated active equipment. It is the preference of HCA for the cabling to be installed by the contractor. Contractor responsibility shall

be coordinated with the system vendor and covered on the telecommunication plans and specifications.

B. Cable Infrastructure Design Guidelines:

1. Cable shall be supported using J-hook style cable supports. DAS cable shall not share supports and sleeves with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.

2. Within the telecommunication space the telecommunication engineer shall coordinate the exact termination requirements with the system vendor and cover within the telecommunication plans and specifications.

EQUIPMENT AND SYSTEMS GUIDELINES – TELECOMMUNICATIONS

SECTION 27 05 26 – GROUNDING AND BONDING FOR TELECOMUNICATION SYSTEMS

Part 1 - General

HCA is electing at this time to not provide guidelines.

Part 2-Products

HCA is electing at this time to not provide guidelines.

Part 3 - Execution

HCA is electing at this time to not provide guidelines.

SECTION 27 05 28 - PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

Part 1 - General

1.1 Section Includes:

A. Conduit and outlet boxes

B. Cable tray

C. Non-continuous cable supports

D. Sleeves

Part 2-Products

2.1 Conduit And Outlet Boxes

A. General Requirements for Metal Conduits and Outlet Boxes:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-D.
3. Flexible metal conduit shall not be used.
4. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

B. General Requirements for Non-Metallic Conduits.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-758-B

C. Recessed flat panel monitor style rough in box: Hubbell part number NSAV62M.

2.2 Cable Tray

A. General Requirements for cable tray:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-D.

B. Manufacturers: provide products by one of the following:

1. Cable Management Solutions

C. Description:

1. Wall Mount: Attaches directly to a wall without additional mounting brackets.
2. Vertical rod Mount: Pathway designed in such a way as to be secured to the structure using a minimum 3/8-inch diameter rod every four (4) feet via built-in integrated vertical mounting rings.

D. Sizes:

1. Straight sections shall be furnished in standard lengths.
2. Wall Mount:
   a. 5-inch usable loading depth by 5 inches wide. CMS part number CM 501-5-8.
   b. 6-inch usable loading depth by 6 inches wide. CMS part number CM 501-6-8.
3. Vertical Rod Mount:
   a. 4-inch usable loading depth by 6 inches wide. CMS part number CM 201-6-8.
   b. 5-inch usable loading depth by 10 inches wide. CMS part number CM 201-5D-8.

E. Fittings: of same materials and finishes as cable tray of same manufacturer.

F. Cable tray supports and connectors, including bonding jumpers, as recommended by manufacturer.

2.3 Non-Continuous Cable Supports

A. Manufacturers: provide products by one of the following:

1. Caddy
2. Cooper B-Line
3. Or preapproved equal

B. General Requirements: Comply with TIA-569-D.

C. Description: J-Hook Style Cable Support NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

2.4 Sleeves

A. Sleeves for pathway and cable penetration of non-fire-rated construction walls.

1. General Requirements: Comply with TIA-569-D.
2. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   a. Galvanized-steel EMT conduit.
   b. Fitted with plastic bushings.

B. Sleeves for pathway and cable penetration of fire-rated construction walls.

1. Manufacturers: provide products by one of the following:
   a. Hilti
   b. STI
2. General Requirements:
   a. Comply with TIA-569-D.
   b. It shall be the responsibility of the telecommunications engineer to confirm with the facility what is being used currently within the facility.
   c. Description: Enclosed fire rated cable management device. Contains integrated intumescent firestop materials sufficient to maintain the hourly rating of the barrier being penetrated.
   d. 2" Sleeve:
      i. Hilti Speed Sleeve part number 2008603

ii. STI EZ-Path part number EZD22

e. 4" Sleeve:

i. Hilti Speed Sleeve Part Number 2008604

ii. STI EZ-Path part number EZD44S2

Part 3 - Execution

3.1 Installation

A. General

1. Separation from EMI Sources:

a. Comply with BICSI TDMM and TIA-569-C for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

i. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

ii. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

iii. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

i. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

ii. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

iii. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

i. Electrical Equipment Rating Less Than 2 kVA: No requirement.

ii. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

            iii. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

    e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
    f. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 6 inches.

B. Conduit And Outlet Boxes

1. General Requirements:
    a. Comply with NECA 1, NECA 101, TIA-758-B, and TIA-569-D for installation requirements except where requirements on drawings are stricter.
    b. Comply with NFPA 70 limitations for types of pathways allowed.
    c. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
    d. No single conduit bend shall be greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull boxes.
    e. Conduits shall be bonded to ground on one or both ends in accordance with AHJ.
    f. Conduits that penetrate through the structural floor shall protrude a minimum 3 inches above the finished floor.
    g. Pull boxes shall not be used in lieu of a conduit bend.
    h. Conduits entering opposite sides of a pull box shall be aligned.
    i. Install pull string in empty pathways. Use line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
2. Metallic Conduit:
    a. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
    b. Flexible metal conduit shall not be used.
    c. Conduits shall contain no continuous sections longer than 100 feet.
    d. All conduit ends shall be reamed and fitted with plastic bushings to prevent cable damage.
    e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated.

f. Install conduits parallel or perpendicular to building lines.

3. Non-Metallic Conduit:
   a. Comply with TIA-758-B.
   b. Conduits shall contain no continuous sections longer than 600 feet
   c. Underground conduit shall include a drain slope, equal to 0.125 inch per foot, away from the building/handhole/manhole being served.
   d. Conduits shall be encased in concrete when placed where vehicular traffic will be present.
   e. Underground conduit shall terminate within the telecommunication space.
   f. Warning tape and locate wire shall be installed above conduit duct bank.
   g. Handholes/manholes/vaults shall be sized as needed based on the pathway it serves.
   h. Any covers and/or lids shall be labeled "Telecommunications".
4. Stub-ups to Above Accessible Ceilings:
   a. Devices located within hard lid areas, or inaccessible ceiling, shall be piped to above the nearest accessible ceiling space.
   b. Use a conduit bushing to terminate stub-ups.
   c. Minimum Pathway Size: 3/4-inch trade size. Contract drawings shall include legend for device type and required stub up size.
      i. Voice/data: Minimum stub up size shall be 1"
      ii. Nurse Call: Minimum stub up size shall be ¾"
      iii. CCTV Camera: Minimum stub up size shall be 1"
      iv. Audio Visual: Minimum stub up size shall be 1"
      v. RFID/RTLS: Minimum stub up size shall be ¾"
      vi. Physiological Monitoring Data: Minimum stub up size shall be 1"
5. Conduit Pathways Above Hard Lid ceiling areas:
   a. EMT conduit shall be used for cable pathway above inaccessible ceiling areas spanning greater than 8 feet.
   b. Conduit size and quantity shall be based on present needs plus 30% future capacity.
      i. EMT conduit shall have a maximum final fill ratio of 40%.

c. Contract drawings shall indicate location, size and quantity.

6. Outlet Boxes:

   a. Outlet boxes shall be no smaller than 2-1/2 inches deep standard four square dual gang back box equipped with a single gang mud ring. Contract drawings shall include legend for device type and required back box.

   b. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not indicated, priority shall be given to ADA requirements.

   c. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

   d. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

   e. Set floor boxes level with finished floor surface.

   f. Recessed flat panel monitor style rough in box shall be used for all wall mounted TV and monitor locations.

C. Snake Tray

1. General Requirements:

   a. Install snake trays according to NEMA VE 2.

2. Contract drawings to include details of routing.

3. Snake trays shall be designed and installed as a complete system, including fasteners, support systems, and bonding.

4. Install snake trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

5. Locate a minimum of 8 inches above ceilings, lights and other ceiling mounted devices.

6. Design fasteners and supports to carry snake tray, the cables, and a concentrated load of 200 lbs.

7. Do not install more than one snake tray splice between supports.

8. Make snake tray connections using manufacturer's recommended fittings.

9. Snake tray shall be sized not to exceed a 40% fill ratio based on present needs. Provide additional snake tray where fill ratio is exceeded.

10. Wall snake tray to be preferred method of cable supports. Where wall mount isn’t applicable provide vertical rod mounted snake tray.

11. Field verification required prior to installation.

D. Non-Continuous Cable Supports

1. General Requirements:
    a. Comply with TIA-569-C.
    b. Material: Steel, pre-galvanized.
2. Size not to exceed a 40% fill ratio based on present needs.
3. Locate a minimum of 8 inches above ceilings.
4. Locate no more than 60 inches between j-hooks. Install additional j-hooks as needed to minimize cable sag.

E. Sleeves

1. General Requirements:
    a. Comply with TIA-569-C
    b. Sleeves shall be located that they are in line with the cable pathway being served.
    c. Sleeves shall be located a minimum of 8 inches above ceilings, lights and other ceiling mounted devices measured from the bottom of the sleeve.
    d. Contract drawings shall include size, type, quantity and location of all required sleeves.
2. Hilti Speed Sleeves and STI EZ-Path Sleeves:
    a. Hilti speed sleeves or STI EZ-Path sleeves used for main cable pathway down corridors shall be 4” Minimum. Quantity shall be based on present needs plus 30% growth capacity.
    b. Hilti speed sleeves or STI EZ-Path sleeves used for cable pathway once cable leaves main cable pathway shall be sized not to exceed an 85% fill ratio based on present needs.
    c. Provide Hilti speed sleeves or STI EZ-Path sleeves when penetrating rated partitions.
    d. Sleeves shall be installed per manufacturer’s specifications using the in wall gang plate and accessories where applicable.
3. EMT Sleeves:
    a. For locations that Hilti Speed sleeves or STI EZ-Path sleeves can’t be used when penetrating a rated partition, use EMT metal conduit. Use fire caulk and putty to obtain a fire rating that of which of the barrier being penetrated.
    b. EMT shall be reamed free of burrs and equipped with a plastic bushing on each end to prevent cable damage.

c. EMT sleeves to be used for all non-rated penetrations. Insert filler material around cables and sealant around outside of conduit to create an air dam.

d. EMT Sleeves shall protrude a minimum 3 inches on both sides of wall being penetrated.

e. EMT sleeves to be used for vertical cable pathways through floors. Sleeves to extend a minimum of 3" above finished floor. Use fire caulk and putty to obtain a rating that of which of the barrier being penetrated.

3.2 Cable Support Outline

System	Cable color	Support Type	Ceiling Zone	Notes	S= Shared NS=Not Shared
Voice	Black	S-1 & J-5	1	Cat 6 for telephone, fax, analog, VOIP.	S
Data	Black	S-1 & J-5	1	Cat 6 for IT&S network needs: PC, Printers, scanners, time clocks, PACS	
CCTV (security & clinical)	Black	S-1 & J-5	1	Cat 6 for CCTV cameras.	
WAP	Yellow	S-1 & J-5	1	Cat 6a for wireless access points (WAPS). Wi-Fi	
Physiological Monitoring (hardwired)	Orange	J-2 & J-5	1	Cat 6 for hard wired physiological monitoring (PM), central stations, remote view monitors, fetal monitors	NS
Telemetry coax (wireless)	White	J-3	2	RG6/RG11/hardline coax cable for wireless telemetry devices mounted to underside of ceiling.	NS
CATV coax	Black	J-4 & J-5	2	RG6/RG11 coax cable for TV system	S
CATV Data	Blue	J-4 & J-5	2	Cat 6 for TV system	
Nurse Call	Green	J-2 & J-5	1	Cat 5e and mix of low voltage control cabling for nurse call system	NS
RFID/RTLS	Purple	J-3	2	Cat 5e, Cat 6 and/or low voltage control cabling for equipment/staff locating/tracking system.	NS
Infant Abduction	White	J-3	2	Cat 5e, Cat 6 and/or low voltage control cabling for infant abduction system	NS
Wondering System	White	J-3	2	Cat 5e, Cat 6 and/or low voltage control cabling for wondering patient tracking system	NS
Overhead Paging	Grey	J-3	3	Low voltage audio cable for speakers, AMPS, microphones, etc.	NS

System	Cable color	Support Type	Ceiling Zone	Notes	S= Shared NS=Not Shared
Distributed Antenna System (DAS)	White	J-3	3	Coax cable for distributed antenna system (DAS). Cell boosting and/or emergency responder radio	NS
EMS radio	White/Black	J-3	3	Coax cable for communication between EMS and ED staff	NS
BAS	White/Grey	J-3	2	Low voltage control wiring for building automation controls.	NS
Intercom	Grey	J-4	2	Low voltage control cabling for intercom devices such as aiphones.	S
Electronic Access Control	White	J-4	2	Low voltage control cable for electronic access control system. Card readers, mag locks, etc.	
Data Fiber Backbone	Yellow	J-1	3	Fiber Optic cable used for network backbone infrastructure.	S
Data Copper Backbone	Yellow	J-1	3	Multi-pair copper cable used for analog/digital telephony backbone infrastructure.	

Ceiling Zone Description	Ceiling Zone #
Easily accessible for frequent moves, adds, and changes. Majority of pathway is under most all other systems.	1
Not as easily accessible as Zone #1 but still accessible for moves, adds, and changes. Pathway may be routed above some systems but still accessible using normal means. Zone 2 would be considered above Zone #1.	2
Not easily accessible. Systems that are not regularly accessed or modified. Majority of pathway can be located above all systems.	3

Support	Support Description
S-1	Main cable pathway down corridors. Snake tray mounted to wall or suspended from overhead structure. Should be sized for present needs plus 30% future capacity. Can support multiple systems as outlined.
J-1	Main cable pathway down corridors. J-hook style support either wall mounted or supported from overhead structure. Should be sized based on present need plus 30% future capacity. Can Support multiple systems as outlined.
J-2	Main cable pathway down corridors. J-hook style support either wall or ceiling mounted from overhead structure. Should be sized for present needs plus 30% future capacity. Should be dedicated to one system.

Ceiling Zone Description	Ceiling Zone #	Support	Support Description
		J-3	Main cable pathway down corridors. J-hook style support either wall or ceiling mounted from overhead structure. Should be sized for present needs with no future capacity. Should be dedicated to one system.
		J-4	Main cable pathway down corridors. J-hook style support either wall or ceiling mounted from overhead structure. Should be sized for present needs plus 30% future capacity. Can support multiple systems as outlined
		J-5	J-hook style supports used to route cabling from main cable pathway within corridors to outlet location within rooms. Support may support all low voltage cabling, unless required otherwise, that is being routed into the same rooms.

SECTION 27 11 00 - TELECOMMUNICATIONS SPACE EQUIPMENT AND FITTINGS

Part 1 - General

1.1 Section Includes:

A. Plywood backboards

B. Telecommunication equipment racks

C. Telecommunication enclosure

D. Cable management

E. Telecommunication space overhead cable support

1.2 Definitions:

A. Telecommunication Space: room or space dedicated to serving telecommunication equipment and infrastructure. Telecommunication Room (TR/IDF), Telecommunication Equipment Room (TER/MDF), Telecommunication Entrance Facility (EF/DEMARC), and Telecommunication Enclosure (TE) are all considered Telecommunication Spaces.

Part 2-Products

2.1 Plywood Backboards:

A. AC Grade ¾ inch thick fire retardant plywood.

B. Manufacturer fire rating stamp shall be on the "A" side.

2.2 Telecommunication Equipment Racks:

A. Manufacturer:

1. Belden

B. General Requirements:

1. Freestanding, modular-aluminum units designed for mounting of telecommunication equipment.
2. Mounting Rail Dimension: Width compatible with EIA 310-D standard, 19-inch mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat. Black in color.
4. Floor-Mounted Racks:
    a. Two Post 19" equipment rack: Belden Part Number BHRR194.
    b. Adjustable Depth Four Post 19" equipment rack. Belden Part Number XDR8419-3M62836.

2.3 Telecommunication Enclosure:

A. General Requirements:

1. Wall/Pole mounted enclosure designed for mounting of telecommunication equipment.
2. Mounting Rail Dimension: Width compatible with EIA 310-D standard, 19-inch mounting.

B. Interior Wall Mounted Enclosure:

1. Welded steel 20RU enclosure equipped with solid lockable door and ventilation fan. Double Hinged. Belden Part Number XWM-2320-SD.
2. Ventilation Fan Assembly: Belden Part Number XWM-9312-1600.

C. Harsh Environment Interior Telecommunication Enclosure:

1. NEMA 3R rated 19RU enclosure equipped with solid lockable door, rear wood mounting panel and ventilation fan. Double hinged. Hoffman Part Number PTHS242424G3
2. Rear Mounting Wood Panel: Hoffman Part Number CP3220W.

2.4 Cable Management:

A. Manufacturer:

1. Belden

B. Vertical Cable Management:

1. Double sided with covers.
2. 6" wide vertical cable manager: Belden Part Number BHVHH06.
3. 3" wide vertical cable manager: Belden Part Number BHVHH03.

C. Horizontal Cable Manager:

1. Width compatible with standard, 19-inch panel mounting.
2. 1RU Horizontal manager with hinged cover: Belden Part Number BHH191UR.
3. 2RU Horizontal manager with hinged cover: Belden Part Number BHH192UR.

2.5 Telecommunication Space Overhead Cable Support:

A. Manufacturer:

1. WBT

B. Description:

1. Cable tray will consist of continuous, rigid, welded steel wire mesh. Finish shall be standard manufacturer's black powder coating.
2. All accessories shall be by same manufacturer.
3. Width shall be 12 inches, 18 inches and 24 inches.
4. Height shall be 2 inches.

C. Straight Sections:

1. 12 Inches wide x 2 inches tall: WBT Part Number WBT2X12SBL
2. 18 Inches wide x 2 inches tall: WBT Part Number WBT2X18SBL
3. 24 Inches wide x 2 inches tall: WBT Part Number WBT2X24SBL

D. Accessories:

1. 6 inch Wide cable drop out radius: WBT Part Number Radius Down 6.

Part 3 - Execution

3.1 General: Communication enlarged drawings and elevations shall show location of all equipment racks, pathways, overhead cable supports, backboards, power outlets, wire management, lights/switches, thermostat, mechanical supply/return, wall/floor sleeves, and all wall mounted equipment within the telecommunication space for coordination in the field.

A. Low voltage designer shall work with facility IT&S director for equipment layout within the telecommunication space. Discussion shall include exact equipment mounting elevations for equipment racks and telecommunication enclosures. Enlarged communication elevation drawings shall include details on mounting location for all rack mounted equipment such as patch panels and wire management.

B. Communication enlarged drawings shall include vertical and horizontal dimensions.

C. All other trade drawings including, but not limited to, electrical power/lighting, mechanical, fire alarm shall have reference to communication enlarged drawings for exact locations of all equipment.

3.2 Plywood Backboards:

A. Plywood backboard shall be mounted on all interior walls of the Telecommunication Room from finished floor to 8 feet above finished floor.

B. Mounted with the grade "A" side facing out.

C. Manufacturer's stamp visible on the "A" side.

D. Be securely fastened using flush hardware to wall framing studs.

E. If painting is required provide two-coats of fire retardant paint on the grade "A" side. Paint color shall be light in color to enhance room lighting.

1. Manufacturer's fire rating stamp shall be left unpainted to facilitate inspection.

3.3 Telecommunication Equipment Racks:

A. Racks shall be secured to building structure per manufacturer's recommendations and AHJ.

B. Racks shall be placed to allow for clearances for working access.

1. Front Clearances: Minimum distance from front most part of equipment rack, or associated wire management to the nearest wall or wall mounted equipment shall be 3 feet.

2. Rear Clearances: Minimum distance from rear most part of equipment rack, or associated wire management, to the nearest wall or wall mounted equipment shall be 5 feet.

C. Grounding:

1. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Telecommunications Systems" for grounding conductors and connectors.

2. Each equipment rack shall be grounded to the ground buss bar within the same room.

3.4 Telecommunication Enclosure:

A. Telecommunication enclosures shall be wall mounted per manufacturer's instructions.

B. NEMA 3R enclosure shall be used for harsh environments such as parking garages and utility plants.

C. Grounding:

1. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Telecommunications Systems" for grounding conductors and connectors.
2. Enclosure and internal mounting rails shall be grounded.

3.5 Wire Management:

A. Vertical Wire Management:

1. Six inch wide double sided vertical wire managers shall be used between equipment racks.
2. Three inch wide double sided vertical managers shall be used at the end of each equipment rack row.

B. Horizontal Wire Management:

1. Equipment racks shall include a variety of horizontal wire management configurations. The low voltage designer and contractor shall be responsible for providing the horizontal wire management configuration based on discussions with facility IT&S director.

3.6 Telecommunication Space Overhead Cable Support

A. General Requirements:

1. Install trays according to NEMA VE 2.
2. Tray shall be designed and installed as a complete system, including fasteners, support systems, and bonding.
3. Install tray so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
4. Locate a minimum of 4 inches above equipment racks.
5. Secure to top of equipment racks and/or cabinets using rack attachment hardware.
6. Make tray connections using manufacturer's recommended fittings.

B. Overhead cable support shall be routed around the perimeter of the telecommunication space and over equipment rack row.

1. Overhead cable support shall be mounted off wall a minimum of 6 inches to allow for wall mounted cable, conduit and other items to be attached to wall without affecting overhead cable support.

C. Overhead cable support shall include cable drop out above all vertical wire managers for cable transition from tray to equipment racks.

D. Grounding:

1. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Telecommunications Systems" for grounding conductors and connectors.
2. Overhead cable support tray shall be grounded to nearest ground buss bar per manufacturer's recommendations.

SECTION 27 13 00: TELECOMMUNICATIONS BACKBONE CABLING

Part 1 - General

1.1 Section Includes:

A. Single mode fiber optic cable

B. Coax cable used for CATV signal

C. Category 3 copper backbone cable used for analog and digital phone signal.

1.2 Definitions:

A. Backbone Cable: Backbone cabling system shall provide interconnections between telecommunication spaces

Part 2-Products

2.1 Category 3 Copper Backbone:

A. Cable:

1. Unshielded Twisted Pair (UTP):
    a. Category 3 UTP 25 Pair:
        i. CMR: Belden Part Number DIW25
        ii. CMP: Belden Pat Number DPLN25
    b. Category 3 UTP 50 Pair:
        i. CMR: Belden Part Number DIW50
        ii. CMP: Belden Pat Number DPLN50
    c. Category 3 UTP 100 Pair:
        i. CMR: Belden Part Number DIW100
        ii. CMP: Belden Pat Number DPLN100
2. Shielded Twisted Pair Outdoor Cable:
    a. Category 3 Outdoor 25 Pair: General Cable Part Number 7524648, or preapproved equal.
    b. Category 3 Outdoor 50 Pair: General Cable Part Number 7524655, or preapproved equal

c. Category 3 Outdoor 100 Pair: General Cable Part Number 7524671, or preapproved equal

B. Cable Termination Hardware:

1. Voice Connecting Blocks: 110-style IDC.

a. 100 pair connector block equipped with 5 pair connector blocks: Belden part number AX100694-S.

b. 300 pair connector block equipped with 5 pair connector blocks: Belden part number AX100696-S.

2. Patch Panel:

a. Cat 5e 48 Port Patch panel: Belden Part Number AX103259

b. Cat 5e 24 Port Patch panel: Belden Part Number AX103258

3. Building Entrance Protector Block: 110-style IDC.

a. 25 pair entrance protector: Circa Part Number 1880ECA1-25

b. 50 pair entrance protector: Circa Part Number 1880ECA1-50

c. 100 pair entrance protector: Circa Part Number 1880ECA1-100

2.2 Single Mode Optical Fiber Backbone Cable

A. Cable:

1. Inner-locking armored indoor fiber optic cable.

~~a. 24 Strand Plenum Rated armored fiber: Belden Part Number FISD024A9~~

~~b.~~a. 48 Strand Plenum Rated armored fiber: Belden Part Number FISD048AK

~~c. 96 Strand Plenum Rated armored fiber: Belden Part Number FISD096AK~~

2. Armored Indoor/Outdoor rated fiber optic cable.

~~a. 24 Strand Indoor/Outdoor Rated armored fiber:~~

~~i. CMR: Belden Part Number FDSD024F9~~

~~ii. CMP: Belden Part Number FDSD024A9~~

~~b.~~a. 48 Strand Indoor/Outdoor Rated armored fiber:

~~i. CMR: Belden Part Number FDSH0485G~~

~~ii.~~i. CMP: Belden Part Number FDSD048P~~A~~K

~~c. 96 Strand Indoor/Outdoor Rated armored fiber:~~

~~i. CMR: Belden Part Number FDSH0965G~~

~~ii. CMP: Belden Part Number FDSD096AK~~

B. Cable Termination Hardware:
   1. Fiber Connectors. LC-Type. Field installable: Belden Part Number AX105203.
   2. Patch Panels: 19” rack mountable equipped with fiber adapter panels.
      a. 1RU patch panel: Belden Part Number AX105563
         i. Fiber Adapter Panels. LC-type 6 port duplex Belden part number FFSU06LD.
      b. 4RU patch panel: Belden Part Number AX100116
         i. Fiber Adapter panels. LC-Type high density duplex Belden Part Number AX101743.

2.3 Coax Backbone Cable

A. Cable: RG-11/U: NFPA 70, Type CATV. No. 14 AWG, solid, bare copper-covered steel conductor. Quad shielded with 100 percent bonded aluminum foil polyester tape, 60 percent aluminum braid, 100 percent aluminum foil polyester tape and 60 percent aluminum braid:
   1. CMR: Belden Part Number 7999A
   2. CMP: Belden Part Number 7999AP

Part 3 - Execution

3.1 General: Communication drawings shall include one-line drawing showing all telecommunication backbone cables and how they are to interconnect throughout the facility. Including type and quantity.

A. Comply with TIA-568-C.1.

B. Bundle, lace, and train cables to termination points without exceeding manufacturer's limitations on bending radii.

C. Do not install damaged cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

D. Install a service loop on each end of cable. Minimum 10 feet.

E. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Cable shall be supported independently of all other trades.

F. Separation from EMI Sources:
   1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.2 Category 3 Copper Backbone Cable Installation and Termination:

A. Comply with TIA-568-C.2.
B. Copper backbone cabling shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling areas.
C. Copper backbone cabling shall be installed within conduit pathways in areas where cable will be inaccessible.
D. Copper backbone cable is permitted to share cable supports with fiber backbone.
E. Copper backbone cable shall be terminated using 24 port or 48 port rack mounted patch panels within the telecommunication room (TR/IDF) or telecommunication enclosure (TE).
   1. One pair per port shall be terminated on pins 4-5, leaving the violet-slate pair unterminated.

F. Copper backbone cable shall be terminated using wall mounted 110-style termination hardware within the telecommunication equipment room (TER/MDF).

G. For underground exterior copper backbone requirements outside plant (OSP) cable shall be utilized.

   1. Entrance protector shall be provided on both ends of OSP copper cable.
   2. Entrance protector shall be located within the telecommunication space.
   3. OSP copper cable shall be routed within conduit between the telecommunication spaces.

H. Identification:

   1. All labels shall be computer generated white tape with black lettering.
   2. Exact labeling scheme shall be coordinated with facility IT&S director.
   3. Copper backbone cable shall be labeled on the cable within 4 inches of termination.
   4. Copper backbone cable patch panels, wall blocks and entrance protectors shall be labeled as to where the cable originates.

3.3 Optical Fiber Backbone Cable Installation and Termination:

A. Comply with TIA-568-C.3.

B. Fiber backbone cabling shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling areas.

C. Fiber backbone cabling shall be installed within conduit pathways in areas where cable will be inaccessible.

D. Fiber backbone cable is permitted to share cable supports with fiber backbone.

E. Fiber backbone shall be terminated using LC style connectors.

F. 1RU fiber patch panel shall be used for fiber termination within the telecommunication room (TR/IDF) or telecommunication enclosure (TE).

   1. Panel to be equipped with LC-style fiber adapter strips.
   2. Panel shall be equipped with blank adapter panels for empty panel slots.

G. 4RU fiber patch panel shall be used for fiber termination within the telecommunication equipment room (TER/MDF).

   1. Panel to be equipped with LC-style fiber adapter strips.

2. Panel shall be equipped with blank adapter panels for empty panel slots.

H. For all interior fiber runs interlocking armored fiber shall be used.

I. For underground exterior fiber connections indoor/outdoor rated fiber shall be used. Fiber to be installed within 1 inch plastic inner duct.

J. Any splicing required shall be done utilizing fusion style splicing mounted within an approved splice enclosure. Mechanical splices are not allowed.

K. Armored fiber shall be grounded on both ends to the nearest telecommunication ground buss bar per manufacturer's recommendations.

L. Identification:

1. All labels shall be computer generated white tape with black lettering.
2. Exact labeling scheme shall be coordinated with facility IT&S director.
3. Fiber optic cable shall be labeled on the cable within 4 inches of the panel.
4. Fiber optic cable patch panels shall be labeled as to where the cable originates.

3.4 Coaxial Backbone Cable Installation:

A. Coax backbone cabling shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling areas.

B. Coax backbone cabling shall be installed within conduit pathways in areas where cable will be inaccessible.

C. Coax backbone cable shall be supported independently of all other cable types and communication systems.

D. One coax backbone shall be installed from TV system headend to each TV junction (TVJ) location.

E. Termination and testing of coax backbone cable shall be performed by the TV system vendor. Contractor shall leave a minimum of 15 feet of slack at the TVJ location and labeling cable as to where it originates.

F. TVJ shall be wall mounted within the telecommunication space.

SECTION 27 15 00: TELECOMMUNICATIONS HORIZONTAL CABLE

Part 1 - General

1.1 Section Includes:

A. Category 5e, 6, and 6a cabling and termination hardware

B. Coax cable used for CATV signal

C. Other horizontal cabling for telecommunications systems.

1.2 Definitions:

A. Horizontal Cable: Cabling and termination hardware connecting the device outlet with the telecommunication space

Part 2-Products

2.1 Category 5e:

A. General. Category 5e (Cat 5e) cabling used for nurse call, and other vendor systems. Communication plans and specifications shall include required cable for each system.

B. Manufacturer: Belden

C. Cable:

1. Cat 5e Cable for Nurse Call:
   a. Cable jacket shall be green.
   b. CMR: Belden Part number 1212005
   c. CMP: Belden Part number 1213 005

D. Cable termination hardware:

1. Termination hardware used for nurse call is not covered in this guideline. Nurse call cabling termination hardware provided and installed by the nurse call vendor.
2. Termination for Cat 5e cable for vendor systems shall be coordinated with designated vendor and specified on communication plans and specifications.

2.2 Category 6:

A. General. Category 6 (Cat 6) cabling used for network data, telephones, PC's, network printers, tracker monitors, CATV data, CCTV and other vendor systems. Communication plans and specifications shall include required cable for each system.

B. Manufacturer: Belden

C. Cable:

1. Cat 6 Cable for network data, telephones, printers, tracker monitors, CCTV:
   a. Cable jacket shall be black.
   b. CMR: Belden part number 2412010
   c. CMP: Belden part number 2413010
2. Cat 6 Cable for RFID/RTLS:

a. Cable jacket shall be purple/violet.
b. CMR: Belden part number 2412007
c. CMP: Belden part number 2413007

3. Cat 6 Cable for CATV data:
    a. Cable jacket shall be blue.
    b. CMR: Belden part number 2412006
    c. CMP: Belden part number 2413006
4. Cat 6 Cable for Physiological/Fetal Monitoring:
    a. Cable jacket shall be orange.
    b. CMR: Belden Part number 2412 003
    c. CMP: Belden Part Number 2413 003

D. Cable Termination Hardware:
1. Cat 6 termination hardware used for network data, telephones, printers, tracker monitors:
    a. Jack color shall be black. Belden part number AX101066.
    b. Jacks shall be mounted in single gang white four port faceplate. Belden part number AX106663
    c. Wall mounted telephone outlets shall be terminated using Cat 6 black jack (Belden part number AX101321) mounted within a single gang wall phone style outlet (Belden part number AX102005).
    d. Within the telecommunication space Cat 6 cabling shall be terminated on standard rack mount patch panels.
        i. 24 port patch panel: Belden part number AX103253
        ii. 48 port patch panel: Belden part number AX103255
2. Cat 6 termination hardware used for CCTV:
    a. Jack color shall be black. Belden part number AX101066.
    b. Jacks shall be mounted in two port surface mount housing. Belden part number A0645273.
        i. If cable is required to be terminated inside an electrical rough in box surface mount housing not required.
    c. Within the telecommunication space Cat 6 cabling shall be terminated on standard rack mount patch panels.
        i. 24 port patch panel: Belden part number AX103253
        ii. 48 port patch panel: Belden part number AX103255

3. Cat 6 termination hardware used for RFID/RTLS:
    a. Jack color shall be Violet. Belden part number AX101072.
    b. Jacks shall be mounted in two port surface mount housing. Belden part number A0645273.
        i. If cable is required to be terminated inside an electrical rough in box surface mount housing not required.
    c. Within the telecommunication space Cat 6 cabling shall be terminated on standard rack mount patch panels.
        i. 24 port patch panel: Belden part number AX103253
        ii. 48 port patch panel: Belden part number AX103255
4. Cat 6 termination hardware used for CATV data:
    a. Jack color shall be Blue. Belden part number AX101071.
    b. Jacks shall be mounted in single gang white four port faceplate. Belden part number AX106663
    c. Within the telecommunication space Cat 6 cabling shall be terminated on standard rack mount patch panels.
        i. 24 port patch panel: Belden part number AX103253
        ii. 48 port patch panel: Belden part number AX103255
5. Cat 6 termination hardware used for physiological monitoring data:
    a. Jack color shall be orange. Belden Part Number AX101067.
    b. Jacks shall be mounted in single gang white four port faceplate. Belden Part Number AX106663.
    c. Within the telecommunication space Cat 6 cabling shall be terminated on standard rack mount patch panels.
        i. 24 port patch panel: Belden part number AX103253
        ii. 48 port patch panel: Belden part number AX103255

2.3 Category 6a:

A. General. Category 6a (Cat 6a) cabling used for wireless network data wireless access points. Communication plans and specifications shall include required cable.

B. Manufacturer: Belden

C. Cable:

1. Cat 6a Cable for wireless network data wireless access points:
    a. Cable jacket shall be yellow.
    b. CMR: Belden part number 10GX12004

c. CMP: Belden part number 10GX13004

D. Cable termination hardware:

1. Cat 6a termination hardware used for wireless network data wireless access points:
   a. Jack color shall be yellow. Belden part number AX102286.
   b. Jacks shall be mounted in two port surface mount housing. Belden part number A0645273.
      i. If cable is required to be terminated inside an electrical rough in box surface mount housing not required.
   c. Within the telecommunication space Cat 6a cabling shall be terminated on standard rack mount patch panels.
      i. 24 port patch panel: Belden part number AX103254
      ii. 48 port patch panel: Belden part number AX103256

2.4 Coax Cable

A. General: Coaxial cable used for horizontal connections between the telecommunication space and the TV outlet.

B. Manufacturer: Belden

C. Cable:

1. RG6 quad shielded coax cable used for CATV outlets:
   a. CMR: Belden part number 5339Q5
   b. CMP: Belden part number 6339Q8

D. Cable termination hardware:

1. Termination hardware used for CATV coax cable is not covered in this specification. CATV coax cabling termination hardware provided and installed by the CATV Vendor.

2.5 Other horizontal cabling for telecommunications systems:

A. Low Voltage power and control cable for nurse call:

1. Low Voltage engineer shall coordinate with nurse call vendor being used for the project to specify and show required cable and scope.
2. Cable jacket shall be green.
3. Termination provided by nurse call vendor.

B. Low Voltage power cable used for RFIS/RTLS:

1. Low Voltage engineer shall coordinate with RFID/RTLS being used for the project to specify and show required cable and scope.

2. Cable jacket shall be violet.

C. Other telecommunication systems that require horizontal cable may or may not be required in the project. It's the responsibility of the architect and low voltage engineer to coordinate the cable requirement for these systems and translate the required cabling requirements on to the telecommunication floor plans and specifications.

1. Any drawings provided by the vendor shall be used only to gather information to apply the design to the telecommunication plans and specifications. Vendor drawings shall not be issued to the field.

Part 3 - Execution

3.1 General: Communication drawings and specifications shall include horizontal cable requirements throughout the project. Including type and quantity of cable, cable support details and cable pathways.

A. Bundle, lace, and train cables to termination points without exceeding manufacturer's limitations on bending radii.

B. Do not install damaged cable. Do not splice cable between termination points. Remove and discard cable if damaged during installation and replace it with new cable.

C. Install a service loop on each end of cable. Minimum 10 feet unless noted otherwise within this specification.

D. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between communications cables and electrical motors and transformers, 5 kVA or HP and larger: A minimum of 48 inches.
5. Separation between communications cables and fluorescent fixtures: A minimum of 5 inches.

3.2 Category 5e Cable Installation and Termination:

A. Nurse Call:

1. Cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
2. Nurse Call cable shall not share supports with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
3. Nurse call cable shall be installed by cabling contractor per telecommunication drawings.
   a. Contractor to leave a minimum of 18 inches of slack at each final outlet location and a minimum of 15 feet at the termination point within the telecommunication space.
4. Contractor to label cables so that nurse call vendor knows where cable originates and what areas it supports.

3.3 Category 6 Cable Installation and Termination:

A. Cat 6 cable for network data, telephones, printers, tracker monitors, CCTV:

1. Cable shall be supported using snake tray when routed above accessible ceiling.
2. Cable shall only be allowed share supports with Cat 6a wireless cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.

3. Within the telecommunication space the cable shall be terminated within a dedicated patch panel.
4. For standard outlet locations the cabling shall be terminated using a standard jack mounted within a 4 port faceplate. All unused ports within the faceplate shall include a blank insert.
5. For wall mounted telephone outlets the cable shall be terminated using a standard jack mounted within wall phone style faceplate.
6. For CCTV camera outlets mounted within accessible ceiling areas cable shall be terminated using a standard jack mounted in a surface mount box. For inaccessible ceiling and exterior camera locations where the camera will be mounted to a rough in box the cable shall be terminated using a standard jack without surface mount box, jack will be located within rough in box. CCTV camera cables shall include a minimum service loop of 25 feet at the camera location.

B. Cat 6 cable for CATV data outlets:

1. Cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
2. CATV cable shall only be allowed to share supports with CATV coax cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
3. Within the telecommunication space the cable shall be terminated within a dedicated patch panel.
4. At the outlet location the cabling shall be terminated using a standard jack mounted within a 4 port faceplate along with CATV coax outlet and nurse call control cable where provided. All unused ports within the faceplate shall include a blank insert.

C. Cat 6 cable for RFID/RTLS:

1. Cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
2. Cable shall not share supports with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
3. Within the telecommunication space the cable shall be terminated within a dedicated patch panel.
4. For outlets mounted within accessible ceiling areas cable shall be terminated using a standard jack mounted in a surface mount box. For inaccessible ceiling locations where the device will be mounted to a rough in box the cable shall be terminated using a standard jack

without surface mount box, jack will be located within rough in box. Cables shall include a minimum service loop of 25 feet at the device location.

D. Physiological/Fetal monitoring:
   1. Cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
   2. Physiological/fetal monitoring cable shall not share supports with other cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
   3. Within the telecommunication space the cable shall be terminated within a dedicated patch panel.
   4. At the outlet location the cabling shall be terminated using a standard jack mounted within a 4 port faceplate. All unused ports within the faceplate shall include a blank insert.

E. Labeling:
   1. Labeling scheme to be coordinated with the facility IT&S director to match existing.
   2. Labels shall have white background with black characters.
   3. Cables shall be labeled using wrap around computer generated labels within 4 inches of the termination point for both ends of cable.
   4. Outlet faceplate and patch panel shall be labeled using computer generated labels.

F. Testing:
   1. Test each cable. Perform the following tests:
      a. Wire Map
      b. Length
      c. Insertion loss
      d. Near-end crosstalk (NEXT) loss
      e. Power sum near-end crosstalk (PSNEXT) loss
      f. Equal-level far-end crosstalk (ELFEXT)
      g. Power sum equal-level far-end crosstalk (PSELFEXT)
      h. Return loss
      i. Propagation delay
      j. Delay skew

2. Test results shall be transferred from tester and provided to the facility IT&S director as one paper copy and one electronic copy.

3.4 Cat 6a Cable Installation and Termination:

A. Cat 6a cable for wireless network access points:

1. Cable shall be supported using snake tray when routed above accessible ceiling.
2. Cable shall only be allowed share supports with Cat 6 network cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
3. Within the telecommunication space the cable shall be terminated within a dedicated patch panel.
4. For wireless access point outlets mounted within accessible ceiling areas cable shall be terminated using a standard jack mounted in a surface mount box. For inaccessible ceiling and exterior locations where the device will be mounted to a rough in box the cable shall be terminated using a standard jack without surface mount box, jack will be located within rough in box. Cables shall include a minimum service loop of 25 feet at the device location.

B. Labeling:

1. Labeling scheme to be coordinated with the facility IT&S director to match existing.
2. Labels shall have white background with black characters.
3. Cables shall be labeled using wrap around computer generated labels within 4 inches of the termination point for both ends of cable.
4. Outlet faceplate and patch panel shall be labeled using computer generated labels.

C. Testing:

1. Test each cable. Perform the following tests:
   a. Wire Map
   b. Length
   c. Insertion loss
   d. Near-end crosstalk (NEXT) loss
   e. Power sum near-end crosstalk (PSNEXT) loss
   f. Equal-level far-end crosstalk (ELFEXT)
   g. Power sum equal-level far-end crosstalk (PSELFEXT)

h. Return loss
i. Propagation delay
j. Delay skew

2. Test results shall be transferred from tester and provided to the facility IT&S director as one paper copy and one electronic copy.

3.5 Coax Cable installation:

A. RG6 coax cable used for CATV outlets.

1. Cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
2. CATV cable shall only be allowed to share supports with CATV data cables when routed down the corridors or main pathways. Once cabling leaves main cable pathway and routed to outlet location cable is allowed to share supports with other Cat 5e and Cat 6 cable.
3. Within the telecommunication space the cable shall be routed to the wall mounted TVJ location. At the TVJ location contractor shall leave a minimum of 15 feet of slack. Termination at the TVJ location shall be completed by the CATV vendor. Contractor to label coax cabling to identify which outlet and area it supports. CATV vendor shall provide and install all required amplifiers, splitters, combiners and any other active equipment.
4. At the outlet location the cabling shall be terminated using a standard F-Style compression style coax connector mounted within a 4 port faceplate along with CATV data outlet and nurse call control cable where provided. All unused ports within the faceplate shall include a blank insert.

B. RG6 and RG11 coax cable used for wireless telemetry outlets.

1. General: Telecommunications engineer shall coordinate with telemetry vendor to shoe all required cabling scope on the telecommunication plans. Any vendor drawings provided by the vendor shall be used only to show scope on telecommunication drawings. Vendor drawings shall not be issued to the field.
2. Coax cable used for telemetry devices shall be provided to the contractor by the vendor to be installed by the contractor.
3. Cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
4. Telemetry cable shall not share supports with other cables when routed down the corridors or main pathways.
5. Telemetry cable shall be installed by cabling contractor per telecommunication drawings.

a. Contractor to leave a minimum of 20 feet of slack at each final outlet location and a minimum of 15 feet at the termination point within the telecommunication space.

6. Within the telecommunication space the telemetry cable shall be routed to the wall mounted distribution location.
7. Contractor to label cables so that telemetry vendor knows where cable originates and what areas it supports.
8. Telemetry vendor shall terminate all telemetry coax cable and provide testing.

3.6 Other Horizontal Cabling:

A. General: There will be other horizontal telecommunication cables included within a project. Systems including, but not limited to, Distributed Antenna System (DAS), overhead paging, Access Control, Intercom, Temperature Monitoring, Intrusion Detection. It shall be the responsibility of the architect and engineer to coordinate with system vendor to cover all requirements within the project drawings and specifications.

DIVISION 28: ELECTRONIC SAFETY AND SECURITY

DESIGN GUIDELINES – ELECTRONIC SAFETY AND SECURITY

HCA is electing at this time not to provide guidelines.

EQUIPMENT AND SYSTEMS GUIDELINES – ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 00: FIRE DETECTION AND ALARM

Part 1 - General

1.1 Work Included:

A. New projects and renovation projects of reasonable size should be specified with an addressable fire alarm system. Existing hardwired systems should be eliminated when financially feasible with renovations. As an alternative, provide addressable systems in the renovated portions and interface with the existing systems. Coordinate closely with the AHJ.

B. For renovation and expansion projects, the design consultants and representatives of the GC shall note the status of the existing fire alarm annunciators during each pre-construction visit. If a panel is found with "troubles" the HCA Construction Manager and the facility DFM shall be notified immediately. Demolition or construction shall not commence until all fire alarm panels are clear of "troubles".

C. Specify Class B wiring unless not permitted by the AHJ (e.g., Utah).

D. Coordinate the requirements for ceiling and duct mounted smoke detectors with the AHJ. Verify requirements for smoke detectors in sleeping rooms and patient rooms. Seek approval to omit ceiling mounted smoke detectors in sleeping areas since quick response (QR) sprinkler heads will be used.

E. In general, limited use of ceiling mounted area smoke detectors is preferred over extensive use of duct mounted smoke detector systems. Closely coordinate the code required minimum system design, the AHJ requirements and local interpretations. Do not place smoke detectors in corridors on 30 foot centers unless required by the AHJ.

F. Where allowed by code and the AHJ, substitute minimally applied area detection or limited ceiling mounted detector applications in lieu of remote, duct mounted smoke detectors installed throughout the duct system.

Part 2-Products

2.1 Acceptable manufacturers: Simplex, Siemens, Edwards, Notifier, JCI, or match existing. Contractor must provide bids for a minimum of three separate fire alarm manufacturers and present to FacilitiGroup for review.

2.2 All conduit is to be color-coded in accordance with HCA Conduit Color Table in Section 26 05 33.

Part 3 - Execution

3.1 Prior to contractor starting any work for any trade, the general contractor must assess and photograph the fire alarm panel in order to count and note all alarms and trouble signals. This information must be reported to the facility and the engineer immediately.

SECTION 28 34 00: FUEL-OIL DETECTION AND ALARM

Part 1 - General

HCA is electing at this time not to provide guidelines.

Part 2-Products

2.1 Fuel Monitoring Systems: Acceptable Manufacturers: Enterprise Brass Works (EBW), Veeder-Root, Pollulert, PetroVend

A. Specify fuel monitoring providing continuous tank monitoring, leak detection, vapor and ground water sensing, tank levels with local alarming and remote monitoring using RS485 or Ethernet communications.

Part 3 - Execution

3.1 Work Included: The subcontractor shall:

A. Calibrate and document the final comparison of all temperature sensors with the standard measurement device used,

B. Adjust the status indicators used for exhaust fan status and preheat pump status to show the exhaust fans alarm when the fans are operating without belts and that the preheat pumps alarm when the pump motor is operating but there is no flow through the preheat coil, and

C. A point to point verification of command outputs and sensor inputs.

SECTION 28 35 00: REFRIGERANT DETECTION AND ALARM

Part 1 - General

1.1 Where required by code, the chiller plant shall be provided with a ventilation evacuation system that meets or exceeds ASHRAE Standard 15. The system shall include refrigerant monitoring, exhaust fans, intake louvers, and visual and audible alarms.

Part 2-Products
HCA is electing at this time not to provide guidelines.

Part 3 - Execution
HCA is electing at this time not to provide guidelines.

APPENDICES

APPENDIX A: COMMISSIONING GUIDANCE

APPENDIX A-1, SPECIFICATION SECTION 01 91 13: GENERAL COMMISSING REQUIREMENTS

Refer to Appendix A-1 Specification Section 01 91 13 General Commissioning Requirements.docx.

APPENDIX A-2: PRE-FUNCTIONAL CHECKLISTS

Refer to the following supplemental documents:

- AHU PFC.xlsx
- Chiller PFC.xlsx
- Condensate Return Pump PFC.xlsx
- Cooling Tower PFC.xlsx
- Deaerator PFC.xlsx
- Duct Mounted Humidifier PFC.xlsx
- Emergency Generator PFC.xlsx
- FCU PFC.xlsx
- Flash Tank PFC.xlsx
- Fuel Oil Pump PFC.xlsx
- General EF PFC.xlsx
- General Piping & Ductwork PFC.xlsx
- HW Boiler PFC.xlsx
- HW Converter PFC.xlsx
- Hydronic Pump PFC.xlsx
- Iso EF PFC.xlsx
- Plate and Frame HEX PFC.xlsx
- PRV PFC.xlsx
- RTU PFC.xlsx
- Split Units PFC.xlsx
- Steam Boiler PFC.xlsx
- VAV Box PFC.xlsx

APPENDIX A-3: FUNCTIONAL PERFORMANCE TESTS

Refer to the following supplemental documents:

- AHU FPT.xlsx
- CHW PS System FPT.xlsx
- CHW VP System FPT.xlsx
- Duct Humidifier FPT.xlsx
- General Exhaust Fan FPT.xlsx
- Hot Water Boiler System FPT.xlsx
- HW Convertor System FPT.xlsx
- Isolation Rooms FPT.xlsx
- Operating Rooms FPT.xlsx
- Terminal Htg and Clg FPT.xlsx
- VAV Trend Data.xlsx

APPENDIX B: BUILDING AUTOMATION SYSTEM (BAS) GUIDANCE

APPENDIX B-1: POINT NAME STANDARDS

Part 1 - General

1.1 Scope

A. This document is to provide direction for naming objects within building automation systems (BAS).

B. This naming guideline is to be applied to an entire site for new construction upon any retrofit. If a project that touches the control system is occurring, the entire site is to be renamed to this standard at the time of the project.

C. HCA intends object names to be able to be read near phonetically by users of all knowledge and skill levels. In support of this, the BAS Naming Guidelines provides a glossary of accepted abbreviations to be used for object naming. In addition, this document includes a prepopulated list of full object names for reference.

D. For any questions on or clarifications to the following guidelines, please consult the FacilitiGroup Energy Service Center. Energy@HCAhealthcare.Com | 615-344-5068

1.2 Naming General

A. Object names shall be written as descriptively as possible and object names to be able to be read near phonetically by users of all knowledge and skill levels.

B. Object names will be written in sequence as follows:

1. Site Qualifier, Area Qualifier, System Name, Value, Multiplier Qualifier, Setpoint Qualifier, Object Qualifier

Site Qualifier	ALSKRMC, AVNTURA, NWESTMC (Must be all caps)
Area Qualifier	MAIN, TOWER, MOB (Must be all caps)
System Name	Oa, Chw, SchwpVFD
Value	CFM, Tmp, Cmd
Multiplier Qualifier	-1000, -100, -10
Setpoint Qualifier	Spt, LoSpt, HiSpt
Object Type Qualifier	.Var, .Calc, .Logic, .Int

a. Site Qualifier is 7 characters. When the Site Qualifier is not available in the breadcrumbs for an object (ex. OaTmp displays as SITQUAL.OaTmp), the Site Qualifier shall appear in the object name (ex. OaTmp becomes SITQUAL.OaTmp).

b. Area qualifier is only to be used when two or more areas are on the same controller and is not to exceed 5 characters.

c. Setpoint qualifier is intended to reflect programming. *Spt* is a target value, *LoSpt* is an "if it drops below" value and *HiSpt* is an "if it rises above" value. All setpoints are to have the object type qualifier *.Var* applied to the end of the point name.

d. All calculated values are to have the object type qualifier *.Calc* applied to the end of the point name. Only to be used when point is calculated in controls programming and not an input such as from a meter or equipment that does the calculation.

e. All integrated points are to have the object type qualifier *.Int* applied to the end of the point name.

C. The only exception to object names in the BAS Naming Guidelines are logic or programming points that do not display on the BAS. These objects may keep their standard naming, but are to have the object type qualifier *.Logic* applied to the end of the standard name.

D. Abbreviations not included in the glossary will be written with the first letter capitalized and following letters in lowercase. Additions to the glossary must be approved by the Energy Service Center.

E. Site codes for naming controllers, servers, etc are to be supplied by the Energy Service Center. These codes will be seven letters and in all caps.

F. Examples:

1. DRSRSTA.NTWRChlr01GPM-100LoSpt.Var

Site Qualifier	DRSRSTA	Doctors' Hospital of Sarasota
Area Qualifier	NTWR	North Tower
System Name	Chlr01	Chiller #1
Value	GPM	Flow (in GPM)
Multiplier Qualifier	-100	Actual value is displayed value x 100
Setpoint Qualifier	LoSpt	Low (minimum) setpoint
Object Type Qualifier	.Var	Variable

2. SaStPHiAlm

Site Qualifier		(none)
Area Qualifier		(none)
System Name	Sa	Supply air*
Value	StPLoAlm	Static Pressure low alarm
Multiplier Qualifier		(none)
Setpoint Qualifier		(none)
Object Type Qualifier		(none)

3. AHU03.RaFanVFDSpd.Calc

Site Qualifier		(none)
Area Qualifier		(none)
System Name	AHU03.RaFanVFD	AHU03 Return Fan VFD*
Value	Spd	Speed (%)
Multiplier Qualifier		(none)
Setpoint Qualifier		(none)
Object Type Qualifier	.Calc	Calculated in programing

*See note under AHU naming for when AHU name must be included.

1.3 Glossary of Site Qualifiers

Site	Code	Site	Code
Alaska Regional Hospital	ALSKRMC	**Bee Cave FSER**	BEECAVE
Alliance Medical Center	ALIANCE	Belton Regional Medical Center	BELTONR
Alvin Urgent Care Center	ALVINUC	Blake Medical Center	BLAKEMC
Atlantic FSER	ATLANTC	**Boynton Beach FSER**	BOYNTON
Aventura Hospital and MC	AVNTURA	Brandon Regional Hospital	BRANDON
Bastrop FSER	BASTROP	Brigham City CH	BRIGHAM
Bayshore Medical Center	BAYSHOR	Capital RMC	CAPITAL

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Site	Code
Cartersville Medical Center	CARTERS
Centerpoint Medical Center	CNTRPNT
Central Florida RH	CENTFLA
Centre Pointe Emergency	CTPTEMR
Citrus Memorial Hospital	CITRSMH
Citrus Park ER	CITRSPK
CJW MC Chippenham	CHIPNHM
CJW MC Johnston Willis	JOHNWIL
Clear Lake Heart and Vascular	CLHEART
Clear Lake RMC	CLRLAKE
Clearwater ER	CLRWATR
Coliseum Medical Center	COLSEUM
Coliseum Northside Hospital	CLSMNTH
Colleton Medical Center	COLLETN
Conroe Regional Medical Center	CONROER
Corpus Christi MC Bay & Heart	CCBYHRT
Corpus Christi MC Doctors RH	CCDOCTR
Corpus Christi MC Northwest RH	CCNWEST
Cypress Fairbanks Medical Center	CYPRESS
Darwin Square FSER	DARWNSQ
Davie FSER	DAVIEER
Denton Regional Medical Center	CCDENTN
Destin ER	DESTNER
Doctors Hospital of Augusta	DRAUGST
Doctors Hospital of Sarasota	DRSRSTA
Dominion Hospital	DOMNION
East FSER	ESTFSER
East Houston RMC	EASTHOU
Eastern Idaho RMC	ESTRNID
Eastside Medical Center	EASTSID
Eastside Medical Center South Campus	ESTSDST
Edinburg FSER	EDINBRG
Englewood Community Hospital	ENGLEWD
ER at The Lakes	ERLAKES
Fairmont FSER	FAIRMNT
Fairview Park Hospital	FRVWPRK
Fall Creek FSER	FALLCRK

Site	Code
Fawcett Memorial Hospital	FAWCETT
Fort Walton Beach MC	FTWALTN
Frankfort RMC	FRANKFT
Gadsden FSER	GADSDEN
Garden Park Medical Center	GRDNPRK
Good Samaritan Hospital	GOODSAM
Good Samaritan Mission Oaks	MISOAKS
Grand Strand RMC	GRNDSTR
Green Oaks Hospital	GRNOAKS
Greenview Regional Hospital	GREENVW
Gulf Coast Medical Center	GULFCST
Hanover FSER	HANOVER
HCA Corporate Building 1	PRKPLZ1
HCA Corporate Building 2	PRKPLZ2
HCA Corporate Building 3	PRKPLZ3
HCA Corporate Building 4	PRKPLZ4
HCA Nashville Data Center – Crossings	HCAXRDC
Henrico Drs' Hospital - Forest	HENFRST
Henrico Drs' Hospital - Parham	HENPRHM
Henrico Drs' Hospital - Retreat	HENRETR
Houston Northwest Medical Center	HOUSTNW
Hunter's Creek ER	HUNTERS
JFK Medical Center	JFKMEDC
JFK Medical Center North	JFKNRTH
John Randolph Medical Center	JOHNRND
Julington Creek FSER	JULNGTN
Katy FSER	KTYFSER
Kendall RMC	KENDALL
Kingwood Medical Center	KNGWOOD
Lafayette RHC	LAFAYET
Lake City Medical Center	LAKECTY
Lakeview Hospital	LAKVWUT
Lakeview RMC	LKVWRMC
Largo MC Indian Rocks Campus	LRGOIRC
Largo Medical Center	LARGOMC
Las Colinas Medical Center	LASCLNS
Las Palmas Del Sol MC	LPDELSL

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Site	Code
Las Palmas Medical Center	LASPALM
Lawnwood RMC	LWNWOOD
Lee's Summit Medical Center	LEESSUM
LewisGale Hospital Alleghany	ALEGANY
LewisGale Hospital Montgomery	MNTGMRY
LewisGale Hospital Pulaski	PULASKI
LewisGale Medical Center	LEWISGL
Lone Peak Hospital	LNEPEAK
Los Robles RMC	LOSROBL
Mainland Medical Center	MAINLND
Mandarin FSER	MANDARN
MC of Arlington	MCARLNG
MC of Aurora - Centennial MP	AURACEN
MC of Aurora North Campus	AURANTH
MC of Aurora South Campus	AURASTH
MC of Lewisville	MCLEWIS
MC of McKinney	MCMCKNY
MC of Plano	MCPLANO
MC of Trinity	MCTRNTY
MC of Trinity West Pasco	MCTRNWP
McAllen/Mission FSER	MCALLEN
Medical City Dallas Hospital	MCDALAS
Medical City ER Burleson	MCBURLS
Medical City ER Flower Mound	MCFLOWR
Medical City ER Grand Prairie	MCPRARI
Medical City ER Park Cities	MCPARKC
Medical City ER Plano	MCERPLN
Medical City ER Saginaw	MCSAGNA
Medical City ER Stonebridge	MCSTNBR
Medical City Fort Worth	PLAZAFW
Medical City Lewisville	MCLEWIS
Medical City McKinney	MCMCKNY
Medical City Plano	MCPLANO
Memorial Hospital Jacksonville	MEMJACK
Memorial Hospital of Tampa	MHTAMPA
Menorah Medical Center	MENORAH
Methodist Boerne ER	MBOERNE
Methodist Hospital	METHODS
Methodist Stone Oak Hospital	METHSTN
Metropolitan Hospital	METROPL
Moncks Corner Medical Center	MONCKSC
Mountain View Hospital UT	MTNVWUT
MountainView Hospital NV	MTNVWNV
Newberry FSER	NEWBERY
North Austin Medical Center	NAUSTIN
North Florida RMC	NFLARMC
North Hills Hospital	NTHHILS
North Strand FSER	NTHSTRD
North Suburban Medical Center	NSUBRBN
Northeast ER	NTHESER
Northshore FSER	NTHSHOR
Northside Hospital	NTHSIDE
Northwest ER	NTHWSER
Northwest FSER	CCNTHWS
Northwest Medical Center	NWESTMC
Oak Hill Hospital	OAKHILL
Ocala Regional Medical Center	OCLARMC
Ocala West Marion CH	OCALAWM
Ogden Regional Medical Center	OGDNRMC
Olathe FSER	OLATHER
Orange Park Medical Center	ORNGPRK
Osceola RMC	OSCEOLA
OU Medical Center	OKLAUMC
OUMC Children's Hospital	OKLAUMC
OUMC Edmund	OUMCEDM
Overland Park RMC	OVRLDPK
Oviedo MC	OVIEDOM
Palm Beach Gardens FSER	PLMBECH
Palm Harbor ER	PLMHRBR
Palms of Pasadena Hospital	PLMSPAS
Palms West Hospital	PLMWEST
Park Plaza Hospital	PRKPLZH
Park West ER	PARKWST
Parkland Medical Center	PARKLND
Parkridge East Hospital	PRKRGES
Parkridge Medical Center	PRKRDGE

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Site	Code
Parkridge Valley Hospital	PRKRGVL
Parkridge West Hospital	PRKRDGW
Pearland Medical Center	PEARLND
Pflugerville FSER	PFLUGER
PGH - Mercy Campus	PGHMRCY
Plant City ER	PLNTCTY
Plantation General Hospital	PLANTGH
Plaza MC of Fort Worth	PLAZAFW
Poinciana Medical Center	PONCIAN
Portsmouth Regional Hospital	PORTSMT
Presbyterian St. Luke's MC	PRESBYT
Putnam Community MC	PUTNMCH
Rapides RMC	RAPIDES
Raulerson Hospital	RAULRSN
Redmond RMC	REDMOND
Research MC - Brookside MC	RESBROK
Research Medical Center	RESRCMC
Research Psychiatric Center	RESPSYC
Reston Hospital Center	RESTNHC
Rio Grande Regional Hospital	RIOGRND
Riverside Community Hospital	RIVERSD
RMC Bayonet Point	RMCBYPT
RMC of Acadiana	RMCACAD
RMC of San Jose	RMCSANJ
Rose Medical Center	ROSMEDC
Round Rock Medical Center	RNDROCK
Saddle Rock FSER	SADLRCK
Seabrook FSER	SEABROK
Shawnee FSER	SHAWNEE
Sky Ridge Medical Center	SKYRDGE
South Austin Medical Center	SAUSTIN
South Bay Hospital	SOUTHBY
South Strand FSER	STHSTRD
Southern Hills HMC	SHILSNV
Spalding Rehabilitation Center	SPALDNG
Specialty Jacksonville	SPCJACK
Spotsylvania RMC	SPTSYLV
St. David's Georgetown	GEORGTN

Site	Code
St. David's Heart of Austin	HRTAUST
St. David's Medical Center	STDAVID
St. Lucie Medical Center	STLUCIE
St. Mark's Hospital	STMARKS
St. Petersburg GH	STPETER
Stapleton ER	STAPLTN
StoneSprings Hospital Center	STNSPRG
Summerfield ER	SUMRFLD
Summerville Medical Center	SUMMRVL
Summlin FSED	SUMMLIN
Sunrise HMC	SUNRISE
Swedish Medical Center	SWEDISH
Swift Creek FSER	SWFTCRK
Tampa Community Hospital	TAMPACH
Taylorsville FSER	TAYLRSV
Terre Haute Regional Hospital	TERAHTE
Texas Orthopedic Hospital	TXORTHO
Thousand Oaks Surgical	THSOAKS
Timpanogos Regional Hospital	TMPNGOS
Town and Country Hospital	TWNCTRY
Tri-Cities FSER	TRICITY
Trident Medical Center	TRIDENT
TriStar Centennial MC	CENTENL
TriStar Centennial MC Ashland	CENTASH
TriStar Hendersonville MC	HNDRSNV
TriStar Horizon Medical Center	HORIZON
TriStar Natchez ER	NATCHEZ
TriStar Portland ER	PORTLND
TriStar Skyline MC Madison	SKYLMAD
TriStar Skyline Medical Center	SKYLINE
TriStar Southern Hills MC	SHILSTN
TriStar Spring Hill ER	SPRNGHL
TriStar StoneCrest MC	STNCRST
TriStar Summit Medical Center	SUMMTMC
Tulane Lakeside Hospital	TULNLAK
Tulane University Hospital	TULNUHC
Twin Cities Hospital	TWINCIT
University Hospital and MC	UNVRSTY

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Site	Code
Valley Regional Medical Center	VALYRMC
Wesley Derby ER	WESLYDR
Wesley MC	WESLYMC
Wesley West ER	WESLYWS
Wesley Woodlawn Hospital	WOODLWN
West Creek FSER	WESTCRK
West Florida Hospital	WESTFLA
West FSER	WSTFSER
West Hills HMC	WESTHIL
West Houston Medical Center	WESTHOU
West Valley Medical Center	WESTVAL
Westside RMC	WESTSID
Woman's Hospital of Texas	WOMANTX
Women’s and Children’s Hospital	WMNCHLD

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1.4 Glossary of Abbreviations

A. Each object name shall be written from the Glossary of Abbreviations. Abbreviations not included in the glossary will be written with the first letter capitalized and following letters in lowercase. Additions to the glossary must be approved by the Energy Service Center.

Glossary of Abbreviations		
Naming	**Definition**	**Notes**
-1000	1000x multiplier	Multiplier Qualifier added to end of object name
-100	100x multiplier	Multiplier Qualifier added to end of object name
-10	10x multiplier	Multiplier Qualifier added to end of object name
.Calc	calculated value	Object Type Qualifier added to end of object name
.Global	global object	Object Type Qualifier added to end of object name
.Logic	logic object	Object Type Qualifier added to end of object name
.Var	user input	Object Type Qualifier added to end of object name
%, Per	percent	Use "%" when system allows in the naming convention otherwise use "Per "
Ahu	air handling unit	
Alm	alarm	
Amp	current	
App	approach	
Aux	auxiliary	
Blr	boiler	
Byp	bypass	
Cap	capacity	
CFM	flow in cubic feet per minute	
Chlr	chiller	
Chw	chilled water	
Clg	cooling	
Cmd	command	
CO2	CO2	
Cond	condenser	
Crit	critical	
CT	cooling tower	

Glossary of Abbreviations		
Naming	**Definition**	**Notes**
CV	constant volume	numbered as CV-1-230 = CV box 230 on AHU 1
Cw	condenser water	
DA	deaerator	
Da	discharge air	discharge air from any terminal unit to space
Day	day	
Decoupler	decoupler	
Dehum	dehumidifier	
Delay	delay	
Delta	delta, drop	eg ΔT > DeltaTmp
Dif	differential	
Dir	direction	
Dmpr	damper	
Dom	domestic water	
DP	differential pressure	
Dp	dew point temperature	listed after temperature, ie TmpDp
Drty	dirty	
Duct	duct	
Econ	economizer	
Eff	efficiency	
Ena	enable	
Ent	enthalpy	
Err	difference between two values	
Evap	evaporator	
Exh	exhaust	
Fail	fail/failure	

Glossary of Abbreviations		
Naming	**Definition**	**Notes**
Fan	fan	
Fbk	feedback	
Fcu	fan coil unit	
Fin	final	
Fire	fire	
FLA	full load amps	
Fltr	filter	
FrzStat	freeze stat	
FuelOil	fuel oil	
Gen	generator	
Gly	glycol	
GPM	flow in gallons per minute	
Hi	high limit	
Hp	horsepower	
Htg	heating	
Hw	hot water	
HwBlr	hot water boiler	
HwP	hot water pump	
Hx	heat exchanger	
Hz	frequency in hertz	
Int	integral	
IsoVlv	isolation valve	
kW	kilowatt	
kWd	kilowatt demand	
kWh	kilowatt hours	

Glossary of Abbreviations		
Naming	**Definition**	**Notes**
Lag	lag equipment	display with number eg LagXX > Lag01, Lag 02, …
Lead	lead equipment	
Lo	low limit	
Load	energy load in Btu/hr or tons	
LockOut	lockout	
Ma	mixed air	
Man	manual	
Max	maximum	
Min	minimum	
Nite	night	
Oa	outside air	
Occ	occupancy	
Offset	offset	
Ovr	override	
P	pump	listed after medium, eg SchwP
Pb	proportional band	
PChw	primary chilled water	
PID	PID	
Pnl	panel	
Pos	position	
Pr	Pre	
Pres	pressure	
PrHt	preheat	
Prop	proportional	
PSI	pressure in pounds per square inch	

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Glossary of Abbreviations		
Naming	**Definition**	**Notes**
Purge	smoke purge	
Pwr	power	
Ra	return air	
Ref	refrigerant	
Relay	relay	
Reset	reset	
Rh	relative humidity	
RLA	run load amps	
Rqst	request	
RunTime	runtime	
Sa	supply air	supply air directly from AHU
SBlr	steam boiler	
Sched	schedule	
SChw	secondary chilled water	
Sel	select	
Smoke	smoke/smoke detector	
Spd	speed	
Spt	setpoint	
State	state	
Stg	stage	
Stm	steam	
StP	static pressure	
Sts	status	
Sys	system	
Test	test	

Glossary of Abbreviations		
Naming	**Definition**	**Notes**
Tmp	temperature	
Tnk	tank	
Tot	totalized or summed value	eg MOB1SchwGPM + MAINSchwGPM = TotSchwGPM.
VelP	velocity pressure	
VFD	variable frequency/speed drive	listed after equipment, eg CTXXVFD
VIn	voltage in	
Vlv	valve	
VOut	voltage out	
VV	variable volume	numbered as VV-1-230 = VV box 230 on AHU 1
Wb	wet bulb temperature	listed after temperature, ie TmpWb

1.5 Glossary of Air Handling Unit Objects

A. The Glossary of Air Handling Unit Objects is a reference to previously created objects that use the BAS Naming Guidelines. It is a guide to proper object naming, not a list of exclusive usable objects. Objects should still be named according to the guidelines listed under *Naming General* starting on page 3.

B. All Air Handling Units (AHU) are to be numbered using a unique two number identifier (ex. AHU01, AHU02, … , AHU98, AHU99). Letters are not allowed in the AHU number. When duplicates exist at a facility, the facility is to renumber AHU to meet the naming standard.

C. Deviations from the naming standard (such as AHU1E, AHU1W) will be considered on a per site basis and must be approved by the Energy Service Center.

D. When the AHU is not available in the breadcrumbs for an object (ex. Co2Alm displays as SiteName.AHU##.Co2Alm), the AHU name shall appear in the object name (ex. Co2Alm becomes AHU##Co2Alm).

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
AHUEna	Air Handling Unit Enable Command	BO	Disable Enable
ChwAirTmp	Air Temperature immediately after the cooling coil	AI	deg F
ChwAirTmpSpt.Var	Air Temp setpoint immediately after the cooling coil	AV	deg F
ChwRetTmp	Chilled Water Coil Return Temp	AI	deg F
ChwSupTmp	Chilled Water Coil Supply Temp	AI	deg F
ChwVlv01Cmd	Cooling Valve 1 Output Command	AO	% open
ChwVlv02Cmd	Cooling Valve 2 Output Command	AO	% open
ChwVlvCmd	Cooling Valve Control Command	AO	%
ChwVlvPos	Chilled Water Valve Position	AI	%
Co2Alm	Carbon Dioxide High Alarm	BI	Normal Alarm
Co2Lvl	Carbon Dioxide Level	AI	ppm
Co2LvlSpt.Var	Carbon Dioxide Level Set Point	AV	ppm
EaCFM	Exhaust Air Airflow	AI	cfm
EaDmprCmd	Exhaust Air Damper Command	AO	%
EaDmprPos	Exhaust Air Damper Position	AI	%
EaFanCmd	Exhaust Air Fan Command	BO	Off On
EaFanHp	Exhaust Air Fan Horsepower	AI	hp
EaFanSpdCmd	Exhaust Air Fan Speed Command	AO	%
EaFanSts	Exhaust Air Fan Status	BI	Off On
EaFanVFDAmp	Exhaust Air Fan VFD Current	AI	A
EaFanVFDCmd	Exhaust Air Fan VFD Command	BO	Off On
EaFanVFDHz	Exhaust Air Fan VFD Output Frequency	AI	Hz
EaFanVFDkWh	Exhaust Air Fan VFD kWh	AI	kWh
EaFanVFDPwr	Exhaust Air Fan VFD Input Power	AI	W
EaFanVFDSpd	Exhaust Air Fan VFD Speed %	AO	%

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
EaFanVFDTmp	Exhaust Air Fan VFD Internal Temp	AI	deg F
EaFanVFDVIn	Exhaust Air Fan VFD Input Voltage	AI	V
EaFanVFDVOut	Exhaust Air Fan VFD Output Voltage	AI	V
EaFanXXCmd	Exhaust Air Fan XX Command	BO	Off On
EconDmprCmd	Economizing Air Damper Command	AO	%
EconEna	Economizer Enable Command	BO	Disable Enable
EconHiSpt.Var	Economizing High Temperature Set Point	AV	deg F
EconLockOutSpt.Var	Economizer Lockout Temperature Setpoint	AV	deg F
EconLowSpt.Var	Economizing Low Temperature Set Point	AV	deg F
EconMidSpt.Var	Economizing Mid Temperature Set Point	AV	deg F
EconSpt.Var	Economizer Setpoint	AV	deg F
EconState	Economize State	BV	Disable Enable
EconState	Economize State	MV	Mech Cooling, OA Mech Cooling, Free Cooling, Heating
EconSts	Economizer Status	BI	Off On
EconTestSts	Economizer Test Status	BI	Off On
EntErr.Var	RaEnt v OaEnt	AI	Btu/lb
FanHeatSpt.Var	Fan Heat Offset	AV	deg F
FinFltrDP	Final Filter differential pressure	AI	in wc
FinFltrDrtyAlm	Dirty Filter Alarm	BI	Normal Alarm
FinFltrSts	Final Filter Status	BI	Normal Alarm
FireAlmSts	Fire Alarm System Status	BI	Normal Alarm
FrzStat	Freeze Stat Status	BI	Normal Alarm
HtgLockOutSpt.Var	Heating Lockout Temperature Setpoint	AV	deg F

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
HumCtrlCmd	Humidifier Control Command	BO	Off On
HumCtrlSpt.Var	Humidifier Control Set Point	AV	%RH
HumRhHiDif.Var	Humidity High Limit Differential	AV	%RH
HumRhHiSpt.Var	Humidity High Limit Setpoint	AV	%RH
HumRhPb.Var	Humidity Proportional Band	AV	%RH
HumVlvCmd	Humidifier Valve Command	AO	%
HumVlvPos	Humidifier Valve Position	AI	%
HumVlvSts	Humidifier Valve Status	AI	Closed Open
HwAirTmp	Air Temperature immediately after the heating coil	AI	deg F
HwAirTmpSpt.Var	Air Temperature setpoint immediately after the heating coil	AV	deg F
HwSupTmp	Heating Coil Supply Water Temperature	AI	deg F
HwVlvCmd	Heating Valve Control Command	AO	%
HwVlvPos	Hot Water Valve Position	AI	%
LoTmp	Freezestat Lo Temp Alarm	BI	Normal Alarm
MaDmprPos	Mixed Air Damper Position	AI	% open
MaTmp	Mixed Air Temperature	AI	deg F
MaTmp.Calc	Mixed Air Dry Bulb Temperature	AI	deg F
MaTmpSpt.Var	Mixed Air Temperature Setpoint	AV	deg F
OaCFM	Outside Air Airflow	AI	cfm
OaCFM.Calc	Outside Air Flow Calculation	AI	cfm
OaCFM-1000	Outside Air Airflow (X1000)	AO	cfm
OaCFMErr.Calc	OaCFM v OaCFMSpt	AI	cfm
OaCFMSpt.Var	Outside Air Flow Setpoint	AV	cfm
OaDmprCmd	Outside Air Damper Control Command	AO	%
OaDmprPos	Outside Air Damper Position	AI	%

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Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
OaDmprSpt.Var	Outside Air Damper Setpoint	AV	%
OaEnt	Outside AirEnthalpy	AI	Btu/lb
OaEntGlobal	Outside Air Enthalpy Global Input	AO	kJ
OaMinDmprCmd	Minimum Outside Air Damper Control Command	AO	%
OaMinDmprPos	Minimum Outside Damper Control Position	AI	% open
OaMinDmprSts	Minimum Outside Damper Control Status	BI	Closed Open
Oa%CFM.Calc	Outside Air Percentage by CFM	AI	cfm
Oa%Tmp.Calc	Outside Air percentage by Temperature	AI	deg F
OaRh	Outside Air Relative Humidity	AI	%RH
OaSmoke	Outside Air Smoke Alarm	BV	Normal Alarm
OaTmp	Outside Air Temperature	AI	deg F
OaTmp.Calc	Outside Air Temperature Calculation	AI	deg F
OaTmpDp	Outside Air DewPoint Temperature	AI	deg F
OaTmpGlobal	Outside Air Temperature Global Input	AO	deg F
OaTmpWb	Outside Air Wet Bulb Temperature	AI	deg F
PrFltrDP	Pre Filter Differential Pressure	AI	in wc
PrFltrDrtyAlm	Dirty Filter Alarm	BI	Normal Alarm
PrFltrSts	Pre Filter Status	BI	Normal Alarm
PrHtBypDmprCmd	Pre-Heat Face and Bypass Damper Command	AO	% open
PrHtBypDmprPos	Pre-Heat Face and Bypass Damper Position	AI	% open
PrHtBypDmprSts	Pre-Heat Face and Bypass Damper Status	BI	Closed Open
PrHtPCmd	Pre-Heat Circulation Pump Command	BO	Off On
PrHtStgCmd	Electric Pre-Heat Stage Control Command	MO	1, 2, …
PrHtStgCmd	Electric Pre-Heat Stage Control Command	BO	Off On

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
PrHtStgSts	Electric Pre-Heat Stage Control Status	BI	Off On
PrHtTmp	Pre-Heat Air Temperature	AI	deg F
PrHtTmpSpt.Var	Pre-Heat Air Temperature Set Point	AV	deg F
PrHtVlvCmd	Pre-Heat Valve Control Command	AO	%
PrHtVlvPos	Pre-Heat Valve Control Position	AO	%
PrHtVlvSts	Pre-Heat Valve Control Status	AO	%
PurgeOff.Logic	Smoke Purge Operation Off	BI	Normal Alarm
PurgeOn.Logic	Smoke Purge Operation	BI	Normal Alarm
RaCFM	Return Air Airflow	AI	cfm
RaCFM.Calc	Return Air Flow Calculation	AI	cfm
RaCFMSpt.Var	Return Air Airflow Setpoint	AV	cfm
RaDmprCmd	Return Air Damper Command	AO	%
RaDmprLimSpt.Var	Return Air Damper Limit Setpoint	AV	% open
RaDmprPos	Return Air Damper Position Analog	AI	%
RaDmprSts	Return Air Damper Status	BI	Closed Open
RaEnt	Return Air Enthalpy	AI	Btu/lb
RaFanCmd	Return Air Fan Command	BO	Off On
RaFanHp	Return Air Fan Horsepower	AI	hp
RaFanSts	Return Air Fan Status	BI	Off On
RaFanVelP	Return Air Fan Velocity Pressure	AI	in wc
RaFanVFDAmp	Return Air Fan VFD Current	AI	A
RaFanVFDCmd	Return Air Fan VFD Command	BO	Off On
RaFanVFDHz	Return Air Fan VFD Output Frequency	AI	Hz
RaFanVFDkWh	Return Air Fan VFD kWh	AI	kWh
RaFanVFDPwr	Return Air Fan VFD Input Power	AI	W

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
RaFanVFDSpd	Return Air Fan VFD Speed %	AO	%
RaFanVFDTmp	Return Air Fan VFD Internal Temp	AI	deg F
RaFanVFDVIn	Return Air Fan VFD Input Voltage	AI	V
RaFanVFDVOut	Return Air Fan VFD Output Voltage	AI	V
RaHiStPAlm	Return Air High Static Pressure Alarm	BI	Normal Alarm
RaLoStPAlm	Return Air Low Static Pressure Alarm	BI	Normal Alarm
Ra%CFM.Calc	Return Air Percentage by Flow	AI	%
Ra%Tmp.Calc	Return Air Percentage by Temperature	AI	%
RaRh	Return Air Relative Humidity	AI	%RH
RaSmoke	Return Air Smoke Detected	BI	Normal Alarm
RaTmp	Return Air Temperature	AI	deg F
RaTmp.Calc	Return Air Temperature Calculation	AI	deg F
ReHtStgCmd	Electric Reheat Stage Control Command	MO	1, 2, …
ReHtStgCmd	Electric Reheat Stage Control Command	BO	Off On
ReHtStg	Electric Reheat Stage #	MI	1, 2, …
ReHtStgSts	Electric Reheat Stage # Status	BI	Off On
SaCFM	Supply Air Airflow	AI	cfm
SaCFM.Calc	Supply air flow calculation	AI	cfm
SaCFMSpt.Var	Supply Air CFM setpoint	AV	cfm
SaDmprCmd	Supply Air Damper Control Command	AO	%
SaFanCmd	Supply Air Fan Command	BO	Off On
SaFanHp	Supply Air Fan Horsepower	AI	hp
SaFanSts	Supply Air Fan Status	BI	Off On
SaFanVelP	Supply Air Fan Velocity Pressure	AI	in wc
SaFanVFDAmp	Supply Air Fan VFD Current	AI	A

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
SaFanVFDCmd	Supply Air Fan VFD Command	BO	Off On
SaFanVFDHz	Supply Air Fan VFD Output Frequency	AI	Hz
SaFanVFDkWh	Supply Air Fan VFD kWh	AI	kWh
SaFanVFDPwr	Supply Air Fan VFD Input Power	AI	W
SaFanVFDSpd	Supply Air Fan VFD Speed %	AO	%
SaFanVFDTmp	Supply Air Fan VFD Internal Temp	AI	deg F
SaFanVFDVIn	Supply Air Fan VFD Input Voltage	AI	V
SaFanVFDVOut	Supply Air Fan VFD Output Voltage	AI	V
SaHiStP	Supply Air High Static Pressure Alarm	BI	Normal Alarm
SaLoStP	Supply Air Low Static Pressure Alarm	BI	Normal Alarm
SaRh	Supply Air Relative Humidity	AI	%RH
SaRhPb.Var	Supply Air Humidity Proportional Band	AO	%RH
SaSmoke	Supply Air Smoke Detected	BI	Normal Alarm
SaStP	Supply Air Static Pressure	AI	in wc
SaStPSpt.Var	Supply Air Static Pressure Set Point	AV	in wc
SaTmp	Supply Air Temperature	AI	deg F
SaTmpErr.Calc	SaTmp v SaTmpSpt	AI	deg F
SaTmpHiSpt.Var	Supply Air Temperature Reset High	AV	deg F
SaTmpHtgSpt.Var	Supply Air Heating Temperature Setpoint	AV	deg F
SaTmpLoSpt.Var	Supply Air Temperature Reset Low	AV	deg F
SaTmpSpt.Var	Supply Air Temperature Setpoint	AV	deg F
SmokeDmprCmd	Smoke Damper Command	BO	Closed Open
ZnDmprXXCmd	Zone Damper XX Command	AO	% open
ZnDmprXXPos	Zone Damper XX Position	AO	% open
ZnDmprXXSts	Zone Damper XX Status	AO	% open

Air Handling Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
ZnXXCO2	Zone XX CO2	AO	% open
ZnXXRh	Zone XX Relative Humidity	AO	% open
ZnXXTmp	Zone XX Temp	AO	deg F
ZnXXTmpSpt.Var	Zone XX Temp Setpoint	AI/AV	deg F

1.6 Glossary of Boiler Plant Objects

A. The Glossary of Boiler Plant Objects is a reference to previously created objects that use the BAS Naming Guidelines. It is a guide to proper object naming, not a list of exclusive usable objects. Objects should still be named according to the guidelines listed under *Naming General* starting on page 3.

B. When multiple plants are present at a site, points should be identified using the building/space qualifier (ex HwrTmp becomes MAINHwrTmp, where "MAIN" is the building qualifier).

Boiler Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
BlrXXAlm	Boiler XX Alarm	BO	Normal Alarm
BlrXXCmd	Boiler XX Enable Command	BO	Off On
BlrXXHwsTmp	Boiler XX Hot Water Supply Temperature	AI	deg F
DCwPSI	Domestic Coldwater Pressure	AI	PSI
DomHwPSI	Domestic Hotwater Pressure	AI	PSI
DomHwTankXXTmp	Domestic Hotwater Tank XX Temp	AI	deg F
HwPAlmManReset	Hot Water Pump Alarm Manual Reset	BO	Off On
HwPLeadLag	Hot Water Pump Lead Lag	BI	Lead Lag
HwPSysEna	Hot Water Pump System Enable Cmd	BO	Off On
HwPXXAlm	Hot Water Pump XX Alarm	BI	Normal Alarm
HwpXXCmd	Hot Water Pump XX Command	BO	Off On
HwPXXSts	Hot Water Pump XX Status	BI	Off On
HwrTmp	Hot Water Return Temperature	AI	deg F
HwsTmp	Hot Water Supply Temperature	AI	deg F
HwsTmpHiLimit.Var	Hot Water Supply High Limit	AV	deg F
HwsTmpHiSpt.Var	Hot Water Supply Reset High	AV	deg F
HwsTmpLoLimit.Var	Hot Water Supply Low Limit	AV	deg F
HwsTmpLoSpt.Var	Hot Water Supply Reset Low	AV	deg F
HwsTmpSpt.Var	Hot Water Supply Setpoint	AV	deg F
HxXXEna	Heat Exchanger XX Enable Status	BI	Disable Enable
HxXXHwGPM	Heat Exchanger XX Hot Water Flow	AI	gpm
HxXXHwrTmp	Heat Exchanger XX Hot Water Return Temp	AI	deg F
HxXXHwsTmp	Heat Exchanger XX Hot Water Supply Temp	AI	deg F
HxXXHwsTmpSpt.Var	Heat Exchanger XX Hot Water Supply Temp SetPoint	AI	deg F

Boiler Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
HxXXVlv1Cmd	Heat Exchanger XX Steam Valve 1/3 Command	AO	%
HxXXVlv2Cmd	Heat Exchanger XX Steam Valve 2/3 Command		AO
HxXXVlvCmd	Heat Exchanger XX Steam Valve Command	AO	%
OaEnt	Outside Air Enthalpy	AI	Btu/lb
OaTmpHiSpt.Var	Outside Air Reset High	AV	deg F
OaTmpLoSpt.Var	Outside Air Reset Low	AV	deg F

1.7 Glossary of Chiller Plant Objects

A. The Glossary of Chiller Plant Objects is a reference to previously created objects that use the BAS Naming Guidelines. It is a guide to proper object naming, not a list of exclusive usable objects. Objects should still be named according to the guidelines listed under *Naming General* starting on page 3.

B. When multiple plants are present at a site, points should be identified using the building/space qualifier (ex ChwrTmp becomes MAIN ChwrTmp, where "MAIN" is the building qualifier).

Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
ChlrStagePt.Calc	Secondary Flow / Primary Flow	AV	%
ChlrXXAlm	Chiller 01 Alarm	BI	Normal Alarm
ChlrXXCap.Var	Chiller Capacity	AI	tons
ChlrXXChwDeltaTmp.Calc	Chiller Chw Delta Temp	AI	deg F
ChlrXXChwGPM	Chiller Chw Flow	AI	gpm
ChlrXXChwIsoVlvCmd	Chiller XX Condenser Iso Valve Command	BO	Open Close
ChlrXXChwIsoVlvCmd	Chiller XX Condenser Iso Valve Command	AO	%
ChlrXXChwIsoVlvPos	Chiller XX Condenser Iso Valve Position	AI	%
ChlrXXChwIsoVlvSts	Chiller XX Condenser Iso Valve Status	BI	Open Close
ChlrXXChwLoad.Calc	Chiller Chw Energy Load (Btu/hr)	AV	Btuh
ChlrXXChwrTmp	Chiller Chw Return Water Flow	AI	gpm
ChlrXXChwrTmpSpt.Var	Chiller Chw Supply Water Temp Setpoint	AV	deg F
ChlrXXChwsTmp	Chiller Chw Supply Water Temp	AI	deg F
ChlrXXChwsTmpSptErr.Calc	Chiller Chw Supply Water Temp v Setpoint	AV	deg F
ChlrXXCmd	Chiller Command	BO	Off On
ChlrXXCondAppTmp.Calc	Chiller Condenser Approach Temp	AV	deg F
ChlrXXCondPSI	Chiller Condenser Pressure	AI	psi
ChlrXXCondRefTmp	Chiller Condenser Refrigerant Temp	AI	deg F
ChlrXXCwDeltaTmp.Calc	Chiller CW Delta Temp	AV	deg F
ChlrXXCwGPM	Chiller CW Flow	AI	gpm
ChlrXXCwIsoVlvCmd	Chiller XX Chilled Water Iso Valve Command	BO	Open Close
ChlrXXCwIsoVlvCmd	Chiller XX Chilled Water Iso Valve Command	AO	%
ChlrXXCwIsoVlvPos	Chiller XX Chilled Water Iso Valve Position	AI	%
ChlrXXCwIsoVlvSts	Chiller XX Chilled Water Iso Valve Status	BI	Open Close
ChlrXXCwLoad.Calc	Chiller CW Energy Load (Btu/hr)	AV	Btuh

Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
ChlrXXCwrTmp	Chiller CW Return Water Temp	AI	deg F
ChlrXXCwsTmp	Chiller CW Supply Water Temp	AI	deg F
ChlrXXEvapAppTmp.Calc	Chiller Evaporator Approach Temp	AV	deg F
ChlrXXEvapPSI	Chiller Evaporator Pressure	AI	psi
ChlrXXEvapRefTmp	Chiller Evaporator Refrigerant Temp	AI	deg F
ChlrXXFLA	Chiller FLA	AI	A
ChlrXXFLAPer	Chiller % FLA	AI	%
ChlrXXIsoVlvCmd	Chiller XX Iso Valve Command	BO	Open Close
ChlrXXIsoVlvSts	Chiller XX Iso Valve Status	BI	Open Close
ChlrXXOilDP	Chiller Oil Differential Pressure	AI	psi
ChlrXXRLA	Chiller RLA	AI	A
ChlrXXRLAPer	Chiller % RLA	AI	%
ChlrXXRunTime	Chiller Run time (current session)	AI	hours
ChlrXXRunTimeTot	Chiller Run time (all time)	AI	hours
ChlrXXSts	Chiller Status	BI	Off On
ChlrXXVFDAmp	Chiller VFD Current	AI	A
ChlrXXVFDCmd	Chiller VFD Command	BO	Off On
ChlrXXVFDHz	Chiller VFD Output Frequency	AI	Hz
ChlrXXVFDkWh	Chiller VFD kWh	AI	kWh
ChlrXXVFDPwr	Chiller VFD Input Power	AI	W
ChlrXXVFDSpd	Chiller VFD Speed %	AO	%
ChlrXXVFDTmp	Chiller VFD Internal Temp	AI	deg F
ChlrXXVFDVIn	Chiller VFD Input Voltage	AI	V
ChlrXXVFDVOut	Chiller VFD Output Voltage	AI	V
ChlXXEna	Chiller XX Enable	BO	Off On

Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
ChwBypDir	Bypass Direction	BI	Forward Reverse
ChwBypDirGPM.Calc	Bypass Direction	BI	Forward Reverse
ChwBypDirTmp.Calc	Bypass Direction	BI	Forward Reverse
ChwBypGPM	Bypass Flow	AI	gpm
ChwBypGPM.Calc	Bypass Flow	AV	gpm
ChwBypTmp	Bypass Temp	AI	deg F
ChwBypVlvCmd	Bypass Valve Command	BO	Off On
ChwBypVlvPos	Bypass Valve Position	AI	% Open
ChwBypVlvSts	Bypass Valve Status	BI	Off On
CTXXChwIsoVlvCmd	Cooling Tower XX Condenser Iso Valve Command	BO	Open Close
CTXXChwIsoVlvSts	Cooling Tower XX Condenser Iso Valve Status	BI	Open Close
CTXXCmd	Cooling Tower Command	BO	Off On
CTXXCwIsoVlvCmd	Cooling Tower XX Chilled Water Iso Valve Command	BO	Open Close
CTXXCwIsoVlvSts	Cooling Tower XX Chilled Water Iso Valve Status	BI	Open Close
CTXXDeltaTmp.Calc	Cooling Tower Delta Temp	AV	deg F
CTXXGPM	Cooling Tower Flow	AI	gpm
CTXXFanHp	Cooling Tower Fan Horsepower	AI	hp
CTXXIsoVlvCmd	Cooling Tower XX Iso Valve Command	BO	Open Close
CTXXIsoVlvSts	Cooling Tower XX Iso Valve Status	BI	Open Close
CTXXLeadFan	Cooling Tower 01 Lead Fan	BO	State0 State1
CTXXLoad.Calc	Cooling Tower Energy Load (Btu/hr)	AV	Btuh
CTXXCwrTmp	Cooling Tower Return Water Temp	AI	deg F
CTXXRunTime	Cooling Tower Run time (current session)	AI	hours
CTXXRunTimeTot	Cooling Tower Run time (all time)	AI	hours

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Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
CTXXCwsTmp	Cooling Tower Supply Water Temp	AI	deg F
CTXXSts	Cooling Tower Status	BI	Off On
CTXXVFDAlm	Cooling Tower 01 VFD Alarm	BI	Off On
CTXXVFDAmp	Cooling Tower VFD Current	AI	A
CTXXVFDCmd	Cooling Tower VFD Command	BO	Off On
CTXXVFDHz	Cooling Tower VFD Output Frequency	AI	Hz
CTXXVFDkWh	Cooling Tower VFD kWh	AI	kWh
CTXXVFDPwr	Cooling Tower VFD Input Power	AI	W
CTXXVFDSpd	Cooling Tower VFD Speed %	AI	%
CTXXVFDSts	Cooling Tower 01 Status	BI	Off On
CTXXVFDTmp	Cooling Tower VFD Internal Temp	AI	deg F
CTXXVFDVIn	Cooling Tower VFD Input Voltage	AI	V
CTXXVFDVOut	Cooling Tower VFD Output Voltage	AI	V
CwBypVlvCmd	Cw Bypass Valve Command	BO	Close Open
CwBypVlvPos	Cw Bypass Valve Position	AI	%
CwBypVlvSpt.Var	Condenser Water Bypass Valve Setpoint	AO	deg F
CwBypVlvSts	Cw Bypass Valve Status	BI	Close Open
CwPXXAlm	Cw Pump 07 Alarm	BI	Off On
CwPXXCmd	Cw Pump Command	BO	Off On
CwPXXHp	Cw Pump Horsepower	AI	hp
CwPXXRunTime	Cw Pump Run time (current session)	AI	hours
CwPXXRunTimeTot	Cw Pump Run time (all time)	AI	hours
CwPXXSts	Cw Pump Status	BI	Off On
CwPXXVFDAmp	Cw Pump VFD Current	AI	A
CwPXXVFDCmd	Cw Pump VFD Command	BO	Off On

Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
CwPXXVFDHz	Cw Pump VFD Output Frequency	AI	Hz
CwPXXVFDkWh	Cw Pump VFD kWh	AI	kWh
CwPXXVFDPwr	Cw Pump VFD Input Power	AI	W
CwPXXVFDSpd	Cw Pump VFD Speed %	AO	%
CwPXXVFDTmp	Cw Pump VFD Internal Temp	AI	deg F
CwPXXVFDVIn	Cw Pump VFD Input Voltage	AI	V
CwPXXVFDVOut	Cw Pump VFD Output Voltage	AI	V
CwrTmp	Condenser Water Return Temperature	AI	deg F
CwsTmp	Condenser Water Supply Temperature	AI	deg F
CwsTmpSpt.Var	Condenser Water Supply Temp Setpoint	AO	deg F
DecouplerTmp	Decoupler Temperature	AI	deg F
OaEnt	Outside Air Enthalpy	AI	Btu/lb
OaRh	Outside Air Relative Humidity	AI	%RH
OaTmp	Outside Air Temp	AI	deg F
OaTmpDp	Outside Air Temp Dew Point	AI	deg F
OaTmpWb	Outside Air Temp Wet Bulb	AI	deg F
PChwPXXAlm	Primary Chw Pump XX Alarm	BI	Off On
PChwPXXCmd	Primary Chw Pump Command	BO	Off On
PChwPXXHp	Primary Chw Pump Horsepower	AI	hp
PChwPXXRunTime	Primary Chw Pump Run time (current session)	AI	hours
PChwPXXRunTimeTot	Primary Chw Pump Run time (all time)	AI	hours
PChwPXXSts	Primary Chw Pump Status	BI	Off On
PChwPXXVFDAmp	Primary Chw Pump VFD Current	AI	A
PChwPXXVFDCmd	Primary Chw Pump VFD Command	BO	Off On
PChwPXXVFDHz	Primary Chw Pump VFD Output Frequency	AI	Hz

Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
PChwPXXVFDkWh	Primary Chw Pump VFD kWh	AI	kWh
PChwPXXVFDPwr	Primary Chw Pump VFD Input Power	AI	W
PChwPXXVFDSpd	Primary Chw Pump VFD Speed %	AO	%
PChwPXXVFDTmp	Primary Chw Pump VFD Internal Temp	AI	deg F
PChwPXXVFDVIn	Primary Chw Pump VFD Input Voltage	AI	V
PChwPXXVFDVOut	Primary Chw Pump VFD Output Voltage	AI	V
PChwrTmp	Primary Chw Return Water Temperature	AI	deg F
PChwsTmp	Primary Chw Supply Water Temperature	AI	deg F
RefAlm	Refrigerant Monitor Alarm	BI	Alarm Normal
SChwDeltaTmp.Calc	SChw Delta Temp (building)	AV	deg F
SChwDP	SChw Differential Pressure	AI	psi
SChwDPErr.Calc	SChw Differential Pressure v Setpoint	AV	psi
SChwDPSpt.Var	SChw Differential Pressure Setpoint	AV	psi
SChwDPSpt.Var	SChw Differential Pressure Setpoint	AO	psi
SChwEna	Secondary Chilled Water System Enable	BO	Off On
SChwGPM	SChw Flow	AI	gpm
SChwLoad.Calc	SChw Load (building)	AV	Btuh
SChwPPIDCmd	Secondary Pump PID Command	AO	%
SChwPXXAlm	Secondary Pump XX Alarm	BI	Off On
SChwPXXCmd	Secondary Chw Pump Command	BO	Off On
SChwPXXEna	Secondary Chilled Water System Enable	BO	Off On
SChwPXXHp	Secondary Chw Pump Horsepower	AI	hp
SChwPXXRunTime	Secondary Chw Pump Run time (current session)	AI	hours
SChwPXXRunTimeTot	Secondary Chw Pump Run time (all time)	AI	hours
SChwPXXSts	Secondary Chw Pump Status	BI	Off On

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Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
SChwPXXVFDAmp	Secondary Chw Pump VFD Current	AI	A
SChwPXXVFDCmd	Secondary Chw Pump VFD Command	BO	Off On
SChwPXXVFDHz	Secondary Chw Pump VFD Output Frequency	AI	Hz
SChwPXXVFDkWh	Secondary Chw Pump VFD kWh	AI	kWh
SChwPXXVFDPwr	Secondary Chw Pump VFD Input Power	AI	W
SChwPXXVFDSpd	Secondary Chw Pump VFD Speed %	AO	%
SChwPXXVFDTmp	Secondary Chw Pump VFD Internal Temp	AI	deg F
SChwPXXVFDVIn	Secondary Chw Pump VFD Input Voltage	AI	V
SChwPXXVFDVOut	Secondary Chw Pump VFD Output Voltage	AI	V
SChwrTmp	SChw Return Temp	AI	deg F
SChwsTmp	SChw Supply Temp	AI	deg F
SChwsTmpErr.Calc	SChw Supply Temp v Setpoint	AV	deg F
SChwsTmpSpt.Var	SChw Supply Temp Setpoint	AV	deg F
SysAlm	System Alarm	BI	Alarm Normal
TotCTDeltaTmp	Total Cooling Tower Cw Delta Temp	AI	deg F
TotCTDeltaTmp.Calc	Total Cooling Tower Cw Delta Temp	AV	deg F
TotCTGPM	Total Cooling Tower Cw Water Flow	AI	gpm
TotCTGPM.Calc	Total Cooling Tower Cw Water Flow	AV	gpm
TotCTLoad.Calc	Total Cooling Tower Cw Load	AV	Btuh
TotCwDeltaTmp	Total Chiller Cw Delta Temp	AI	deg F
TotCwDeltaTmp.Calc	Total Chiller Cw Delta Temp	AV	deg F
TotCwGPM	Total Chiller Cw Water Flow	AI	gpm
TotCwGPM.Calc	Total Chiller Cw Water Flow	AV	gpm
TotCwLoad.Calc	Total Chiller Cw Load	AV	Btuh
TotPChwDeltaTmp	Total Primary Chw Delta Temp	AV	deg F

Chiller Plant Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
TotPChwDeltaTmp.Calc	Total Primary Chw Delta Temp	AV	deg F
TotPChwGPM	Total Primary Chw Flow	AV	gpm
TotPChwGPM.Calc	Total Primary Chw Flow	AV	gpm
TotPChwLoad.Calc	Total Primary Chw Load	AV	Btuh
TotSChwDeltaTmp	Total Secondary Chw Delta Temp	AV	deg F
TotSChwDeltaTmp.Calc	Total Secondary Chw Delta Temp	AV	deg F
TotSChwGPM	Total Secondary Chw Flow	AI	gpm
TotSChwGPM.Calc	Total Secondary Chw Flow	AV	gpm
TotSChwLoad.Calc	Total Secondary Chw Load	AV	Btuh
xxxxxkWd	xxxxx kW Demand	AI	kW
xxxxxkWh	xxxxx kW Hours	AI	kWh
xxxxxkWPulse	xxxxx kW Pulse Counter	BI	Off On

1.8 Glossary of Terminal Unit Objects

A. The Glossary of Terminal Unit Objects is a reference to previously created objects that use the BAS Naming Guidelines. It is a guide to proper object naming, not a list of exclusive usable objects. Objects should still be named according to the guidelines listed under *Naming General* starting on page 3.

B. All Terminal Units (VV, CV, FCU) are to be numbered using the associated AHU two digit identifying number a unique three number identifier (ex VV-01-001, VV-01-002, … , VV-01-998, VV-01-999). Letters are not allowed in the Terminal Unit number. When duplicates exist at a facility, the facility is to renumber Terminal Unit to meet the naming standard.

C. Deviations from the naming standard (such as AHU1E > VV-1E-001 from AHU or VV-01-01M, VV-01-01S for master/slave) will be considered on a per site basis and must be approved by the Energy Service Center.

D. The Energy Service Center will make considerations to allow vendors to use their own naming standard for terminal units and will be made on a per vendor basis.

E. When the Terminal Unit is not available in the breadcrumbs for an object (ex. DaCFM displays as SiteName.AHU##.VV-##-###.DaCFM), the Terminal Unit name shall appear in the object name (ex. DaCFM becomes VV-##-###.DaCFM).

Terminal Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
DaCFM	Discharge Air Flow in CFM	AI	cfm
DaCFMSpt.Var	Discharge Air Flow Setpoint in CFM	AI	cfm
DaRh	Discharge Air Relative Humidity	AI	%
DaTmp	Discharge Air Temperature	AI	deg F
DaTmpSpt.Var	Discharge Air Temperature Setpoint	AO	deg F
DmprCmd	Damper Command	BO	Close Open
DmprPos	Damper Position	AI	% open
HwVlvCmd	Heating Valve Control Command	AO	% open
HwVlvPos	Hot Water Valve Position	AI	% open
ReHtStgCmd	Electric Reheat Stage Control Command	MO	1, 2, …
ReHtStgCmd	Electric Reheat Stage Control Command	BO	Off On

Terminal Unit Objects			
Object Name	**Object Definition**	**Point Type**	**Units**
ReHtStg	Electric Reheat Stage #	MI	1, 2, …
ReHtStgSts	Electric Reheat Stage # Status	BI	Off On
SysEna	System Enable	BI	Off On

APPENDIX B-2: CHILLER PLANT SEQUENCE OF OPERATIONS

Variable Speed Primary

Heat Recovery Chiller – No Economizer

A BAS shall be provided to control, monitor, and automate the operation of the chilled water production plant and pumping system. The system can consist of any number of chillers and pumps, though this sequence is written around the following scenario: two water cooled chillers - each equipped with a variable frequency drive, (CH-1, 2), two chilled water pumps with variable frequency drives (CHWP-1, 2) in a headered configuration, two cooling towers (CT-1, 2) and two condenser water pumps headered together with variable frequency drives (CWP-1, 2).

Additionally, the system shall include a heat recovery chiller (HRC-1) piped in a side stream configuration upstream of the chilled water plant on the chilled water return. The heat recovery chiller shall have duplex pumps on the chilled water side (HRCCHP-1 and -2) and duplex pumps on the hot water side (HRCHWP-1 and -2), each sized for 100% of the design flow and controlled in a lead/lag scenario with only one respective pump running at a time.

Chilled Water Plant Optimization

The building automation system (BAS) shall optimize the performance of the chilled water plant to meet the building load while minimizing the total plant energy use. The control system shall use the manufacturer-provided performance curves specific to the installed cooling towers, pumps, and chillers to determine the optimal arrangement in which to run.

Variable inputs to the optimization algorithm shall include outdoor wet bulb temperature and building chilled water load as measured by BTU meter installed on the system.

Fixed inputs represent limiting characteristics in the system. These are to be set by a qualified factory-controls representative during startup and verified through the commissioning process. These variables include a combination of any or all of the following:

- rated machine capacities (tons);
- rated full load amps (FLA);

- rated condenser water flow (GPM);
- minimum condenser water flow;
- rated chilled water flow;
- minimum chilled water flow;
- maximum chilled water flow;
- peak coefficient of performance (COP);
- design lift;
- and lift sensitivity.

Controlled variables shall include a combination of any or all of the following:

- staging of cooling towers;
- cooling tower fan speeds;
- staging of condenser water pumps;
- condenser water pump speeds;
- staging of chilled water pumps;
- chilled water pump speeds;
- staging of chillers;
- chiller speeds;
- bypass valve positions;
- and activation of water-side economizer (where applicable);

Modifications to this control sequence shall be considered if the additional cost is low versus the incremental savings in energy. These alternatives may include such features as:

- adaptive tuning of the control algorithm based on real-time equipment performance feedback;
- and weather station data and forecasting inputs for predictive plant control.

Chilled Water Temperature Reset
The BAS shall monitor the position of the chilled water valves throughout the system to determine which is in the widest open position. This shall be designated as the critical zone (Cz) valve. The BAS shall reset the chilled water temperature by increasing the chilled water temperature setpoint up 0.5 deg. F every 15 minutes and rechecking the Cz valve position. This process is to be repeated continually until the maximum chilled water temperature of

48°F (adj.) is reached or the Cz chilled water valve position is greater than 85% (adj.) open for 10 min. (adj.)

Any chilled water valve may be added to an exception list to be ignored by the BAS as a potential critical zone.

The BAS shall also monitor return air humidity in all the air handlers. In the event any AHU measures humidity higher than 56% for greater than 10 min. (adj.), the BAS shall halt the reset and the chilled water temp will not be allowed to go higher until the return air humidity drops below 54% for 10 minutes (adj.)

If the high limit setpoint of the temperature reset scheme is reached but the Cz valve is still not open above 85%, then the BAS shall initiate the chilled water pump differential pressure reset.

Once the Cz valve is open to greater than 95% (adj.) for longer than 10 min. (adj.) the reset scheme shall operate in reverse, with the BAS turning down the chilled water temperature setpoint by 0.5 deg. every 15 minutes until the Cz valve is at or below 95% open.

Chilled Water Differential Pressure Reset

Once the chilled water is at its high limit but the Cz valve is still not opened above 85%, the BAS shall reset the differential pressure (DP) by decreasing the chilled water DP setpoint down 0.2 psi (adj.) every 15 minutes and rechecking the Cz valve position. This process is to be repeated continually until the critical zone chilled water valve position is greater than 85% open for 10 min. (adj.)

If the Cz valve is open to greater than 95% for longer than 10 min. (adj.) the reset scheme shall operate in reverse, with the BAS turning up the DP setpoint by 0.2 psi every 15 minutes until the Cz valve is at or below 95% open.

Chiller Start and Stop

The chilled water and condenser water pumps are energized manually through the action of an H-O-A switch when it is in the hand position or by the BAS when the H-O-A is in the automatic position.

To ensure that minimum flow is achieved at all times for any operable chiller, the evaporator flow rate for each respective chiller is to be determined from:

- the manufacturer’s verified and witnessed design minimum flow rate;
- the corresponding verified and witnessed design evaporator differential pressure;

- and the measured evaporator differential pressure from the measured differential pressure from the sensors located on the supply and return chilled water line for each chiller using the following formula:

$$Flow_{actual} = \sqrt{\frac{\Delta P_{actual}}{\Delta P_{design}}} \times Flow_{design}$$

A flow meter is not to be installed at each chiller.

The minimum chilled water flow shall be maintained through all operating chillers by modulating the system bypass valve located in the bypass line. When the chilled water flow decreases past the minimum flow rate required for the online chiller(s), the bypass valve shall be modulated open. This valve shall be a spherical ball valve with a minimum turndown ratio of 400:1.

Each time a chiller is started or stopped the following information shall be logged:

- Date and time
- Identity of chillers operating before adding or stopping
- Chilled water supply temp
- Chilled water return temp
- Chilled water flow
- Identity of chilled water pumps operating
- Speed of chilled water pumps
- Chilled water differential pressure set point
- Chilled water differential pressure reading
- Outside air temperature
- Outside air humidity

All timers and other specified parameters are to be independently adjustable.

Lead/Lag Equipment Selection
The BAS shall accommodate user input data that defines the design cooling capacity of the chillers (tons) and the maximum and minimum chiller flow rates and corresponding differential pressures for both the evaporator and the condenser. These values shall be verified from the manufacturer and used for operator information on the BAS graphics.

The BAS shall be programmed to accommodate user assignment of the order in which multiple chillers are to be staged.

The BAS shall provide an operator interface graphic screen per the requirements of the HCA BAS Graphics Design Guidelines to track run hours, rotate the lead/lag, and designate a chiller as "out of service". The BAS shall track and display the run times of each chiller, pump, and cooling tower. The BAS shall not automatically rotate lead/lag but shall display a prompt to the operator to initiate rotation.

Heat Recovery Chiller
As the primary source of heating, the normal mode of operation is for the heat recovery chiller to run all the time, unless in alarm or maintenance override. This means the lead HRC chilled water pump and lead hot water pump will be energized continually. With no building chillers in operation, the lead building chilled water pump will be energized and running at constant volume, turned down to provide the minimum flow allowed by the heat recovery chiller. All building chillers will have their chilled water isolation valve closed except for the lead chiller. The lead chiller will have its chilled water isolation valve open to allow for flow to the building.

In the event of a failure of either lead hot water or lead chilled water HRC pump to start and prove flow, the BAS shall alarm at the operator workstation, disable the failed pump, change the standby pump to the lead, and attempt to start that pump.

Starting the Chilled Water System
The BAS shall monitor the chilled water supply temperature, the chilled water return temperature, and the total chilled water flow. The BAS shall display the distributed system tonnage as calculated from the BTU meter on the chilled water system graphics screen.

If the leaving chilled water temperature set point is not met for 10 minutes (adj.), the BAS shall perform the following sequence:

1. Initiate cooling tower control
2. Ramp the lead chilled water pump speed to the design flow for a single chiller
3. Enable the lead chiller
4. Prove the lead chiller's flow switches
5. Attempt to start the lead chiller

If the lead chilled water pump status is not received, the BAS will fail that lead pump and start the standby pump. If any isolation valve fails to open, the BAS will fail that chiller and initiate the process for starting the next chiller in sequence. If the lead chiller fails to start within 10 minutes (adj.) following the BAS command, the BAS shall issue an alarm, deactivate the chiller, initiate the process for starting the next chiller in sequence, open the evaporator and condenser valves on the next chiller in the lineup, and close both evaporator and condenser isolation valves on the lead chiller.

The lead chiller shall maintain a chilled water discharge temperature corresponding to the common chilled water system supply water set point (42°F, adj.). The BAS shall be capable of resetting the common chilled water system supply temperature based on the reset scheme or by operator command.

Chilled Water Pump Speed Control
The chilled water pump speed shall be maintained through a PID loop control. The speed of the chilled water pump shall be modulated to maintain the chilled water system differential pressure as sensed by the differential pressure sensor installed across the coil at the most remotely located AHU.

Starting the Lag Chilled Water Pump
The lag chilled water pump shall be started when the BAS optimization algorithm determines it is more efficient to run with another pump. If a chilled water pump fails to start or run on command, the next lag chilled water pump shall start immediately, an alarm shall be reported to the BAS graphics, and the failed pump is to be marked as "out of service".

Once the lag chilled water pump has started, all running pumps shall be modulated together to maintain the chilled water differential pressure at set point. The chilled water differential pressure transmitter shall be wired to the same BAS controller that is controlling the chilled water pumps. The operation of the chilled water pumps shall not be dependent on the controls network level communications.

Stopping the Lag Chilled Water Pump
The lag chilled water pump shall be stopped when the BAS optimization algorithm determines it is more efficient to run with a single pump.

Starting the Lag Chiller
The lag chiller shall be started when the BAS optimization algorithm determines it is more efficient to run with another chiller online. If a chiller fails to start or continue running on command, the BAS shall immediately initiate the starting sequence for the next lag chiller in the lineup as programmed.

When the first chiller is energized, no additional chillers shall be added or removed for an adjustable length of time (30 minutes) to allow the system to stabilize. After a lag chiller is added or removed, no additional chillers shall be added or removed for an adjustable length of time (15 minutes) to allow the system to stabilize.

The lag chiller's evaporator isolation valves shall be slowly opened over a period of 2 minutes (adj.) to avoid large flow variations in the operating chillers. Once valve is proved open, the running chiller shall unload and the lag chiller shall start, match capacity, and operate in parallel with lead chiller to maintain chilled water supply temperature setpoint.

Stopping a Lag Chiller
The lag chiller shall be stopped when the BAS optimization algorithm determines it is more efficient to run with one fewer chiller online. At that time, the lag chiller shall be disabled and its isolation valve slowly modulated closed to avoid sudden variation in chiller flow. The lag chiller shall be disabled in reverse order as dictated by the BAS lineup.

Stopping the Lead Chiller
The first chiller started in the lead/lag sequence shall be disabled if the temperature of the water returning to the chiller plant is within 2°F (adj.) of the chilled water leaving water temperature setpoint.

At that time, the lead chiller shall be disabled and its tower water isolation valve shall slowly modulate closed to avoid a sudden variation in chiller flow. The chilled water isolation valve, however, shall remain open to allow for flow to the building from the HRC.

Condenser Water Return Temp Control
Upon a call for condenser water flow from the BAS, due to a call for mechanical cooling beyond the HRC's capacity, the BAS shall perform the following sequence:

1. Open the lead tower's return valve
2. Close the lead tower's supply valve
3. Open the lead tower's bypass valve (bypass to the basin)
4. Energize lead tower pump and ramp up to design flow.

If the tower return loop temperature is a minimum of 5 deg. (adj.) above minimum running temperature allowed by chiller manufacturer instructions for 1 min. (adj.), then bypass valve shall close and the supply valve shall open. If the tower return loop temperature is still a minimum of 5 deg. (adj.) above the minimum running temperature allow the chilled manufacturer, the tower fan shall start at minimum speed. All control points shall then be released to automatic mode and controlled on the BAS optimization algorithm.

If the BAS optimization algorithm determines it is beneficial to start another cooling tower, the BAS shall perform the following sequence:

1. Open the lag tower's return valve
2. Open the lag tower's supply valve
3. Energize the lag tower's fan at minimum speed

4. Slowly ramp the lag tower's fan to match the speed of the running tower fans.

Once all the tower fans are operating at the same speed, all tower fans shall be released to automatic control by the BAS optimization algorithm.

If the BAS optimization algorithm determines it is beneficial to start another tower pump, the BAS shall energize that pump to its minimum speed and slowly ramp it up until its speed matches the running pumps. Once all the tower pumps are operating at the same speed, all tower pumps shall be released to automatic control by the BAS optimization algorithm.

If the condenser pumps are dedicated rather than in a headered arrangement, they shall be energized along with their respective chiller.

Tower Loop Sub-Freezing Operation (at ambient of 35 deg. (adj.) and below)

When outside air temp is 35 deg (adj.) or below and either tower bypass valve is not in bypass mode, then tower shall operate every 30 minutes (adj.) in defrost mode. In defrost mode, tower fans shall reverse direction and run at low speed for 5 minutes (adj.).

When outside air temp is 35 deg (adj.) or below and either tower is de-energized or is in bypass mode, then basin heaters shall cycle on to maintain basin temp above 34 deg. (adj.).

Air Handler Chilled Water Coil Freeze Protection

Upon a call to activate the freeze protection mode from an air handler - caused by the freeze stat trip - the associated AHU chilled water valve shall swing to 100% open (full flow), all primary chilled water pumps will be energized, and the BAS shall modulate the pump speed to meet the DP setpoint maximum with no reset. The building chillers, waterside economizer, and heat recovery chiller will all remain in their current state.

Once all AHUs have exited freeze protection mode through manual reset of every AHU freeze stat, the chilled water pumps will be released back to automatic mode and all reset loops will be enabled.

Chilled Water Loop Freeze Protection

In the unlikely event the chilled water return temperature drops below 38 deg. F, the BAS shall alarm at the operator workstation.

If the chilled water return temp drops below 33 deg. F, ALL of the following shall happen:

1. the chilled water pumps shall continue to run under control of the BAS with DP setpoint locked at maximum and the chilled water temperature reset disabled;

2. the heat recovery chiller shall shut down but the HRC chilled water pumps shall continue to flow water through the evaporator barrel and the HRC hot water pumps shall continue to flow water through the condenser barrel;
3. the waterside economizer tower loop bypass valve shall close (fully bypassing the Hx) and the chilled water Hx valve shall fully bypass the Hx as well;
4. the building chillers shall be disabled;
5. the tower fans shall be disabled;
6. the tower pumps shall be deenergized;
7. the tower bypass valve shall fully bypass flow to the basin (not the upper spray bars or hot deck);
8. and the tower basin heaters shall be energized.

This mode shall remain active until the return temperature rises above 36 deg. F.

Primary - Variable Speed Secondary

Heat Recovery Chiller or Economizer
A BAS shall be provided to control, monitor, and automate the operation of the chilled water production plant and pumping system. Although the system can consist of any number of chillers and pumps, this sequence is written around the following scenario: two water cooled chillers - each equipped with a variable frequency drive, (CH-1, 2), two constant volume primary chilled water pumps (PCHWP-1, 2) on variable speed drives in a dedicated configuration, two secondary pumps on variable speed drives (SCHWP-1, 2) in a headered configuration, two cooling towers (CT-1, 2) and two condenser water pumps headered together with variable frequency drives (CWP-1, 2).

Additionally, the system shall include a heat recovery chiller (HRC-1) piped in a side stream configuration off of the chilled water secondary return. The heat recovery chiller shall have duplex pumps on the chilled water side (HRCCHP-1 and -2) and duplex pumps on the hot water side (HRCHWP-1 and -2), each sized for 100% of the design flow and controlled in a lead/lag scenario with only one respective pump running at a time.

As an alternative to the heat recovery chiller, the sequence for a waterside economizer has been included below. In this case, the plate and frame heat exchanger is to be also installed in a sidestream configuration off the chilled water secondary return.

Insertion type temperature sensors are to be located in secondary return – one upstream and one downstream of the Hx or heat recovery chiller – one on the primary supply, and one on the secondary supply. Temperature sensors are also required upstream and downstream of the tower side of the Hx and the hot water side of the HRC. In addition, all the points from the chillers are to be integrated and available to the BAS. The return and supply temps of both chillers shall be shown on the graphics screen.

The flow through each chiller shall also be calculated from the DP and shown on the BAS for each machine and summed to show the flow through the primary.

Chilled Water Plant Optimization
The building automation system (BAS) shall optimize the performance of the chilled water plant to meet the building load while minimizing the total plant energy use. The control system shall use the manufacturer-provided performance curves specific to the installed cooling towers, pumps, and chillers to determine the optimal arrangement in which to run.

Variable inputs to the optimization algorithm shall include outdoor wet bulb temperature and building chilled water load as measured by BTU meter installed on the system.

Fixed inputs represent limiting characteristics in the system. These are to be set by a qualified factory-controls representative during startup and verified through the commissioning process. These variables include a combination of any or all of the following:

1. rated machine capacities (tons);
2. rated full load amps (FLA);
3. rated condenser water flow (GPM);
4. minimum condenser water flow;
5. rated chilled water flow;
6. minimum chilled water flow;
7. maximum chilled water flow;
8. peak coefficient of performance (COP);
9. design lift;
10. and lift sensitivity.

Controlled variables shall include a combination of any or all of the following:

1. staging of cooling towers;
2. cooling tower fan speeds;
3. staging of condenser water pumps;
4. condenser water pump speeds;
5. staging of secondary chilled water pumps;

6. secondary chilled water pump speeds;
7. staging of chillers;
8. chiller speeds;
9. and activation of water-side economizer (where applicable);

Modifications to this control sequence shall be considered if the additional cost is low versus the incremental savings in energy. These alternatives may include such features as:

1. adaptive tuning of the control algorithm based on real-time equipment performance feedback;
2. weather station data and forecasting inputs for predictive plant control;
3. and variable speed pumping in the chilled water primary.

Primary Chilled Water Temperature Reset
The BAS shall monitor the position of the chilled water valves throughout the system to determine which is in the widest open position. This shall be designated as the critical zone (Cz) valve. The BAS shall reset the primary supply chilled water temperature by increasing the chilled water temperature setpoint up 0.5 deg. F every 15 minutes and rechecking the Cz valve position. This process is to be repeated continually until the maximum chilled water temperature of 48˚F (adj.) is reached or the Cz chilled water valve position is greater than 85% (adj.) open for 10 min. (adj.)

Any chilled water valve may be added to an exception list to be ignored by the BAS as a potential critical zone.

The BAS shall also monitor return air humidity in all the air handlers. In the event any AHU measures humidity higher than 56% for greater than 10 min. (adj.), the BAS shall halt the reset and the chilled water temp will not be allowed to go higher until the return air humidity drops below 54% for 10 minutes (adj.)

If the high limit setpoint of the temperature reset scheme is reached but the Cz valve is still not open above 85%, then the BAS shall initiate the secondary chilled water pump differential pressure reset.

Once the Cz valve is open to greater than 95% (adj.) for longer than 10 min. (adj.) the reset scheme shall operate in reverse, with the BAS turning down the primary chilled water temperature setpoint by 0.5 deg. every 15 minutes until the Cz valve is at or below 95% open.

Secondary Chilled Water Differential Pressure Reset

Once the primary chilled water temperature setpoint is at its high limit but the Cz valve is still not opened above 85%, the BAS shall reset the differential pressure (DP) by decreasing the secondary chilled water DP setpoint down 0.2 psi (adj.) every 15 minutes and rechecking the Cz valve position. This process is to be repeated continually until the critical zone chilled water valve position is greater than 85% open for 10 min. (adj.)

If the Cz valve is open to greater than 95% for longer than 10 min. (adj.) the reset scheme shall operate in reverse, with the BAS turning up the DP setpoint by 0.2 psi every 15 minutes until the Cz valve is at or below 95% open.

Once the DP setpoint gets to its high limit of 8.0 psi (adj.), the BAS shall halt the secondary chilled water differential pressure reset and step back into the primary chilled water temperature reset loop.

Chiller Start and Stop
The chilled water and condenser water pumps are energized manually through the action of an H-O-A switch when it is in the hand position or by the BAS when the H-O-A is in the automatic position.

Each time a chiller is started or stopped the following information shall be logged:

1. Date and time
2. Identity of chillers operating before adding or stopping
3. Chilled water supply temp
4. Chilled water return temp
5. Chilled water flow
6. Identity of primary and secondary chilled water pumps operating
7. Speed of secondary chilled water pumps
8. Secondary chilled water differential pressure set point
9. Secondary chilled water differential pressure reading
10. Outside air temperature
11. Outside air humidity

All timers and other specified parameters are to be independently adjustable.

Lead/Lag Equipment Selection
The BAS shall accommodate user input data that defines the design cooling capacity of the chillers (tons) and the maximum and minimum chiller flow rates and corresponding

differential pressures for both the evaporator and the condenser. These values shall be verified from the manufacturer and used for operator information on the BAS graphics.

The BAS shall be programmed to accommodate user assignment of the order in which multiple chillers are to be staged.

The BAS shall provide an operator interface graphic screen per the requirements of the HCA BAS Graphics Design Guidelines to track run hours, rotate the lead/lag, and designate a chiller as "out of service". The BAS shall track and display the run times of each chiller, pump, and cooling tower. The BAS shall not automatically rotate lead/lag but shall display a prompt to the operator to initiate rotation.

Heat Recovery Chiller
As the primary source of heating, the normal mode of operation is for the heat recovery chiller to run all the time, unless in alarm or maintenance override. This means the lead HRC chilled water pump and lead hot water pump will be energized continually. With no building chillers in operation, the lead secondary chilled water pump will always be energized with its speed controlled by the BAS. The minimum pump turndown will be the minimum flow required by the chilled water side of the HRC.

If no heat recovery chiller is present in the system, the lead secondary chilled water pump may be allowed to shut off with no cooling load on the building.

In the event of a failure of either lead hot water or lead chilled water HRC pump to start and prove flow, the BAS shall alarm at the operator workstation, disable the failed pump, change the standby pump to the lead, and attempt to start that pump.

Waterside Economizer (if applicable)
If a plate and frame heat exchanger for waterside economization is present in the system, it should be installed in the entering (secondary return) chilled water side in a sidestream configuration with a bypass to divert water around the heat exchanger (Hx) during warm weather. On the tower side, it is assumed the Hx is installed in parallel to the chillers to provide coldest water possible during integrated Hx / chiller operation.

When the BAS optimization program determines the conditions are right to enable the waterside economizer system based upon outdoor wet bulb, building load, and chilled water secondary temperature setpoint, the BAS shall initiate the condenser water temp control sequence. At the same time, the BAS shall confirm the secondary lead chilled water pump is running.

With the condenser return temp under BAS control and the secondary chilled water loop flowing, the BAS shall slowly modulate the Hx chilled water bypass valve to 100% closed to initiate flow through the Hx. The BAS optimization program shall modulate the 3-way valve on the Hx to control the secondary chilled water supply temperature.

When the BAS determines the Hx is not able to meet the secondary chilled water temperature setpoint for 10 min. (adj.) with the tower side valve modulated to 100% flow through the Hx, the chiller start sequence shall be initiated. Once the lead chiller has been released to automatic control, the BAS optimization shall operate the chiller plant in integrated mode.

Once the BAS determines it is no longer beneficial, the integrated waterside economizer shall be shut down. The Hx tower side 3-way valve shall slowly modulate to full bypass and the chilled water valve shall slowly modulate to full bypass. At this time, the building chilled water system will be 100% mechanical cooling.

Starting the Chilled Water System
The BAS shall monitor the secondary chilled water supply temperature, the secondary chilled water return temperature, and the total chilled water flow through the secondary. The BAS shall display the distributed system tonnage as calculated from the BTU meter on the chilled water system graphics screen.

If the leaving chilled water temperature set point is not met for 10 minutes (adj.), the BAS shall perform the following sequence:

1. Initiate cooling tower control
2. Ramp the lead chiller primary chilled water pump up to the design flow
3. Enable the lead chiller
4. Prove the lead chiller's flow switches
5. Attempt to start the lead chiller

If the lead chilled water pump status is not received, or if the lead chiller fails to start within 10 minutes (adj.) following the BAS command, the BAS shall issue an alarm, deactivate the chiller, initiate the process for starting the next chiller in sequence, open the evaporator and condenser valves on the next chiller in the lineup, and close both evaporator and condenser isolation valves on the lead chiller.

The lead chiller shall maintain a chilled water discharge temperature corresponding to the common primary chilled water system supply water set point (42°F, adj.). The BAS shall be capable of resetting the common primary chilled water system supply temperature and the secondary chilled water temperature setpoints based on the reset scheme by the optimization program or by operator command.

Chilled Water Pump Speed Control

The secondary chilled water pump speed shall be maintained through a PID loop control. The speed of the chilled water pumps shall be modulated to maintain the chilled water system differential pressure as sensed by the differential pressure sensor installed across the coil at the most remotely located AHU.

Starting the Lag Chilled Water Pump
The lag chilled water pump shall be started when the BAS optimization algorithm determines it is more efficient to run with another pump. If a chilled water pump fails to start or run on command, the next lag chilled water pump shall start immediately, an alarm shall be reported to the BAS graphics, and the failed pump is to be marked as "out of service".

Once the lag chilled water pump has started, all running pumps shall be modulated together to maintain the chilled water differential pressure at set point. The chilled water differential pressure transmitter shall be wired to the same BAS controller that is controlling the chilled water pumps. The operation of the chilled water pumps shall not be dependent on the controls network level communications.

Stopping the Lag Chilled Water Pump
The lag chilled water pump shall be stopped when the BAS optimization algorithm determines it is more efficient to run with a single pump.

Starting the Lag Chiller
The lag chiller shall be started when the BAS optimization algorithm determines it is more efficient to run with another chiller online. If a chiller fails to start or continue running on command, the BAS shall immediately initiate the starting sequence for the next lag chiller in the lineup as programmed.

When the first chiller is energized, no additional chillers shall be added or removed for an adjustable length of time (30 minutes) to allow the system to stabilize. After a lag chiller is added or removed, no additional chillers shall be added or removed for an adjustable length of time (15 minutes) to allow the system to stabilize.

The lag chiller's evaporator isolation valves shall be slowly opened over a period of 2 minutes (adj.) to avoid large flow variations in the operating chillers. Once valve is proved open, the running chiller shall unload and the lag chiller shall start, match capacity, and operate in parallel with lead chiller to maintain chilled water supply temperature setpoint.

Stopping a Lag Chiller
The lag chiller shall be stopped when the BAS optimization algorithm determines it is more efficient to run with one fewer chiller online. At that time, the lag chiller shall be disabled and its isolation valve slowly modulated closed to avoid sudden variation in chiller flow. The lag chiller shall be disabled in reverse order as dictated by the BAS lineup.

Stopping the Lead Chiller
The first chiller started in the lead/lag sequence shall be disabled if the temperature of the water returning to the chiller plant is within 2°F (adj.) of the chilled water leaving water temperature setpoint.

At that time, the lead chiller shall be disabled and its tower water isolation valve shall slowly modulate closed to avoid a sudden variation in chiller flow. The chilled water isolation valve, however, shall remain open to allow for flow to the building from the HRC.

Condenser Water Return Temp Control
Upon a call for condenser water flow from the BAS, due to a call for mechanical cooling beyond the HRC's capacity or a call for free-cooling through the waterside economizer, the BAS shall perform the following sequence:

1. Open the lead tower's return valve
2. Close the lead tower's supply valve
3. Open the lead tower's bypass valve (bypass to the basin)
4. Energize lead tower pump and ramp up to design flow as follows:
    a. For mechanical cooling on systems with HRC, this is the design flow through the condenser of the lead chiller
    b. For 100% free-cooling, this is the design flow through the Hx
    c. For integrated chiller/Hx operation, this is the design flow through the Hx + the design flow through the lead chiller

If the tower return loop temperature is a minimum of 5 deg. (adj.) above minimum running temperature allowed by chiller manufacturer instructions for 1 min. (adj.), then bypass valve shall close and the supply valve shall open. If the tower return loop temperature is still a minimum of 5 deg. (adj.) above the minimum running temperature allow the chilled manufacturer, the tower fan shall start at minimum speed. All control points shall then be released to automatic mode and controlled on the BAS optimization algorithm.

For free cooling operation, as directed by the optimization program, the BAS shall modulate the 3-way valve on the tower side of the Hx to maintain the secondary supply temperature at setpoint.

For integrated chiller / Hx operation, as directed by the optimization program, the BAS shall drive the Hx 3-way tower water valve to full flow through the Hx and ramp up to the design flow through the Hx + design flow through the chiller condenser (as determined and set on the VFD by the test and balance contractor).

For 100% mechanical cooling, as directed by optimization program, the Hx 3-way tower water valve shall close to divert water around the Hx and the speed and staging of the tower pumps shall be released to automatic control by the BAS.

If the BAS optimization algorithm determines it is beneficial to start another cooling tower, the BAS shall perform the following sequence:

1. Open the lag tower's return valve
2. Open the lag tower's supply valve
3. Energize the lag tower's fan at minimum speed
4. Slowly ramp the lag tower's fan to match the speed of the running tower fans.

Once all the tower fans are operating at the same speed, all tower fans shall be released to automatic control by the BAS optimization algorithm.

If the BAS optimization algorithm determines it is beneficial to start another tower pump, the BAS shall energize that pump to its minimum speed and slowly ramp it up until its speed matches the running pumps. Once all the tower pumps are operating at the same speed, all tower pumps shall be released to automatic control by the BAS optimization algorithm.

If the condenser pumps are dedicated rather than in a headered arrangement, they shall be energized along with their respective chiller or upon a call for waterside economizer.

Tower Loop Sub-Freezing Operation (at ambient of 35 deg. (adj.) and below)
When outside air temp is 35 deg (adj.) or below and either tower bypass valve is not in bypass mode, then tower shall operate every 30 minutes (adj.) in defrost mode. In defrost mode, tower fans shall reverse direction and run at low speed for 5 minutes (adj.).

When outside air temp is 35 deg (adj.) or below and either tower is de-energized or is in bypass mode, then basin heaters shall cycle on to maintain basin temp above 34 deg. (adj.).

Air Handler Chilled Water Coil Freeze Protection
Upon a call to activate the freeze protection mode from an air handler - caused by the freeze stat trip - the associated AHU chilled water valve shall swing to 100% open (full flow), the secondary chilled water pumps will be energized, and the BAS shall modulate the secondary pump speed to meet the DP setpoint maximum with no reset. The building chillers, waterside economizer, and heat recovery chiller will all remain in their current state.

Once all AHUs have exited freeze protection mode through manual reset of every AHU freeze stat, the secondary chilled water pumps will be released back to automatic mode and all reset loops will be enabled.

Chilled Water Loop Freeze Protection
In the unlikely event the secondary chilled water return temperature drops below 38 deg. F, the BAS shall alarm at the operator workstation.

If the secondary chilled water return temp drops below 33 deg. F, ALL of the following shall happen:

1. the secondary chilled water pumps shall continue to run under control of the BAS with DP setpoint locked at maximum and the primary chilled water temperature reset disabled;
2. the heat recovery chiller shall shut down but the HRC chilled water pumps shall continue to flow water through the evaporator barrel and the HRC hot water pumps shall continue to flow water through the condenser barrel;
3. the waterside economizer tower loop bypass valve shall close (fully bypassing the Hx) and the chilled water Hx valve shall fully bypass the Hx as well;
4. the building chillers and their primary pumps shall be disabled;
5. the tower fans shall be disabled;
6. the tower pumps shall be deenergized;
7. the tower bypass valve shall fully bypass flow to the basin (not the upper spray bars or hot deck)
8. and the tower basin heaters shall be energized.

This mode shall remain active until the secondary return temperature rises above 36 deg. F.

APPENDIX B-3: STEAM PLANT SEQUENCE OF OPERATIONS

Pending development.

APPENDIX B-4: HOT WATER PLANT SEQUENCE OF OPERATIONS

Variable Speed Primary
A BAS shall be provided to control, monitor, and automate the operation of the hot water production plant and pumping system. The system may consist of any number of condensing hot water boilers, heat exchangers, and pumps, though this sequence is written around the following scenario: an array of hot water boilers piped in a variable speed primary arrangement with manifolded pumps and a heat recovery chiller. Motorized isolation valves are to be installed on each boiler in the lineup.

A single heat recovery chiller is the standard for new construction and is included here as the first stage of heating. The condenser side of the chiller is to be located in the return line in series with the building boilers or heat exchanger.

The boiler array shall be operated by the control system provided by the manufacturer. The controller shall handle equipment level parameters such as firing rate, damper position, blower control, safeties, and circulation pump control (where applicable). The boiler controller shall be capable of handling multiple boilers in the array to determine the optimal mode of operation for efficiency and longevity. The boiler controller shall receive inputs from the BAS for parameters including, at minimum:

- Boiler control system enable/disable
- Hot water supply temperature setpoint
- Boiler in/out of service
- Operator designation of boiler order in lineup

The boiler controller shall send back to the BAS all available onboard data points from the boilers.

Hot Water Temperature Reset
Hot water temperature setpoint shall be reset based on outdoor air temperature as follows:

Outdoor Temp	Hot Water Temp Setpoint
40˚F (adj.) and below	140˚F (adj.)
70˚F (adj.) and above	100˚F (adj.)

General Sequence of Operations
The hot water pumps are energized manually through the action of an H-O-A switch when it is in the hand position or by the building automation system (BAS) when the H-O-A is in the automatic position. The BAS shall monitor the building supply and the return hot water temperatures and the building hot water flow.

The minimum flow rate shall be preprogrammed into the BAS for each boiler and the heat recovery chiller based on information to be provided by the manufacturer. The BAS shall dynamically set the minimum flow rate for the building hot water pumps as the total flow for the greater of: 1) all the energized boilers or 2) the minimum flow through the condenser of the heat recovery chiller.

Hot Water Pump Speed Control

The hot water pump speed shall be maintained through a PID loop control. The speed of the hot water pump shall be modulated by the VFD to maintain the hot water system differential pressure as sensed by the differential pressure sensor installed across the coil at the most hydraulically-remote AHU.

Starting the Lag Hot Water Pump
If the lead pump VFD reaches 95% of max speed for 10 minutes (adj.), the second (lag) hot water pump shall be started. If a hot water pump fails to start or to run on command, the next lag hot water pump shall start immediately, an alarm shall be reported to the BAS graphics, and the failed pump is to be marked as "out of service".

Once the lag hot water pump has started, both the lead and lag hot water pumps shall be modulated together to maintain the hot water differential pressure at set point. The hot water differential pressure transmitter shall be wired to the same BAS controller that is controlling the hot water pumps. The operation of the hot water pumps shall not be dependent on the controls network level communications.

Stopping the Lag Hot Water Pump
The lag hot water pump shall be stopped when doing so would still keep the remaining energized pumps operating at or below 80% for an adjustable period of time (10 min.).
If required by system design, the minimum hot water flow shall be maintained through all operating boilers and the heat recovery chiller by modulating the system bypass valve located in the bypass line. When the hot water flow reaches the minimum flow rate required for the online boiler(s), the bypass valve shall be modulated open. This valve shall be a spherical ball valve with a minimum turndown ratio of 400:1.

Each time a boiler is started or stopped, the following information shall be logged:

- Date and time
- Identity of boilers operating before starting or stopping
- Hot water supply temp
- Hot water return temp
- Hot water flow
- Identity of hot water pumps operating
- Speed of hot water pumps
- Hot water differential pressure set point
- Hot water differential pressure reading
- Outside air temperature
- Outside air humidity

All timers and other specified parameters are to be independently adjustable.

Lead/Lag Equipment Selection
The BAS shall be programmed to accommodate user assignment of the order in which multiple boilers are to be staged.

The BAS shall provide an operator interface graphic screen per the requirements of the HCA BAS Graphics Design Guidelines to track run hours, rotate the lead/lag, and designate a boiler as "out of service". The BAS shall track and display the run times of each chiller, pump, and cooling tower. The BAS shall not automatically rotate lead/lag but shall display a prompt to the operator to initiate rotation.

Heat Recovery Chiller
As the primary source of heating, the normal mode of operation is for the heat recovery chiller to run all the time (typically in heating priority), unless in alarm or maintenance mode. This means the lead HRC chilled water pump and lead hot water pump will be energized continually. Additionally, the lead building hot water pump will be energized, even with no boiler energized. The minimum flow through the pumps is the minimum flow allowed by the heat recovery chiller condenser. In the event the heat recovery chiller is able to handle the full load of the building hot water demand with no boilers online, all building boilers will have their hot water isolation valves closed except for the lead boiler. That boiler will have its isolation valve open to allow for flow to the building.

Starting the Boiler System
The BAS shall monitor the hot water supply temperature, the hot water return temperature, and the total hot water flow. The BAS shall display the distributed system energy flow in BTUH as calculated from the BTU meter on the hot water system graphics screen.

If, with only the heat recovery chiller operational, the leaving hot water temperature set point is not met for 10 minutes (adj.), the BAS shall enable the boiler controller to begin the lead boiler startup procedure.

If the lead boiler fails to start within its time limit (predetermined by the manufacturer) or if the lead boiler status is not received following the command, the controller will fail that boiler, alarm at the BAS operator panel, and start the standby boiler. If any isolation valve fails to open, the controller will fail that boiler and initiate the process for starting the next boiler in sequence.

Starting the Lag Boiler
The lag boiler shall be started when the boiler controller algorithm determines it is more efficient to run with another boiler online. If a boiler fails to start or fails to continue running on command, the controller shall immediately initiate the starting sequence for the next lag boiler in the lineup as programmed.

When the first boiler is energized, no additional boilers shall be added or removed for an adjustable length of time (30 minutes) to allow the system to stabilize. After a lag boiler is added or removed, no additional boilers shall be added or removed for an adjustable length of time (15 minutes) to allow the system to stabilize.

The lag boilers isolation valve shall be slowly opened over a period of 2 minutes (adj.) to avoid large flow variations to the operating boilers. Once the valve is proved open, the running boiler shall unload and the lag boiler shall energize, match capacity, and operate in parallel with the lead boiler to maintain hot water supply temperature setpoint.

Stopping a Lag Boiler
The last lag boiler shall be stopped when the boiler controller determines it is beneficial to run with one fewer boiler online.

At that time, the lag boiler shall be disabled and its isolation valve slowly modulated closed to avoid sudden variation in chiller flow. The lag boilers shall be disabled in reverse order as dictated by the BAS lineup.

Stopping the Lead Boiler
The first boiler started in the lead/lag sequence shall be disabled if the temperature of the water returning to the boiler plant is within 2°F (adj.) of the chilled water leaving water temperature setpoint.

At that time, the lead boiler shall be deenergized. The isolation valve, however, shall remain open to allow for flow to the building from the heat recovery chiller.

APPENDIX B-5: STANDARD AHU SEQUENCE OF OPERATIONS AND SCHEMATIC

Supply Air a~~A~~nd Return Air Fan
Supply air and return air fans shall be energized/de-energized from the VFD in hand position or the DDC system when in auto mode. The DDC control system shall sense when the fan is in hand position by the fan status verification and initiate the AHU control sequence.

In auto mode the two-position minimum outside air damper (D-min) shall open. Once the damper is open, the supply fan shall start, and the DDC system shall signal the associated return and exhaust fans to start. If the fan is started in hand the two position minimum outside air damper shall open immediately upon sensing fan status as on.

Fans shall shut down from a signal from:

- The fire alarm panel thru the F/A relay.
- The supply air smoke detector(s) (SD-SA).
- The return air smoke detector(s) (SD-RA).
- Freeze stat, (TS-FRZ).
- The high/low limit static pressure switches (SPS-SHI & RLO).
- Preheat low limit (TT-PHT).

When the supply fan shuts down the following shall occur:

- The minimum outside air damper (D-min) shall close.
- The economizer outside air damper (D-EOA) shall close.
- The relief damper (D-REL) shall close.
- The return damper (D-RET) shall open.
- The chilled water valve (V-CHW) shall close.
- The preheat coil (V-HTG) shall remain under control of the preheat discharge temperature sensor (TT-PHT).
- The return fan and the associated exhaust fans shall shutdown.

Supply Fan Speed Control
The supply fans variable frequency drive (VFD) shall be controlled by a duct mounted differential static pressure transmitter (SPT-SA) modulating the VFD to maintain a supply duct static pressure at the lowest set point possible as determined by the tab contractor. For multiple static pressure transmitters, the DDC system shall provide a separate set point for each static pressure transmitter, and select the static pressure transmitter that is farthest below its set point to control the speed of the VFD. The VFD shall output the % full speed to the DDC system through the network interface.

On a fall in differential pressure sensed by SPT-SA, the DDC system shall speed up the supply fan's VFD to maintain SPT-SA at set point. On a rise in differential pressure sensed by SPT-SA, the DDC system shall slow down the supply fan's VFD to maintain SPT-SA at set point. SPT-SA shall alarm the DDC system if its measured pressure is either too high or too low.

SPS-SHI shall shutdown the fans whenever it senses a high static pressure, alarm the DDC system, and require a local manual reset to restart the fan. SPS-RLO shall shutdown the fans whenever it senses a low static pressure and alarm the DDC system and require a local manual reset to restart the fan

Volumetric Tracking

The return air fan VFD shall be controlled from an outside air quantity software set point (scheduled outside air quantity, adj.) using airflow measuring devices and transmitters AM-SA and AM-RA installed at the inlet of the supply and return fans. AM-SA shall measure the total airflow of the supply fan and AM-RA shall measure the total airflow of the return fan. The airflow measuring transmitters shall output the total CFM reading to the DDC system. The DDC system shall calculate the difference of the total supply air and the total return air to make an outside air quantity software point. The DDC system shall modulate the speed of the return air fan VFD to maintain the calculated outside air quantity within 2% of the outside air quantity set point.

Static Pressure Reset

The Supply air static pressure shall be reset based on the terminal box air damper position. The static pressure control loop shall poll all terminal boxes in the system and reduce static pressure over an adjustable transition time until any terminal box air damper has opened to 95% (adj.). Static pressure will increase in the same manner when any terminal box in the system is above 95%. Any terminal box in the system may be added to an exception list and eliminated from the static pressure reset control loop.

Discharge Air Temperature Reset

When the outdoor air temperature is below 65°F, the ~~static~~ discharge air temperature~~pressure~~ reset control loop shall start. When outdoor air temperature is above 65°F, the reset loop will be off and system will revert back to original discharge temperature setpoint. The discharge air temperature is reset up to a maximum of 60°F (adj.) when all terminal box reheat valves are above 5% open (adj.). If any terminal box reheat valve is below 5% or a zone humidistat is reading humidity above maximum setpoint for an adjustable transition time the discharge air temperature will reset down. The temperature reset loop will make 1deg incremental changes over a 1 hour (adj.) time period. Any terminal box in the system may be added to an exception list and eliminated from the discharge temperature reset control loop.

Air Handler Operating States

The air handling unit shall operate in four distinct states. Criteria to transition between states are indicated below. To transition between states the specified criteria shall be met for an adjustable minimum period of time referred to as "transition time". Each individual operating state to have an individual PID control loop for that state.

State 1 – Full Cooling Coil

Economizer outside air dampers shall be closed. The cooling coil control valve, V-CHW, shall be controlled by a control loop with the discharge temperature transmitter, TT-DAT, as the input, and a set point equal to the discharge air set point of (55°F, adj.). On a rise in temperature above TT-DAT set point, the valve shall modulate open. On a fall in temperature below TT-DAT set point, the valve shall modulate closed. TT-DAT shall alarm the DDC system whenever the discharge temperature is too high or low. The cooling coil control loop shall control the leaving air temperature within +/- 0.5°F.

Transition From State 1 To State 2 (Full Economizer With Cooling Coil):
There shall be an adjustable outside air economizer enable temperature (65°F) and an adjustable dead band (+/-2°F). The unit shall transition from State 1 to State 2 whenever the outside air temperature is below the economizer enable temperature less the dead band (65°F – 2°F = 63°F) for an adjustable transition time (5 minutes).

Transition From State 2 To State 1:
The unit shall transition from State 2 to State 1 whenever the outside air temperature is above the economizer enable temperature plus the dead band (65°F + 2°F = 67°F) for an adjustable transition time (5 minutes).

State 2 – Full Economizer with Cooling Coil
Economizer outside air dampers shall be fully open. The cooling coil control valve, V-CHW, shall be controlled by a control loop with the discharge temperature transmitter, TT-DAT , as the input, and a set point equal to the discharge air set point of (55°F, adj.). In the event of a transfer from state 3 to state 2 due to humidifier valve control loop output as described below, the economizer damper shall start closing until humidifier control loop output is below 90% (adj).

Transition From State 2 To State 3 (Free Cooling):
The unit shall transition from State 2 to State 3 whenever both of the following occurs. The cooling coil control loop has a cooling value output of 0% open for an adjustable transition time (5 minutes). The humidifier control loop output is below 90% for an adjustable transition time.

Transition From State 3 To State 2:
The unit shall transition from State 3 to State 2 whenever either of the following occurs. The economizer damper control loop has an output of 100% open for an adjustable transition time (10 minutes). The unit humidifier valve control loop has been at 100% for and adjustable transition time.

State 3 – Free Cooling:
The cooling coil valve shall remain closed and the economizer air damper (D-EOA), relief air damper (D-REL), and the return air damper (D-RET) shall modulate to maintain the discharge air temperature at the discharge air temperature set point.

The discharge air temperature control loop shall have the unit discharge air temperature transmitter (TT-DAT) as the input and a set point equal to the cooling coil set point (55°F). On a rise in discharge air temperature the economizer outside air and relief air dampers shall modulate open and the return air damper shall modulate closed. On a fall in discharge air temperature the economizer outside air damper and relief air damper shall modulate closed and the return air damper shall modulate open. Dampers shall maintain DAT to within +/- ½ °F of set point.

Transition From State 3 To State 4 (Preheat):
The unit shall transition from State 3 to State 4 whenever the economizer damper control loop has an output of 0% open for an adjustable transition time (5 minutes).

Transition From State 4 (Preheat) To State 3 (Free Cooling):
The unit shall transition from State 4 to State 3 whenever the preheat valve control loop has an output of 0% open for an adjustable transition time (5 minutes).

State 4 – Preheat Normal Control:
When the unit is in State 4 the preheat hot water valve, V-HTG, shall be controlled by a selecting the minimum output of the discharge air temperature control loop and the preheat coil low limit temperature control loop (as described in the next paragraph). The discharge air temperature control loop shall have the discharge air temperature transmitter (TT-DAT) as input and a set point of 55°F (adj.).

Preheat Coil Low Limit Control
The preheat coil low limit control loop shall be operative at all times when the unit is in any State, including when the unit is de-energized, to maintain a minimum preheat coil discharge temperature. The preheat low limit control loop shall have the preheat coil leaving air temperature transmitter (TT-PHT) as input and the set point shall be 42°F (adj.). The BAS shall issue a "Preheat Low Limit Alarm" if the PHT falls below set point -1°F. The alarm shall reset when the PHT rises +1°F above set point.

If the preheat coil leaving air temperature fall to 38°F (adj.), the BAS shall shut down the supply fan. A "Preheat Temperature Shutdown Alarm" shall be generated at the BAS front-end. A software reset shall be required to restart the unit.

Preheat Coil Circulating Pump
The preheat coil circulating pump shall be energized whenever the outside air temperature falls below 35°F (adj.) without regard to whether the AHU supply fan is running. This pump shall de-energize whenever the outside temperature rises above 37°F. (adj.) A differential pressure switch across the circulating pump PHP-STS shall be employed to sense the presence of flow through the preheat coil. If the loss of flow is sensed and the outside air temperature is below 35°F (adj.), the preheat valve shall open and the BAS shall generate a "Preheat Coil Circulating Pump Alarm" at the front-end.

Freezestat

Whenever freeze stat, TS-FZ, senses a temperature below 36°F (adj.), it shall perform the following:

- The supply fan, return fan, and the associated exhaust fans shall shutdown.
- Start pre-heat re-circulating pump.
- The minimum outside air damper (D-MIN) shall close.
- The economizer outside air damper (D-EOA) shall close.
- The relief damper (D-REL) shall close.
- The return damper (D-RET) shall open.
- Fully open the chilled water valve (V-CHW).
- Open the lead chiller chilled water isolation valve, if applicable.
- Issue a unique alarm.
- The preheat coil (V-HTG) shall remain under control of the preheat discharge temperature sensor (TT-PHT).
- Command "on" the variable primary or secondary chilled water pump and control speed to maintain the differential pressure set point.

A manual reset at the AHU shall be required to restart an AHU that has automatically shut down from a freeze stat trip.

Filters
All filters shall have a differential pressure switch (DPS-FIL & DPS-PFL) measuring the pressure drop across the filter banks. Each shall alarm the DDC system whenever the pressure drop across the filter is excessive (dirty filter) (adj.).

Humidifier
The humidifier controls shall be active any time the supply fan is running.

As the space humidity rises to its adjustable set point, the humidifier valve, V-HUM, shall modulate closed. As the space humidity decreases below its set point the humidifier valve, V-HUM, shall modulate open.

Whenever the discharge air humidity is above the controlling limit set point (80% adj.) as sensed by the high limit humidistat, HT-SAH, the humidifier valve shall be modulated closed to maintain the controlling limit set point.

Whenever the discharge air humidity is above the high limit set point, 95% adjustable, as sensed by the HT-SAH, the DDC system shall disable the humidifier, close the steam valve, and an alarm shall be sent to the operator which must be acknowledged and reset in order to re-enable the humidifier.

Fire Alarm Shutdown

Whenever the fire alarm system senses smoke/fire, the fire alarm system shall signal the DDC system.

The DDC system is to de-energize the unit and shall perform the following.

- Shutdown the supply air fan.
- Shutdown the return air fan.
- Shutdown the associated exhaust fans.
- Close chilled water valve V-CHW.
- Close the relief air damper (D-REL).
- Close the outside air damper (D-MIN).
- Close the economizer damper (D-EOA).
- Open the return air damper (D-RET).
- The preheat coil (V-HTG) shall remain under control of the preheat coil discharge thermostat, TT-PHT.

Program Design

When the supply fan is started, the AHU shall always go to State 1 without enabling the chilled water plant. The unit shall operate in State 1 for a 4 minute time period (adj.). After the 4 minute timer has expired one of the following shall occur:

- If the OAT is equal to or greater than 52°F (adj.) the unit shall remain in State 1 until it transitions to another operating State per the detailed sequences above or,
- If the OAT is less than 52°F (adj.) the unit shall transition to State 3 and remain in State 3 until it transitions to another operating State per the detailed sequences above.

If the facility's chilled water plant is not required to operate continuously throughout the year, an outdoor air temperature shall be established, T-Disable, to prevent the plant from being inadvertently started. The chilled water plant shall not be activated below outdoor temperatures equal to or less than T-Disable, for example 44°F (adj.).

This AHU sequence of operation shall initiate the operation of the chilled water plant, if it is not already in operation, if both of the following occur:

- The OAT exceeds the T-Disable set point for the chilled water plant and,

- The AHU transitions from State 3 to State 2.

All timers and other specified parameters are to be independently adjustable.

Software status points shall be created for the following lockouts and finite states. The current status of the software lockout points, enabled or disabled, shall be displayed at the BAS/FMS front end:

- Chilled water control valve fully closed lockout
- Economizer dampers fully open lockout
- Economizer dampers fully closed lockout
- Preheat valve normal control lockout
- State #1
- State #2
- State #3
- State #4

The AHU shall restart automatically after a momentary power failure or after transfer to an alternate power source and operate in the same State it was in prior to the power failure or transfer of power.

APPENDIX B-6: VAV SEQUENCES OF OPERATIONS

VAV with Reheat

Unit Enable
A network unit enable (UNITEN-MODE) signal will control the mode of the box. Occupancy mode will be controlled via a network input (OCC-SCHEDULE).

Temperature Setting:

Location	Low Range	High Range	Default Setpoint	Occ Deadband +/-	Unocc Low	Uno~~O~~cc High	Alarm Low	Alarm High	Warning Offset
General	66	78	72	2	61	82	55	90	5
OR	62	72	68	0.5	62	72	55	75	2
Critical	66	78	72	0.5	61	82	55	90	5

General; Patient Rooms, Lobby, corridor, Nurse Stations,..
Critical Spaces; PACU, NICU, …

Occupied Mode
When the zone temperature (ZN-T) is between the occupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) setpoints (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the cooling setpoint (EFFCLG-SP), the primary air damper (DPR-O) will increase the supply air flow (SA-F) (between CLGOCC-MINFLOW to CLG-MAXFLOW) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the heating setpoint (EFFHTG-SP), the reheat coil will modulate to maintain the discharge air temperature setpoint. The discharge air temperature setpoint will be reset as the zone temperature (ZN-T) changes. After the discharge air temperature setpoint reaches the high limit setpoint, the box flow is increased to the heating max flow setpoint (HTG-MAXFLOW).

Unoccupied Mode
When in this mode, while the zone temperature (ZN-T) is between the unoccupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) setpoints (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the unoccupied cooling setpoint (EFFCLG-SP), the primary air damper (DPR-O) will increase the supply air flow (SA-F) (between CLGUNOCC-MINFLOW to CLG-MAXFLOW) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the unoccupied heating setpoint (EFFHTG-SP), the reheat coil will be used to maintain the zone temperature (ZN-T) and the primary air damper (DPR-O) will be at the minimum CFM (SA-F).

Network Warmup-Cooldown
Warm-up and Cooldown modes will be activated by a network command (WC-C). When the zone temperature (ZN-T) is below the effective heating setpoint (EFFHTG-SP), the box will use warm air flow, then reheat coil to maintain the zone temperature (ZN-T). When the box is satisfied the flow will remain at the warm-up minimum position until the warm command has been removed.

Remote Temperature Sensor
Provide remote temperature sensor mounted in return grille behind security grille to control VAV 1-6. Thermostat to be mounted outside secure hold to provide setpoint adjustment and remote temperature display. Label thermostat "secure hold temperature adjustment".

APPENDIX B-7: BAS GRAPHICS

Part 1 - General

1.1 Scope

A. This document is to provide direction for the graphical user interface (GUI) for building automation systems (BAS).

B. The BAS GUI is intended to be used both by users at the facility and corporate. All information including system design, system logic and actual plant environments shall be easily identifiable to users of all levels of familiarity to the facility.

C. In addition, the BAS GUI will be used both at a desk view and on large monitors throughout the plant operation area. Special consideration shall be made that all information is clearly represented and concise in these areas.

D. The following sensitive areas **SHALL NOT BE REPRESENTED IN ANY WAY ON ANY GRAPHIC PANEL.** These sensitive areas include, but are not limited to: Nursery, Pharmacy, Nuclear Medicine, NICU, Labor and Delivery, HIM (Health information management (Records)), IT Closets, Security, and PBX.

E. Information represented in the overall GUI shall include at a minimum all physical I/O, controlling variables, operating parameters, equipment capacities (air flow, water flow, hp, Bhp, tons, etc.), and certain nameplate data (manufacturer, model #, serial #, and installation date).

1.2 Design General

A. The BAS GUI is to be designed for use in full screen mode (no operating system taskbar) on a 27” 1920 x 1080 pixel monitor. This space shall include BAS system tools panel and navigation panel (or browser window) when applicable.

B. Text shall be easily legible on the standard monitor size mentioned above. Special consideration should be made to how text and the GUI as a whole will represent on larger (50”+) screens.

C. Darker, neutral backgrounds are in general preferred but not required as limited by graphic image packages. When possible it is preferred that the background is not printed.

D. Status may be shown by animation, but needs to be identifiable on a static image (such as printed view) of the panel.

E. Vendor identification may be represented only once within the GUI in the designated area on the Building Dashboard panel.

F. Only Automated Valves shall be represented graphically. Manual valves are not to be shown.

G. All piping, equipment, equipment configurations, components, and component configurations must match actual installations.

H. Equipment shall be labeled/numbered according the FacilitiGroup Naming convention and as closely as possible to what is present at the facility.

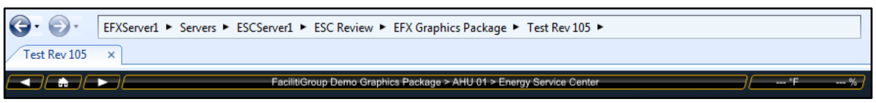
1.3 Information to be Included on All Graphic Panels

A. Every panel of the BAS GUI is to include the following information. In the event that information is already displayed in the BAS system panel, it is not required to be duplicated within the GUI unless specifically noted.

Navigation buttons (Forward, Back)	Header Left
Navigation Path (Facility > Equipment > Area Served) [1]	Header Mid
Conditions (Weather, Outside Air Temp, Outside Air RH)	Header Right
Date / Time	Footer Right

[1] Navigation Path (breadcrumbs) may appear in the system panel / address bar as well, but Facility, Equipment and Area Served must be in the graphic panel. See image below.

B. Some graphical representations in this document do not show navigation buttons or a timestamp. These are included in the BAS system window panel and are not required in the graphics panel.



C. Navigation links that shall appear on every page in the footer beginning at left:

1. Building Dashboard
2. Floor Plan
3. Chiller Plant
4. Boiler Plant
5. AHU Summary
6. Electric Systems
7. Auxiliary Systems
8. Alarms
9. Trends

D. This information is to be static and not vary in layout on each screen. Design may vary slightly depending on vendor, but consistency is to be maintained from screen to screen, and facility to facility.

1.4 Links and Attached Documents

A. *"Sequence…", "Logic…", and "Details…"* are 3 links that appear on all graphic panels, with the exceptions being the Building Dashboard, Legend, Floor Plans, and Contacts.

1. The *Sequence…* shall navigate the user to a graphic panel detailing the sequence of operation with both static text and the active controlled setpoints (See 02.02 Chiller Plant Sequence of Operations, and 04.05 AHU Sequence of Operations).The PDF of the SOO for the unit shall be accessible from the Sequence graphic panel.
2. The *Logic…* link will navigate the user to the actual programming of the unit within the control system. If the BAS is not capable of displaying the actual programming logic within the same user interface as the graphics, then the *Logic…* hyperlink shall be removed.
3. The *Details…* link will navigate the user to an additional external files available for the unit, such as a photo, O&M Material, and One-Line Diagrams.

B. The links shall be greyed-out when not in use.

C. Where schedules exist for a piece of equipment, a button or link shall exist on its graphic panel that navigates the user to the schedule editor.

D. The following documents shall be hosted on the BAS server and linked from each applicable page.

1. Sequence of Operations for each individual system
2. Operation and Maintenance Manuals for mechanical systems
3. Operation and Maintenance Manuals for control systems
4. Operation and Maintenance Manuals for electrical systems
5. All Mechanical Drawings in PDF format (Link to file system on BAS server)
6. All Control Drawings in PDF format (individual system)
7. Electrical system one-line drawings in PDF format
8. Link to Facility Public website
9. Link to Maintenance Management Software (work order tracking program)
10. Link to HCA Facility Infrastructure website (link from FacilitiGroup logo)

1.5 Units and Precision

A. The following units and precisions shall be used.

Temperature	21.1 °F	Fahrenheit
Humidity	0.0 – 100.0 % [1]	percent
Pressure (air)	1.12 in wc	inches water column

Pressure (water/steam)	21.1 psi	pounds / inch^2
Flow rate (air)	54,321 cfm	feet^3 / minute
Flow rate (natural gas)	54,321 CFH	feet^3 / hour
Flow rate (steam)	54,321 lb/hr	pounds / hour
Flow rate (water)	54,321 gpm	gallons / minute
Valve/Damper Position	0.0 – 100.0 % open [1]	percent
VFD Speed	0.0 – 100.0 % [1]	percent
Chiller Plant Efficiency	1.12 kW/Ton	kilowatt / ton
Power	321.1 kW	kilowatts
Current	321.1 A	amps
Voltage	321.1 V	volts
Power Factor	-100.0 – 100.0 % [1]	percent

[1] 100.0 % shall truncate to 100 % when possible.

Digital Command	On / Off Enabled / Disabled (system enablers only) Open / Closed (two position valves and dampers only)
Digital Status	On / Off Open / Closed (two position valves and dampers only)
System Attributes	True / False Online / Offline
Alarm	Alarm / Normal [2]

[2] Filter status shall NOT represent as Clean/Dirty, but as Alarm/Normal as indicated.

B. In addition to metered points from the equipment, static user data points (such as Nominal Capacity, Serial Number or Manufacturer) will be present in the BAS. These points are to be used in the BAS GUI when requested instead of plain text.

1.6 System Status Colors

A. Status colors should remain consistent throughout GUI.

On, no faults	Green
Off, no faults	Blue
Alarm	Red
Alarm (warning)	Yellow
Overridden	Orange
Communication Loss	Black

1.7 Piping Colors

A. Piping colors shall remain consistent throughout GUI.

Chilled Water Supply	Bright Blue	(Supply from Chiller)
Chilled Water Return	Dark Blue	(Return to Chiller)
Glycol (Low Temp) Supply	Bright Purple	(Supply from Low Temp Chiller)
Glycol (Low Temp) Return	Dark Purple	(Return to Low Temp Chiller)
Condenser Water Supply	Bright Green	(Supply to Chiller)
Condenser Water Return	Dark Green	(Return from Chiller)
Steam Supply	Bright Orange	
Condensate Return	Dark Orange	
Hot Water Supply	Bright Red	(Supply from Boiler)
Hot Water Return	Dark Red	(Return to Boiler)
Domestic Water	Dark Gray	
Natural Gas	Gold	
Fuel Oil	Brown	

Part 2-Products

Part 3 - Execution

3.1 Building Dashboard

A. The Building Dashboard panel shall give a quick overview of the major equipment on the BAS. This includes but is not limited to chillers, cooling towers, boilers, and air handlers.

B. In addition to the navigation buttons mentioned above, the Building Dashboard panel needs to include three images that are linked to other panels or sites.

Facility Logo	Facility Public website
HCA FacilitiGroup Logo	HCA Facility Infrastructure > Site Building Dashboard
Vendor Logo	Graphic panel with contact information (not external website)

C. Beginning with the Building Dashboard, any instance where an Air Handling Unit is displayed, its equipment name shall read "AHU ## - <Area Served>". For instance, "AHU 01 – Kitchen" means that AHU 01 supplies air to the kitchen. DO NOT include information regarding where the AHU is physically located within the AHU name. This will be displayed graphically on the floor plan.

D. The following points shall be present for each piece of equipment at a minimum on the Building Dashboard panel. This list is not intended to be limiting, but is a reference to a minimum.

1. Chiller - % FLA
2. Chiller - CHW Supply Temp
3. Chiller - CHW Return Temp
4. Boiler - % Firing Rate

5. Boiler - Steam Flow
6. Boiler – Steam Pressure
7. HW Boiler - % Firing Rate
8. HW Boiler - HW Supply Temp
9. HW Boiler - HW Return Temp
10. Cooling Tower - Fan Speed
11. Cooling Tower - CW Supply Temp
12. Cooling Tower - CW Return Temp
13. AHU Summary - Supply Air Temp
14. AHU Summary - Supply Air Static Pressure

Figure 1: Building Dashboard (Representation 1)

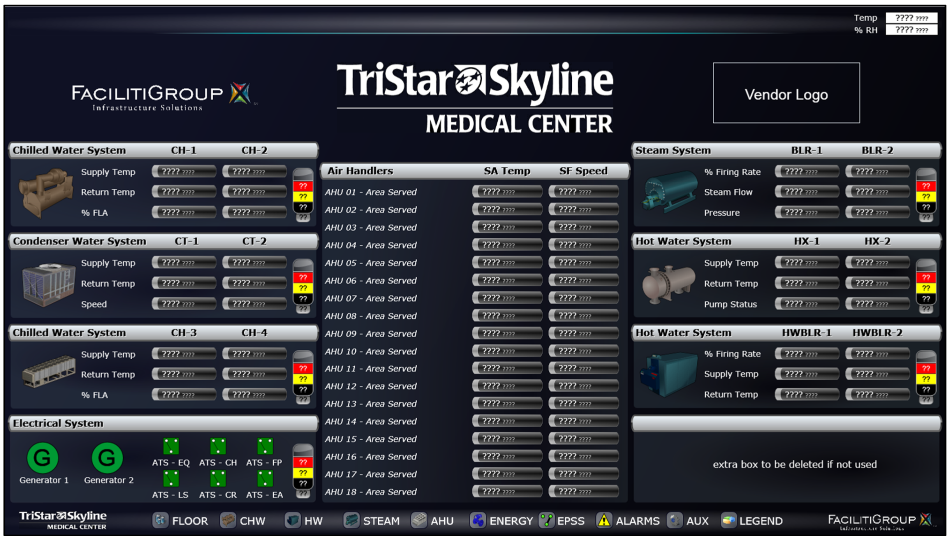


Figure 2: Building Dashboard (Representation 2)

3.2 Contacts

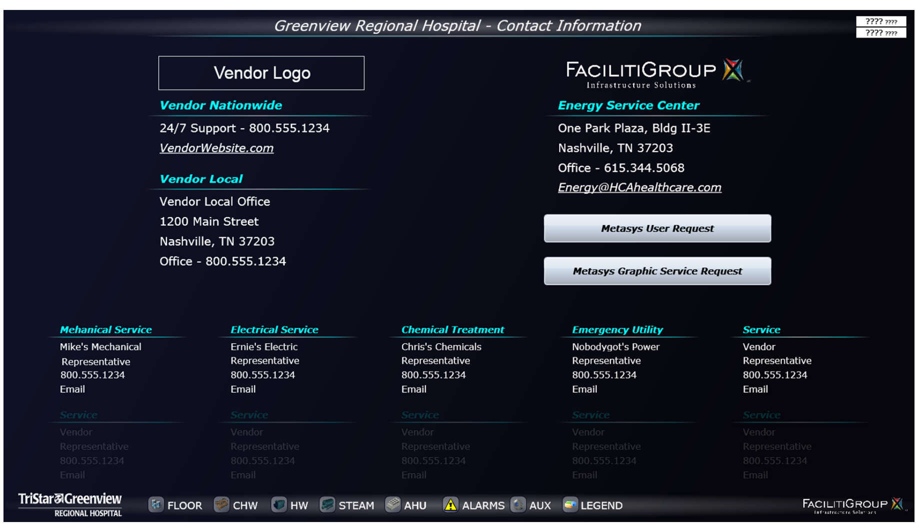


Figure 3: Sample Contacts

3.3 Legend

A. The Legend panel displays the system colors, piping colors, equipment icons and any other icons used throughout the GUI.

Figure 4: Sample Legend

3.4 Building Layout

A. Floor Plan

1. The Floor Plan panel is to show the facility floor plan with an overlay of space conditions.
2. If vendor specific widgets/modules exist for Floor Plan Graphics, PDF files detailing their function shall be accessed by clicking the "*Details…*" link for that graphic panel.
3. The following information shall be present.
    a. Space names
    b. Physical Equipment location
    c. Area serviced by Air Handling Unit
    d. Space Temp

e. Indication of warm/cool zones
f. VAV Data (separate box)
g. Alarm Summary (spaces with warm/cool alarm and warning)

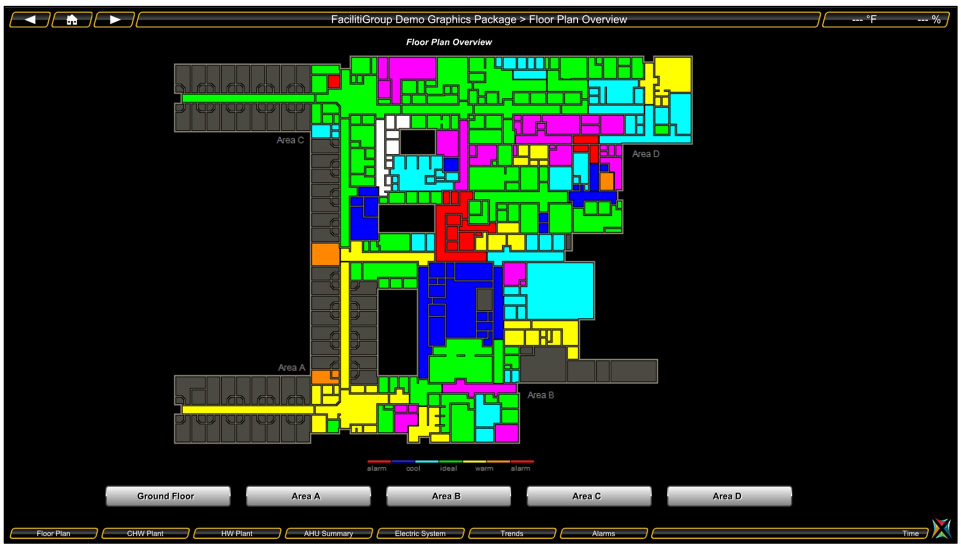


Figure 5: Floor Plan (Representation 1)

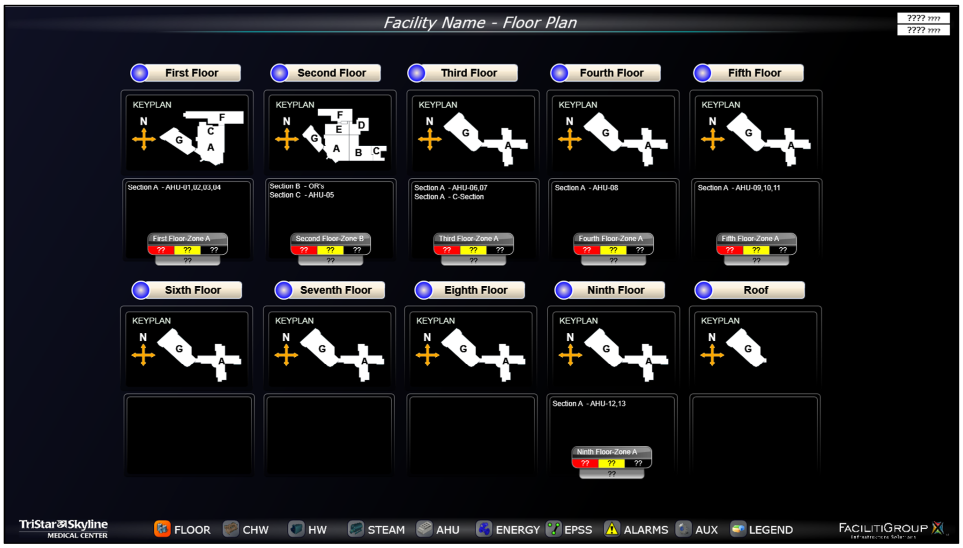
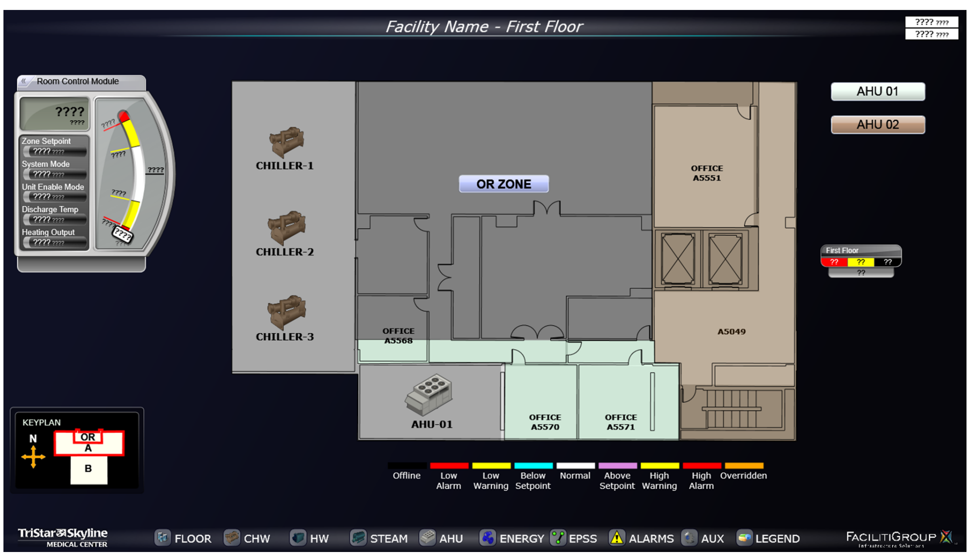


Figure 6: Floor Plan (Representation 2)

B. Area Plan

1. The Area Plan panel is to show a smaller portion of the facility floor plan, with an overlay of space conditions.
2. If vendor specific widgets/modules exist for Area Plan Graphics, PDF files detailing their function shall be accessed by clicking the "*Details…*" link for that graphic panel.
3. The following information shall be present.
    a. Space names
    b. Physical Equipment location
    c. Area serviced by Air Handling Unit
    d. Space Temp
    e. Indication of warm/cool zones
    f. VAV Data (separate box)
    g. Alarm Summary (spaces with warm/cool alarm and warning)

Figure 7: Area Plan (Representation 1)



C. OR Zone

1. The OR Zone panel is to show an exclusive look at operating and other procedural rooms, with an overlay of space conditions. All adjacent spaces, including central sterile rooms and corridors, with temperature, humidity, or pressurization requirements, shall be included in this panel.
2. If vendor specific widgets/modules exist for Area Plan Graphics, PDF files detailing their function shall be accessed by clicking the "*Details…*" link for that graphic panel.
3. The following information shall be present.
    a. Space names
    b. Physical Equipment location
    c. Area serviced by Air Handling Unit
    d. Space Temp
    e. Space Humidity
    f. Space Pressure
    g. Indication of warm/cool zones
    h. VAV Data (separate box)
    i. Alarm Summary (spaces with warm/cool alarm and warning)

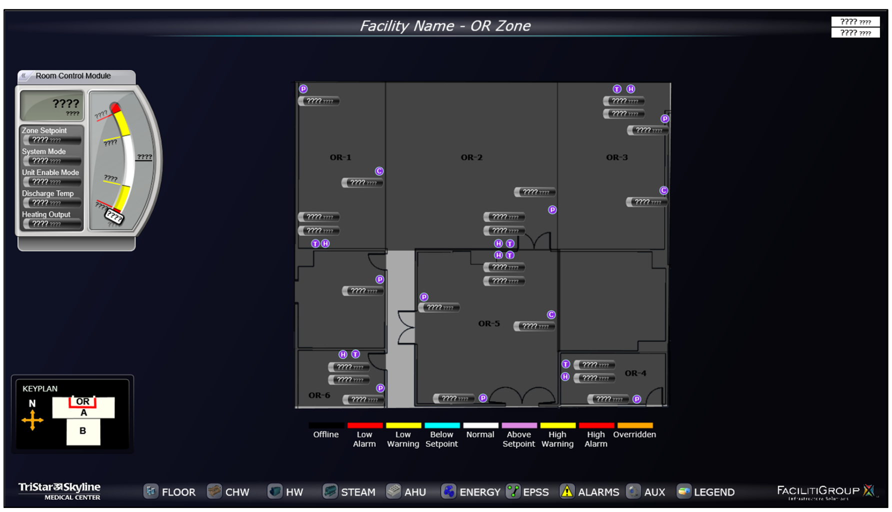


Figure 9: Floor Plan (Representation 1)

3.5 Cooling Systems

A. All piping and equipment configurations must match actual installations.

B. Chiller Plant Overview

1. The condenser water loop and chilled water loop are both shown on this panel and split on other panels. Equipment shown on this and all panels shall represent actual equipment as closely as possible. Equipment shall be labeled / numbered according to what is present at the facility. Commands and overrides will not be available on this screen.
2. The following points shall be present.
    a. Plant kW/Ton
    b. All temperatures
    c. Chilled Water Supply Temperature setpoint
    d. All flows
    e. All flow setpoints
    f. Chiller - % FLA
    g. Chiller - Status
    h. Chiller - Nominal Capacity
    i. Pump - Speed
    j. Pump - Status
    k. Cooling Tower - Speed
    l. Cooling Tower - Status
    m. Bypass - Direction Indicator May be flow, temperature, or valve (system dependent)
    n. Secondary Loop - Total load
3. The following links shall be present.

a.	Chiller Detail	On equipment
b.	Cooling Tower Detail	On equipment
c.	Condenser Water System	Button
d.	Chilled Water System	Button

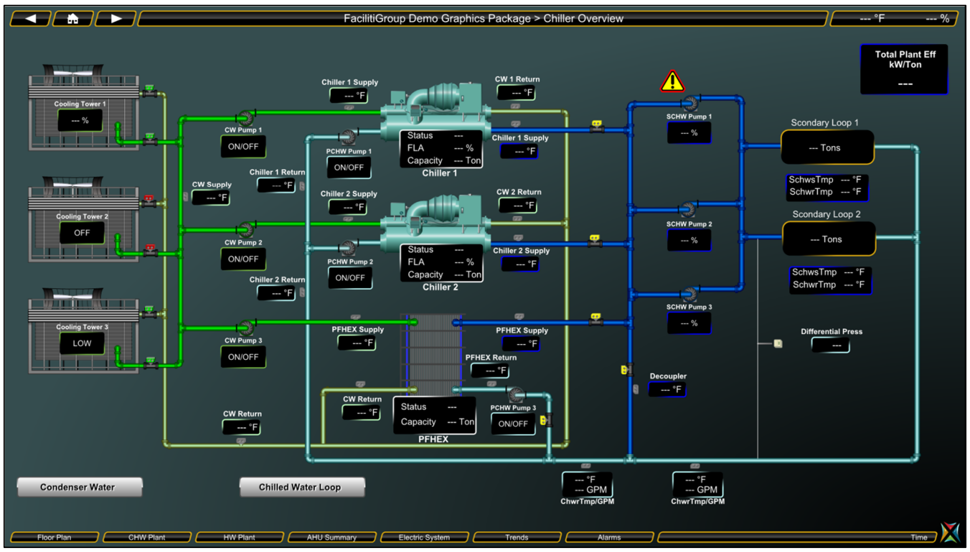


Figure 10: Chiller Plant Overview (Representation 1)

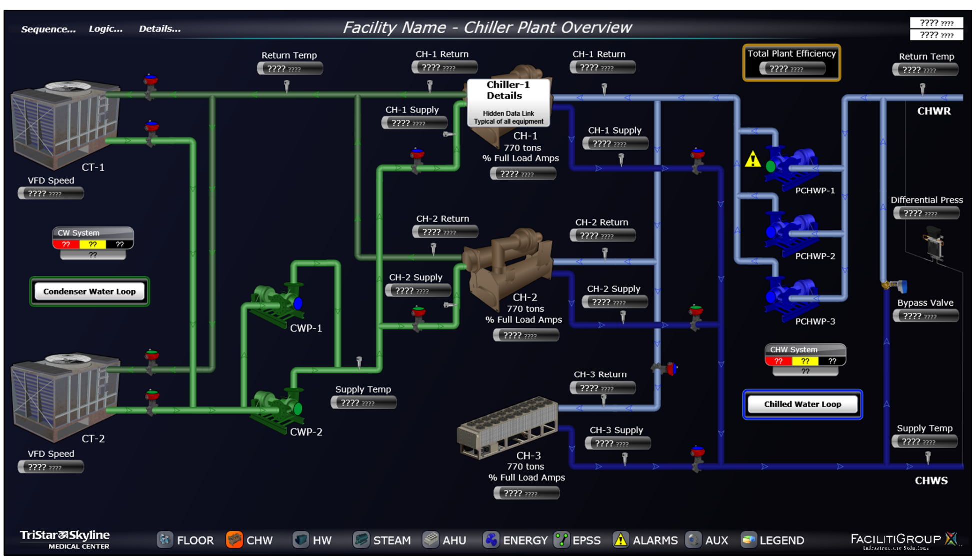
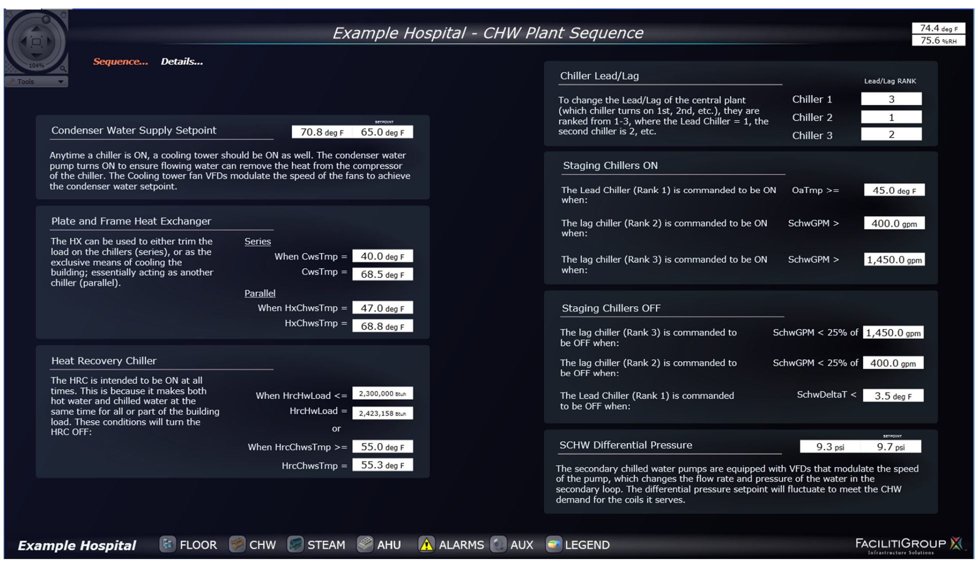


Figure 11: Chiller Plant Overview (Representation 2)

C. Chiller Plant Sequence of Operations

1. The Chiller Plant Sequence of Operations panel is to briefly describe the programming logic using both static text and live point values. This panel may also contain buttons/links to actual programming logic if the BAS is capable.
2. The following sequence descriptions and points shall be present for applicable equipment.
    a. Lead/Lag
    b. Turning On/Off
    c. Staging Up/Down
    d. Control Points/Set points
    e. Notes from the MEP Guidelines (if necessary)
    f. Applicable Reset Schedules



D. Condenser Water System

1. The Condenser Water System panel is to show the condenser water loop including the chillers, cooling towers and heat exchangers. Commands and overrides issued to the system will be available from this screen.
2. The following points shall be present.
    a. Plant kW/Ton
    b. All temperatures
    c. All temperature setpoints
    d. All flows
    e. All flow setpoints
    f. All loads
    g. All valves
    h. Chiller - % FLA
    i. Chiller - Command
    j. Chiller - Status
    k. Chiller - Nominal Capacity
    l. Chiller - ΔT
    m. Pump - Command
    n. Pump - Status
    o. Pump - Speed
    p. Pump - HP or kW
    q. Cooling Tower - Command
    r. Cooling Tower - Status
    s. Cooling Tower - Speed
    t. Cooling Tower - Fan HP or kW
    u. Cooling Tower - ΔT
    v. Cooling Tower - Makeup Flow
    w. Cooling Tower - Blowdown Flow
    x. Cooling Tower - Makeup / Blowdown Ratio
3. The following links shall be present.
    a. CW Sequence of Operations *Sequence…*

b. CW Control Drawings	*Details…*
c. CW Mechanical Drawings	*Details…*
d. Chiller Detail	On equipment
e. Cooling Tower Detail	On equipment
f. Chiller Plant	Button
g. Chilled Water System	Button

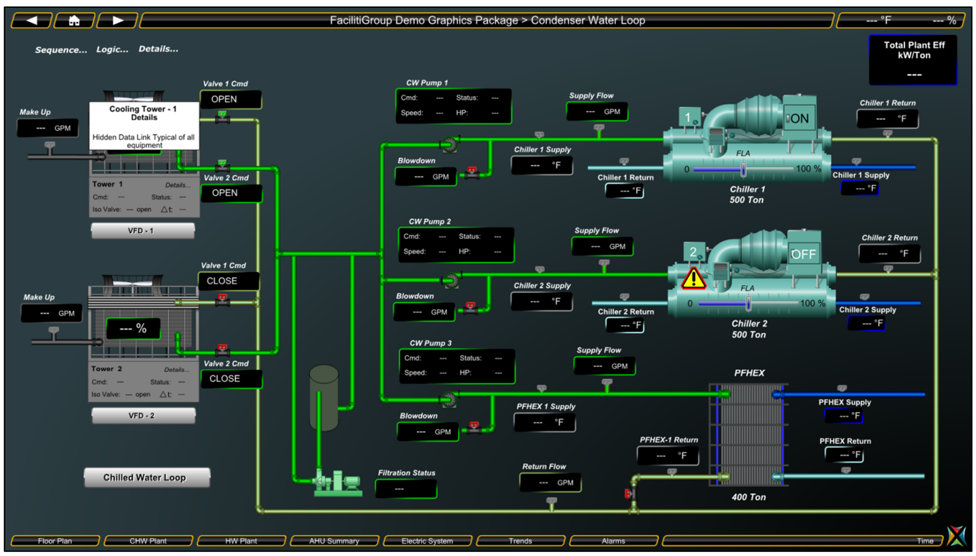


Figure 13: Condenser Water System (Representation 1)

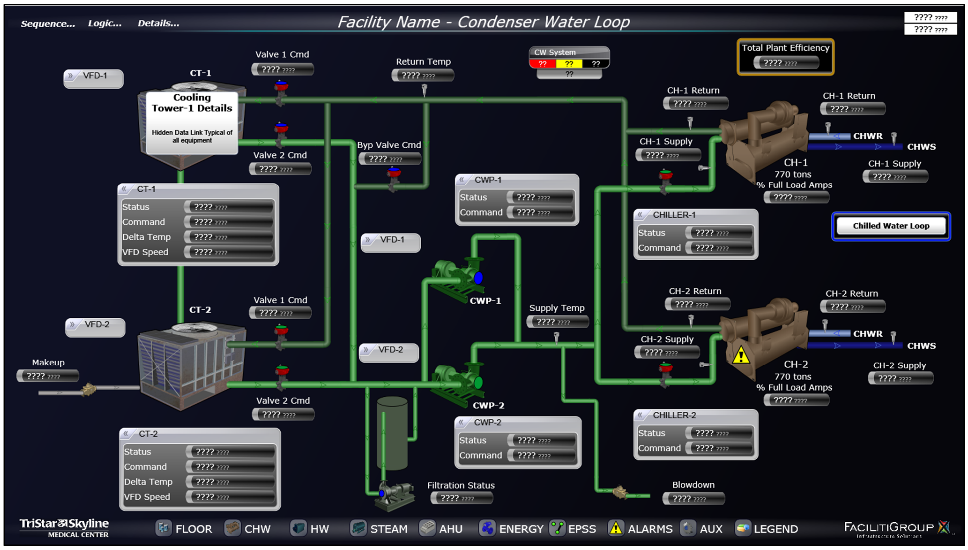


Figure 14: Condenser Water System (Representation 2)

E. Chilled Water System

1. The Chilled Water System panel is to show the primary and secondary (where applicable) chilled water loops including chillers and heat exchangers. Commands and overrides issued to the system will be available from this screen.
2. The following points shall be present.
    a. Plant kW/Ton
    b. All temperatures
    c. All temperature setpoints
    d. All flows
    e. All flow setpoints
    f. All loads
    g. All valves
    h. Chiller - % FLA
    i. Chiller - Command
    j. Chiller - Status

k. Chiller - Nominal Capacity

l. Chiller - ΔT

m. Pump - Command

n. Pump - Status

o. Pump - Speed

p. Pump - HP or kW

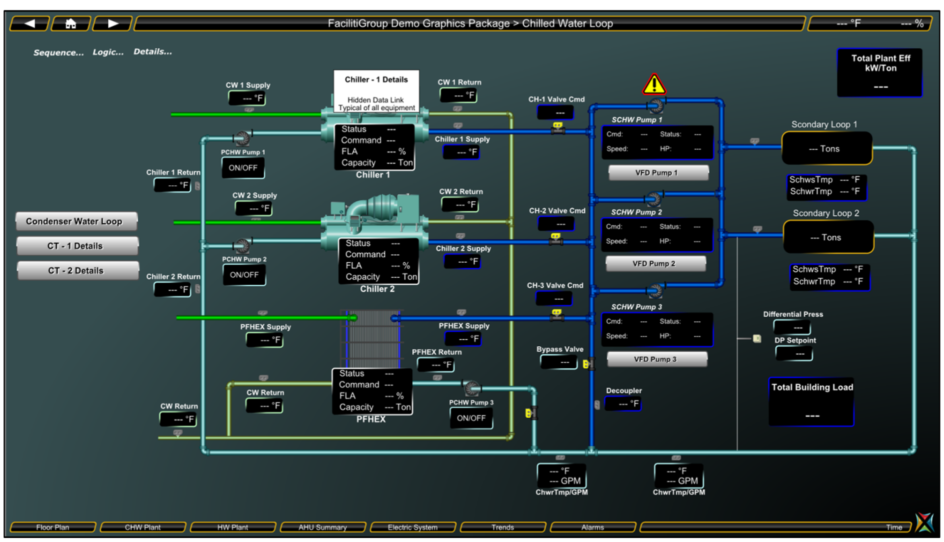
q. Secondary Loop - dP

r. Secondary Loop - dP setpoint

s. Secondary Loop - ΔT

3. The following links shall be present.

a.	CHW Sequence of Operations	*Sequence…*
b.	CHW Control Drawings	*Details…*
c.	CHW Mechanical Drawings	*Details…*
d.	Chiller Detail	On equipment
e.	Chiller Plant	Button
f.	Condenser Water System	Button



CONFIDENTIAL - Contains proprietary information. For restricted use only.

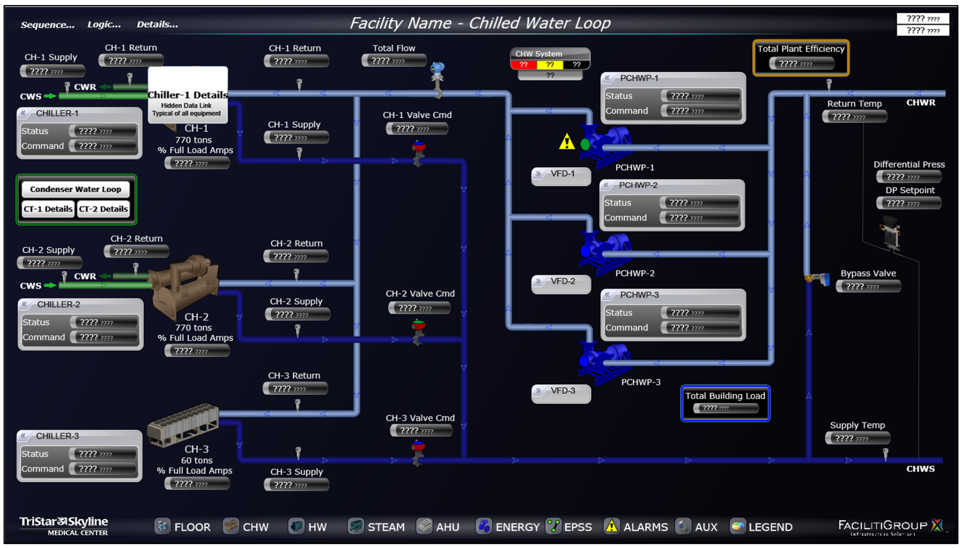


Figure 16: Chilled Water System (Representation 2)

F. Chiller Detail

1. The Chiller Detail panel shall show all data, both from the BAS and communicated directly from the chiller, as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. All feeds to and from the chiller (supply and return CW / CHW and electrical metering) shall be shown.
2. The following points shall be present.
   a. Any point that can be communicated from chiller
   b. CHW return temp
   c. CHW supply temp
   d. CHW flow
   e. CHW Pump Status (if dedicated)
   f. CW return temp
   g. CW supply temp
   h. CW flow

i. CW Pump Status (if dedicated)

3. The following links shall be present.

a.	Sequence of Operations	Sequence…
b.	Control Drawings	Details…
c.	Mechanical Drawings	Details…
d.	O & M Manual	Details…
e.	Chiller Plant	Button
f.	Condenser Water System	Button
g.	Chilled Water System	Button
h.	Other Chillers	Button
i.	Electric System	Meter (when chiller electric metering exists then an icon on the graphic panel will link to live chiller electrical data)

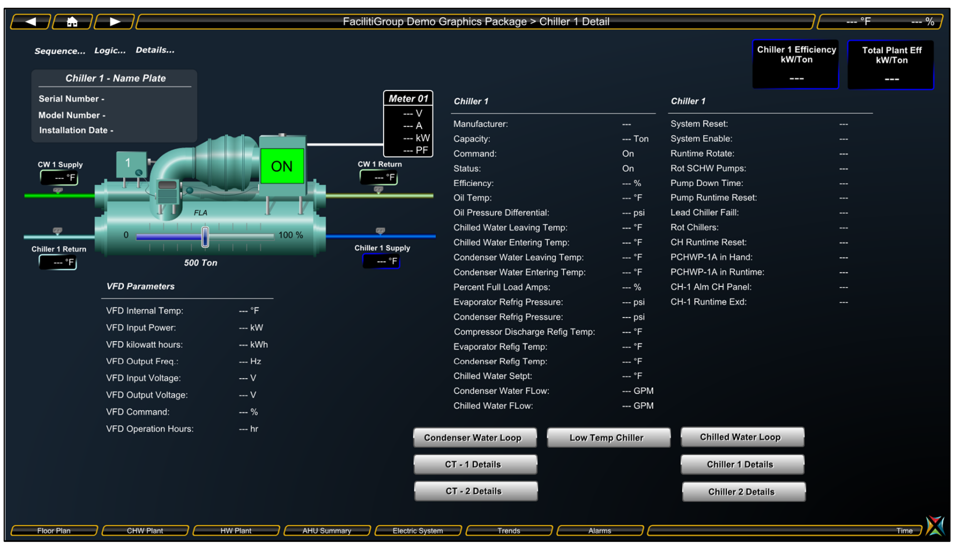


Figure 17: Chiller Detail - Representation 1

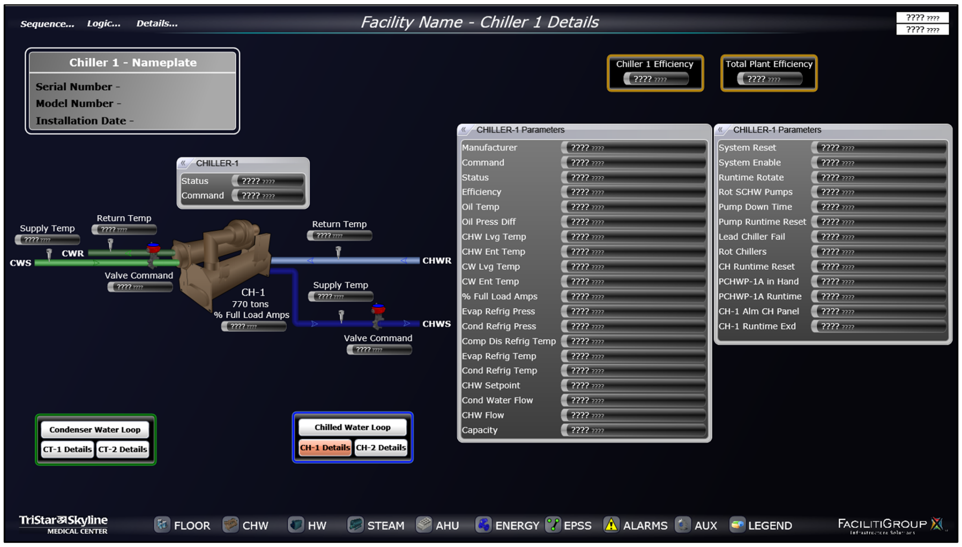


Figure 18: Chiller Detail (Representation 2)

G. Low-Temperature Chiller Detail

1. The Low-Temperature Chiller Detail panel shall show all available data, both from the BAS and communicated directly from the chiller, as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. All feeds to and from the chiller (supply and return CHW / Glycol and electrical metering) shall be shown.
2. The following points shall be present.
    a. Any point that can be communicated from chiller
    b. CHW return temp
    c. CHW supply temp
    d. CHW flow
    e. CHW Pump Status (if dedicated)
3. The following links shall be present.
    a. Sequence of Operations *Sequence…*
    b. Control Drawings *Details…*
    c. Mechanical Drawings *Details…*

d. O & M Manual *Details…*

e. Chiller Plant Button

f. Condenser Water System Button

g. Chilled Water System Button

h. Other Chillers Button

i. Electric System Meter (when chiller electric metering exists then an icon on the graphic panel will link to live chiller electrical data)

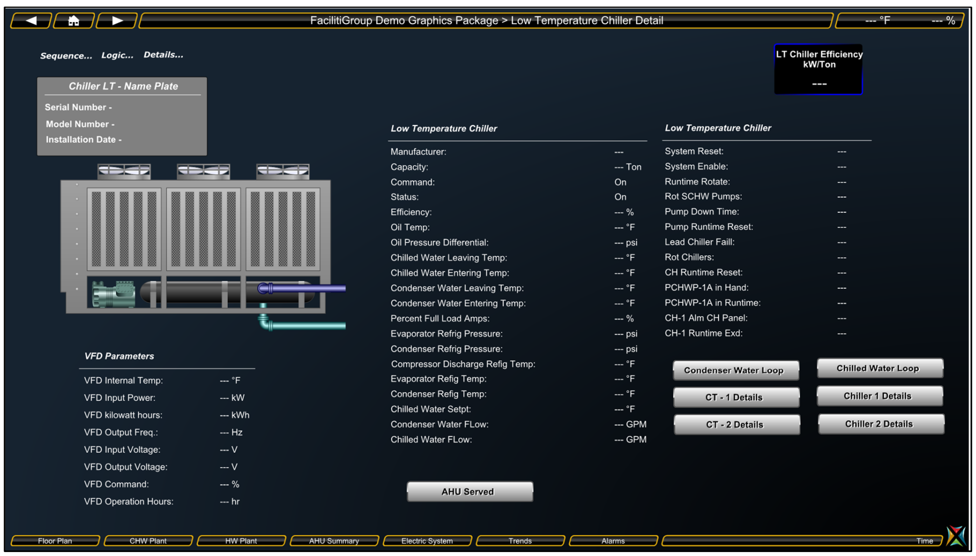


Figure 19: Low Temperature Chiller Detail (Representation 1)

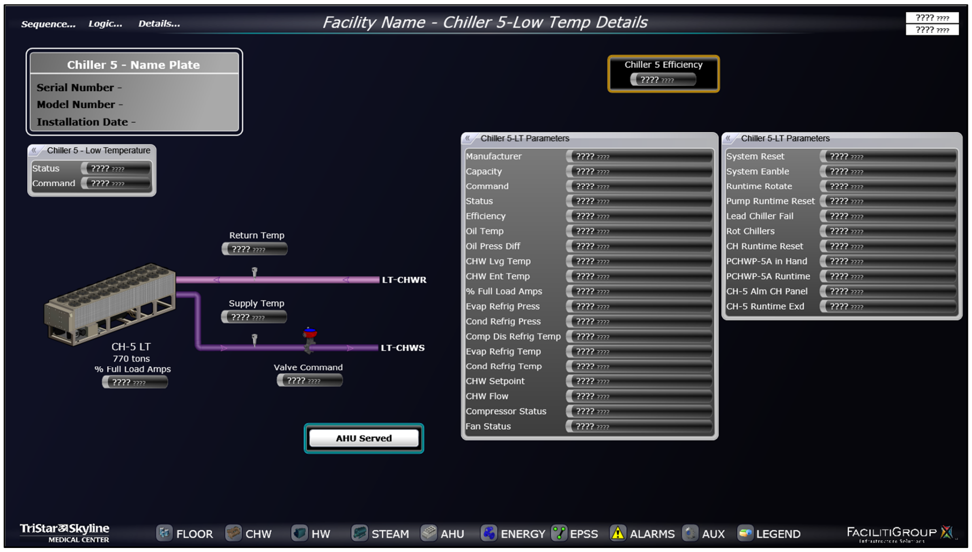


Figure 20: Low Temperature Chiller Detail (Representation 2)

H. Plate and Frame Heat Exchanger Detail

1. The Plate and frame HX Detail Panel shall show all available data from the BAS as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. In addition, special consideration shall be made to include the Sequence of Operations and Chilled Water Plant Mode within the panel. All feeds to and from the Heat Exchanger (supply and return CW / CHW) shall be shown.
2. Points Listed shall include:
   a. CHW Supply and Return Temp
   b. CW Supply and Return Temp
   c. CW Valve Position and Command
   d. CHW Supply Valve Position and Command
   e. CHW Return Valve Position and Command
   f. Chiller Plant Mode
   g. PF HX Status

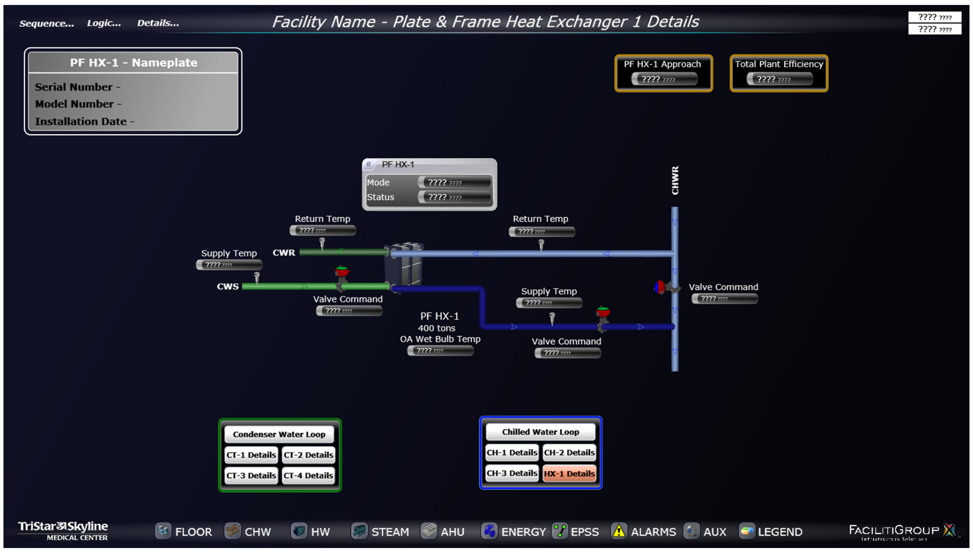


Figure 21: Plate & Frame Heat Exchanger Detail (Representation 1)

I. Cooling Tower Detail

1. The Cooling tower Details panel shall show all available data from the BAS as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. All feeds to and from the cooling tower (supply and return CW and makeup, and blowdown) shall be shown.
2. Points Listed shall include:
   a. Unit Status
   b. Unit Command
   c. CW Supply and Return Temp
   d. Isolation Valve Position and Command
   e. Bypass Valve Position and Command
   f. Tower Fan VFD Speed and integrated VFD data
   g. Make-up Water and Blow down meter data
3. Links on this panel shall include:
   a. Condenser Water Loop
   b. Chilled Water Loop

c. Additional Cooling Tower Details Panels

d. Chiller Detail Panels

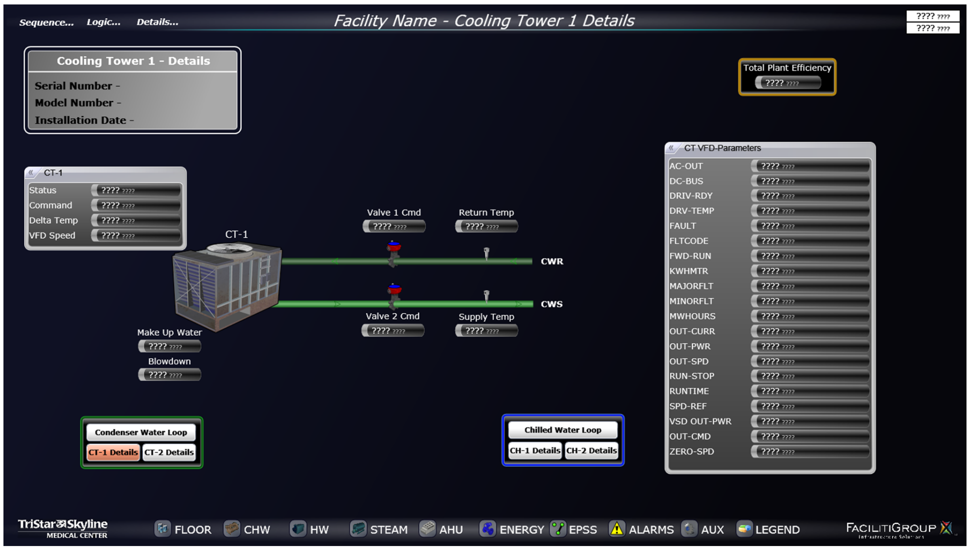


Figure 22: Cooling Tower Detail (Representation 1)

3.6 Heating Systems

A. All piping and equipment configurations must match actual installations.

B. Boiler Plant

1. The Steam / HW boilers, DA / Feedwater tanks and Heat Exchangers shall both be shown on the Boiler Plant panel. If both steam and hot water boilers are present and separate systems they are to be shown on separate panels. Equipment shown on this and all panels shall represent actual equipment as closely as possible.
2. The following points shall be present.

    a. Boiler Efficiency

    b. All temperatures

    c. All temperature setpoints

    d. All flows

   e. All flow setpoints
   f. All loads
   g. Boiler - Command
   h. Boiler - Status
   i. Boiler - Nominal capacity
   j. Boiler - % firing range
   k. Boiler - Feedwater Temp
   l. Boiler - Steam Temp
   m. Boiler - Steam Pressure
   n. Boiler - Natural gas flow
   o. Boiler - Makeup / Feedwater Ratio
   p. DA Tank - Make up Flow
   q. Heat Exchanger - Steam Valves
   r. HW Loop - Supply Temp
   s. HW Loop - Return Temp
   t. HW Loop - ΔT
   u. HW Loop - Load
   v. HW Pump - Speed or Status

3. The following links shall be present.

a. Sequence of Operations	*Sequence…*
b. Control Drawings	*Details…*
c. Mechanical Drawings	*Details…*
d. Boiler Detail	On equipment
e. Heat Exchanger Detail	On equipment

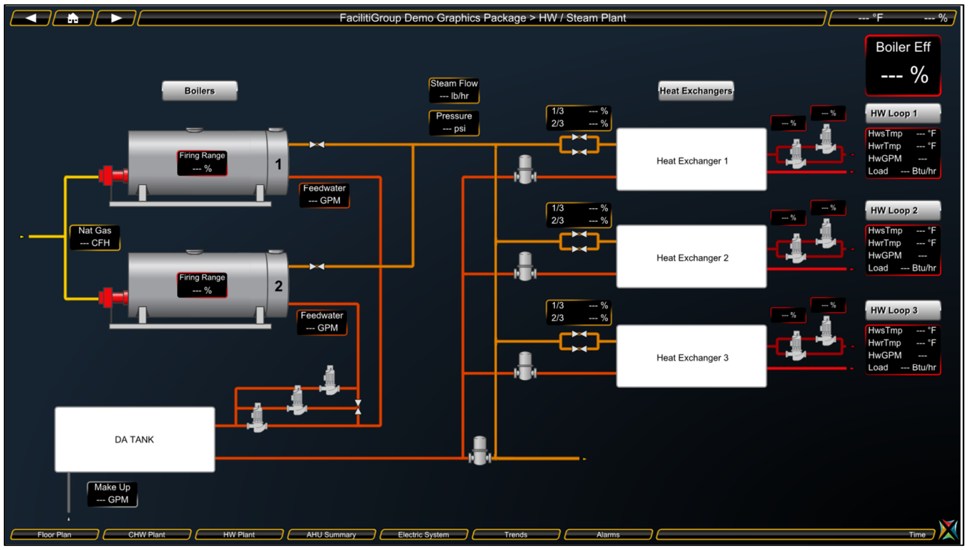


Figure 23: Steam Boiler Plant Overview (Representation 1)

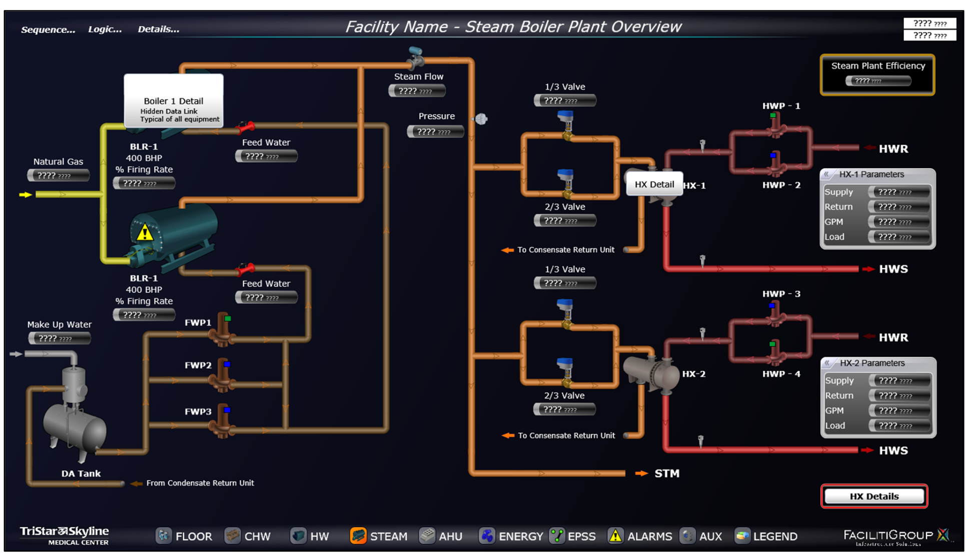


Figure 24: Steam Boiler Plant Overview (Representation 2)

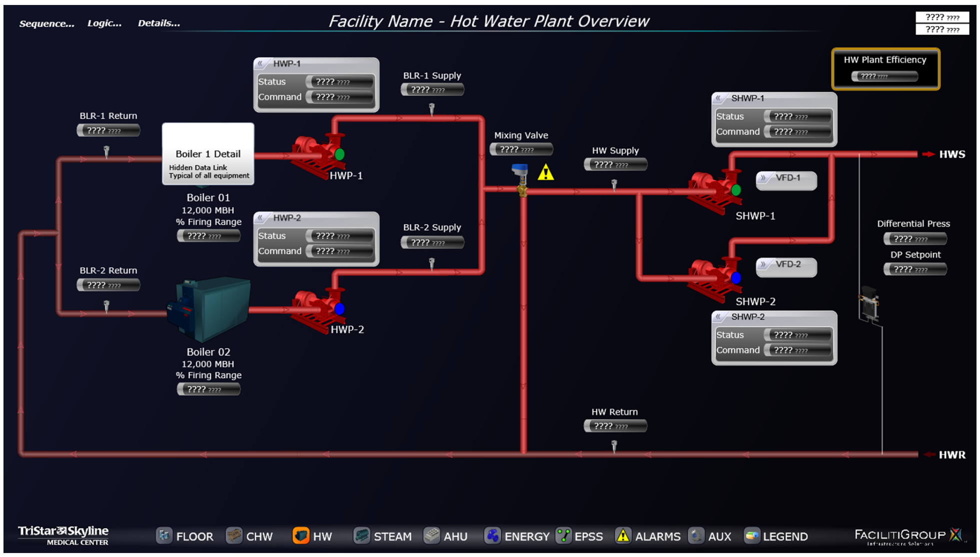


Figure 25: Hot Water Boiler Plant Overview (Representation 1)

C. Steam Boiler Detail

1. The Steam Boiler Detail panel is to show all available data, both from the BAS and communicated directly from the boiler, as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. All feeds to and from the boiler (Feedwater, steam and natural gas / fuel oil) shall be shown. All boilers and DA / Feedwater tanks may be shown on the same panel.
2. The following points shall be present.
    a. Any point that can be communicated from boiler and nameplate data
    b. Boiler Efficiency
    c. Boiler - Nominal Capacity
    d. Boiler - Natural gas flow
    e. Boiler - Makeup / Feedwater Ratio
    f. Boiler - Feedwater Temp
    g. Any point that can be communicated from DA Tank and nameplate data
    h. DA Tank - Make up Flow

i. Feedwater Pump - Command
j. Feedwater Pump - Status
k. Feedwater Pump - Speed
l. Feedwater Pump - HP or kW

3. The following links shall be present.

a.	Sequence of Operations	*Sequence…*
b.	Control Drawings	*Details…*
c.	Mechanical Drawings	*Details…*
d.	O & M Manual	*Details…*
e.	Boiler Plant	Button
f.	Heat Exchanger Detail	Button

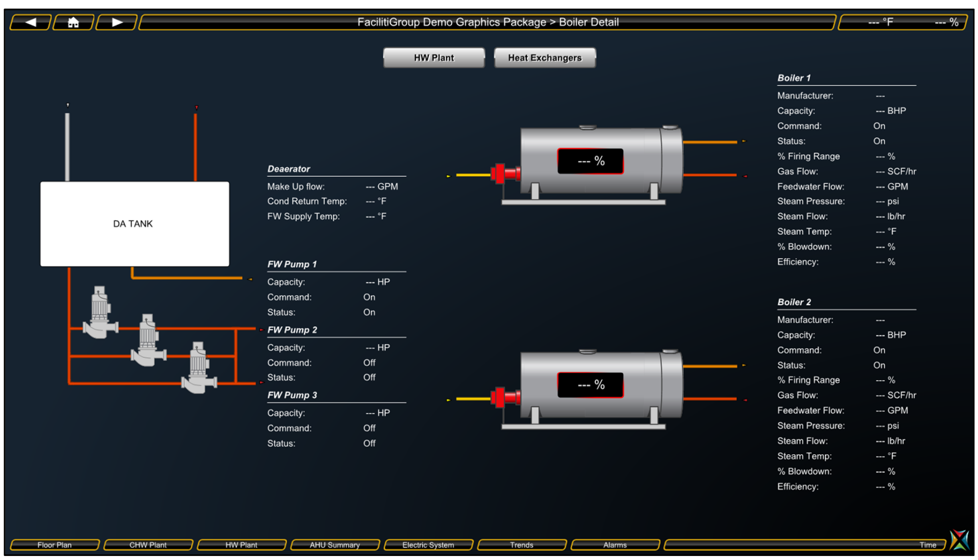


Figure 26: Steam Boiler Detail (Representation 1)

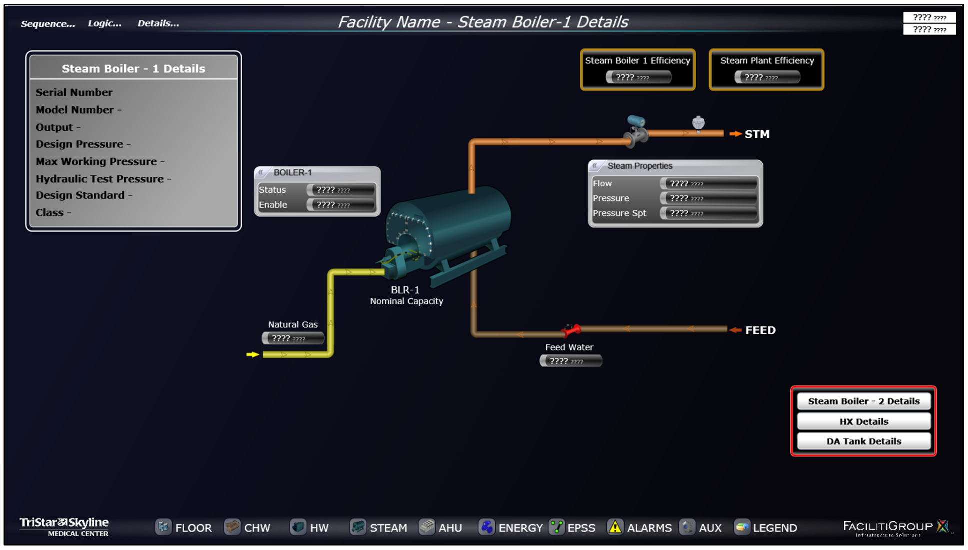


Figure 27: 03.02 Steam Boiler Detail (Representation 2)

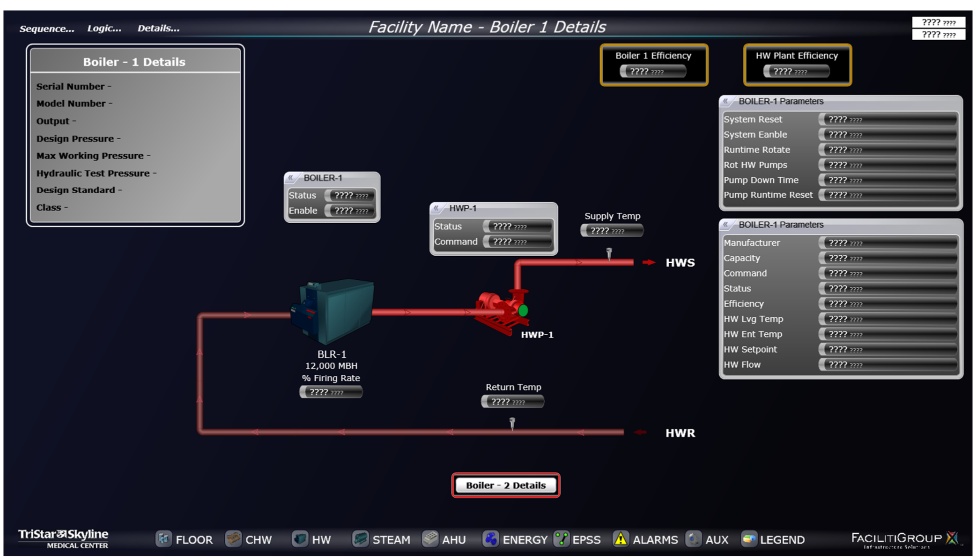


Figure 28: Hot Water Boiler Detail (Representation 2)

D. Heat Exchanger Detail

1. The Heat Exchanger Detail panel is to show information about the heat exchangers and the hot water loops they supply. Multiple heat exchangers / hot water loops may be shown on one panel.
2. The following points shall be present.
    a. HW Pump - Command
    b. HW Pump - Status
    c. HW Pump - Speed
    d. HW Pump - HP or kW
    e. Heat Exchanger - Steam Valves
    f. HW Loop - Supply Temp
    g. HW Loop - Return Temp
    h. HW Loop - ΔT
    i. HW Loop – Load
3. The following links shall be present.
    a. Sequence of Operations *Sequence…*
    b. Control Drawings *Details…*
    c. Mechanical Drawings *Details…*
    d. Boiler Plant Button

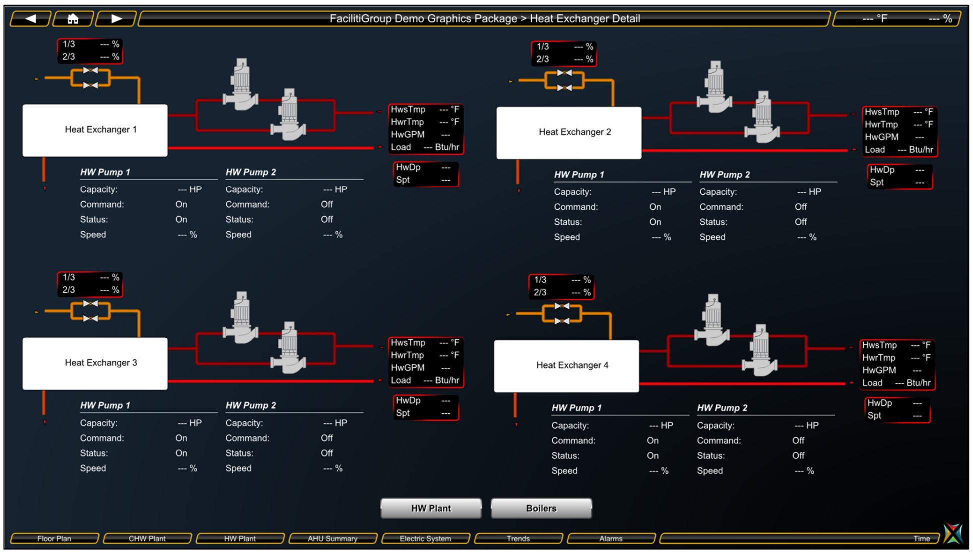


Figure 29: Heat Exchanger Detail (Representation 1)

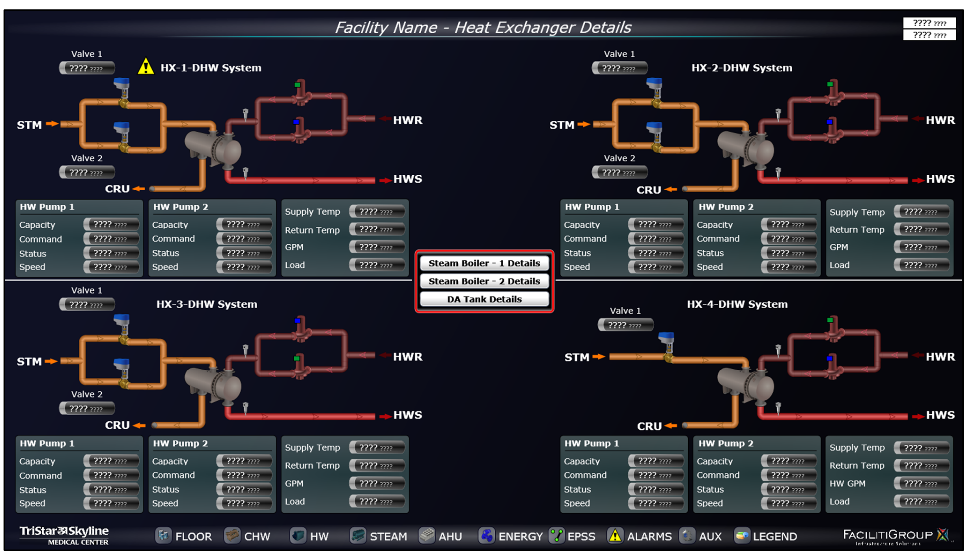


Figure 30: Heat Exchanger Detail (Representation 2)

E. DA Tank Details

1. The DA Tank Details panel is to show all available data from the as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. All feeds to and from the DA Tank (condensate return, steam, makeup water, and boiler feed water) shall be shown.
2. The following points shall be present:
    a. Feed Water Pump Status
    b. Feed Water Flow Rate
    c. Feed Water Temperature (Where available)
    d. Makeup Water Flow rate
3. The following links shall be present:
    a. Heat Exchanger Details Button
    b. Steam Boiler Details Button

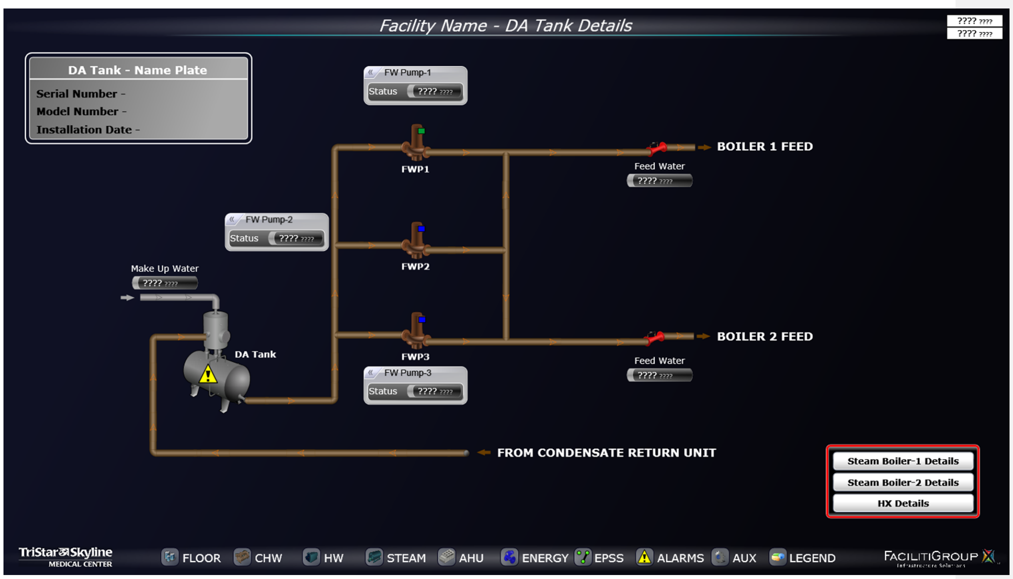


Figure 31: DA Tank Details (Representation 1)

3.7 Air Systems

A. All piping and equipment configurations must match actual installations.

B. AHU Summary

1. The AHU Summary panel is to be a table of available data from all air handlers. This table shall show alarms, warnings and overrides and be sortable if functionality exists. Multiple pages may be used for large amounts of AHUs. In addition to this table, information for the chiller and boiler plants shall be shown. Summary information shall be represented on three different panels.

2. The following points shall be present.

a. Panel 1:

i. Mode – Occupied/Unoccupied

ii. Economizer State – "1 Mech Clg", "2 Free+Mech", "3 Free Clg", "4 Heating"

iii. Supply Air Temp

iv. Supply Air Temp Setpoint

v. CHW Valve Position

vi. Mixed Air Temp

vii. Preheat Temp

viii. Preheat/HW Valve Position

ix. Economizer Damper Position

x. Minimum OA Damper Position

xi. Return Air Temp

xii. Return Air RH

xiii. Supply Air CFM

xiv. Box Total CFM

b. Panel 2:

i. Mode – Occupied/Unoccupied

ii. Economizer State – "1 Mech Clg", "2 Free+Mech", "3 Free Clg", "4 Heating"

iii. Supply Static Pressure

iv. Supply Static Pressure Setpoint

v. Supply Air Fan Speed

vi. Supply Air CFM

vii. Supply Air CFM Differential (This is a calculated Outside Air flow rate value)

viii. Supply Air CFM Differential Setpoint

ix. Return Air Fan Speed

x. Return Air CFM

c. Panel 3:

i. Mode – Occupied/Unoccupied

ii. Economizer State – "1 Mech Clg", "2 Free+Mech", "3 Free Clg", "4 Heating"

iii. Supply Air Temp

iv. Supply Air Temp Setpoint

v. Return Air Relative Humidity

vi. Return Air Temp

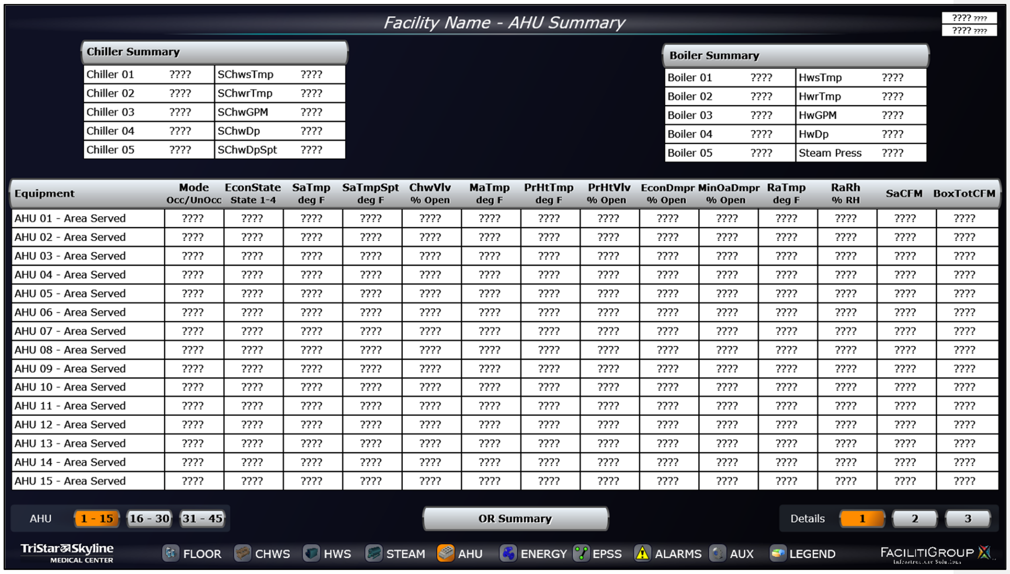
vii. Humidifier Valve Position

viii. Supply Air Relative Humidity High Limit

ix. Zone Humidity

3. The following links shall be present.

a. OR Summary	Button
b. AHU	On text
c. Chiller Plant	Chiller Plant info box
d. Boiler Plant	Boiler Plant info box

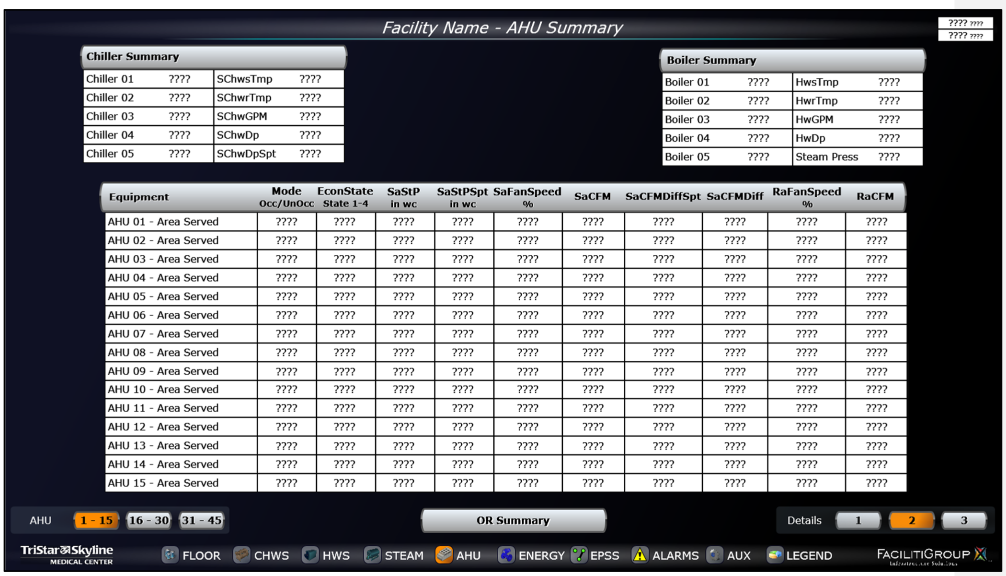


Chiller Summary			
Chiller 01	????	SChwsTmp	????
Chiller 02	????	SChwrTmp	????
Chiller 03	????	SChwGPM	????
Chiller 04	????	SChwDp	????
Chiller 05	????	SChwDpSpt	????

Boiler Summary			
Boiler 01	????	HwsTmp	????
Boiler 02	????	HwrTmp	????
Boiler 03	????	HwGPM	????
Boiler 04	????	HwDp	????
Boiler 05	????	Steam Press	????

Equipment	Mode Occ/UnOcc	EconState State 1-4	SaTmp deg F	SaTmpSpt deg F	ChwVlv % Open	MaTmp deg F	PrHtTmp deg F	PrHtVlv % Open	EconDmpr % Open	MinOaDmpr % Open	RaTmp deg F	RaRh % RH	SaCFM	BoxTotCFM
AHU 01 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 02 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 03 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 04 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 05 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 06 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 07 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 08 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 09 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 10 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 11 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 12 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 13 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 14 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 15 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????

Figure 32: AHU Summary (Panel 1 of 3)



Chiller Summary			
Chiller 01	????	SChwsTmp	????
Chiller 02	????	SChwrTmp	????
Chiller 03	????	SChwGPM	????
Chiller 04	????	SChwDp	????
Chiller 05	????	SChwDpSpt	????

Boiler Summary			
Boiler 01	????	HwsTmp	????
Boiler 02	????	HwrTmp	????
Boiler 03	????	HwGPM	????
Boiler 04	????	HwDp	????
Boiler 05	????	Steam Press	????

Equipment	Mode Occ/UnOcc	EconState State 1-4	SaStP in wc	SaStPSpt in wc	SaFanSpeed %	SaCFM	SaCFMDiffSpt	SaCFMDiff	RaFanSpeed %	RaCFM
AHU 01 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 02 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 03 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 04 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 05 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 06 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 07 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 08 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 09 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 10 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 11 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 12 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 13 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 14 - Area Served	????	????	????	????	????	????	????	????	????	????
AHU 15 - Area Served	????	????	????	????	????	????	????	????	????	????

Figure 33: AHU Summary (Panel 2 of 3)

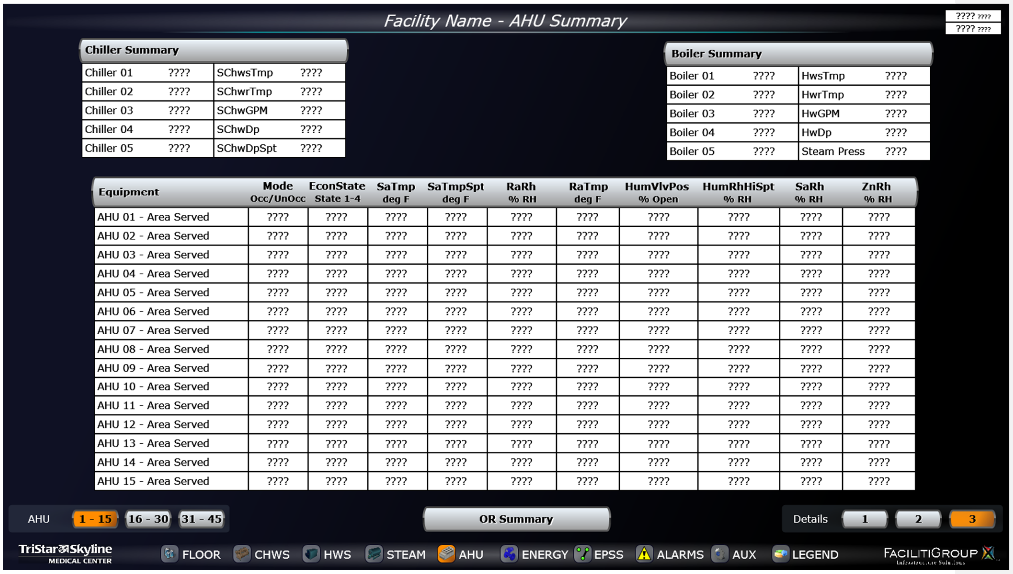


Figure 34: AHU Summary (Panel 3 of 3)

C. OR Summary

1. The OR Summary panel is to be a table of available data from all operating rooms. This table shall show alarms, warnings and overrides and be sortable if functionality exists. Multiple pages may be used for large amounts of ORs. In addition to this table, information for the chiller and boiler plants and AHU serving the ORs shall be shown.
2. The following points shall be present.
    a. OR – Mode – Occupied/Unoccupied
    b. OR - Room Temp
    c. OR - Room Temp Setpoint
    d. OR - Room RH
    e. OR - Room RH Setpoint
    f. OR - Reheat Valve Position
    g. OR - Discharge Airflow
    h. OR - Discharge Airflow Setpoint
    i. OR - Damper Position

j. OR - Door Sensor
k. OR - Pressurization
l. AHU - Economizer State
m. AHU - Supply Air Temp
n. AHU - Return Air Temp
o. AHU - CHW Valve Position
p. AHU - Preheat/HW Valve Position
q. AHU - Return Air RH
r. AHU - Box Total CFM
s. AHU - Load
t. CHW - Chiller Status
u. CHW - Chiller % FLA
v. CHW - CHW Supply Temp
w. CHW - CHW Return Temp
x. CHW - CHW Flow
y. CHW - CHW Loop Load
z. HW - Boiler Status
aa. HW - Boiler % Firing Range
bb. HW - HX Valve Position
cc. HW - HW Supply Temp
dd. HW - HW Return Temp
ee. HW - HW Flow
ff. HW - HW Loop Load

3. The following links shall be present.

a. AHU	info box
b. Chiller Plant	Chiller Plant info box
c. Boiler Plant	Boiler Plant info box

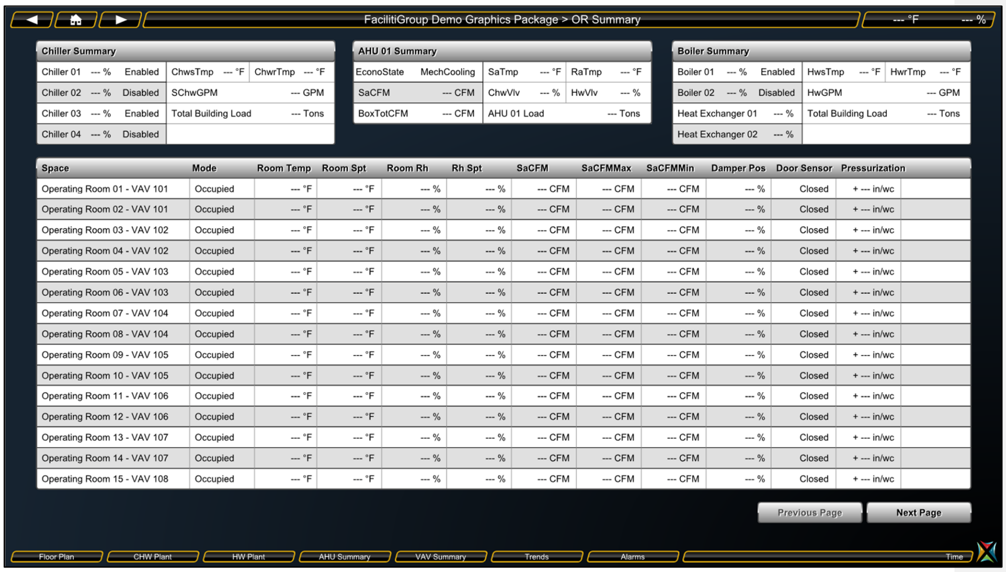


Figure 35: OR Summary (Representation 1)

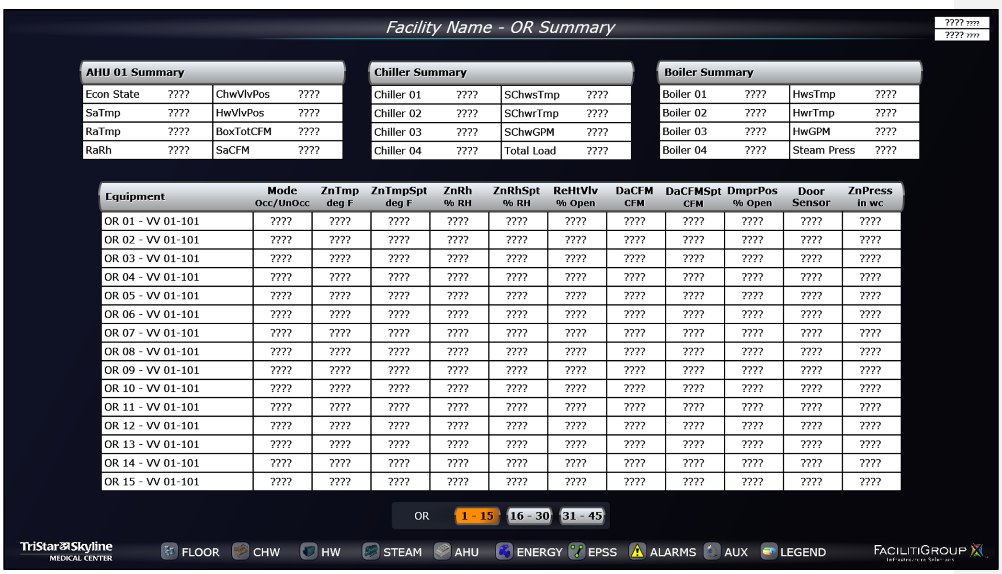


Figure 36: OR Summary (Representation 2)

D. Air Handling Unit

1. The Air Handling Unit shall show all equipment, both that report data to the BAS and those that do not (such as blenders, filters, etc.). It is very important that the graphic panel represents the appropriate equipment in the proper location. Any active alarm for any component of the unit shall be displayed.
2. If any existing point is a calculated value, such as Outside Air CFM, then it shall be denoted as a calculated point. For instance: OaCFM.calc
3. The following points shall be present.
   a. All temperature values, setpoints, and active alarms
   b. All flow values, setpoints, and active alarms
   c. All filter status values, and alarms
   d. Box Total CFM
   e. All humidities
   f. All humidity setpoints
   g. All valve positions/statuses
   h. All valve commands
   i. All fan speeds/statuses
   j. All fan commands
   k. All fan HP or kW
   l. All air pressures
   m. All air pressure setpoints
   n. All damper positions/statuses
   o. All damper commands
   p. All Safety Devices
   q. Electric Reheat Status
   r. Electric Reheat Stage
   s. Electric Reheat Command
4. The following links shall be present.
   a. AHU Sequence of Operations *Sequence…*

b. AHU Control Drawings *Details…*
c. AHU Mechanical Drawings *Details…*
d. CV / VAV Summary Button

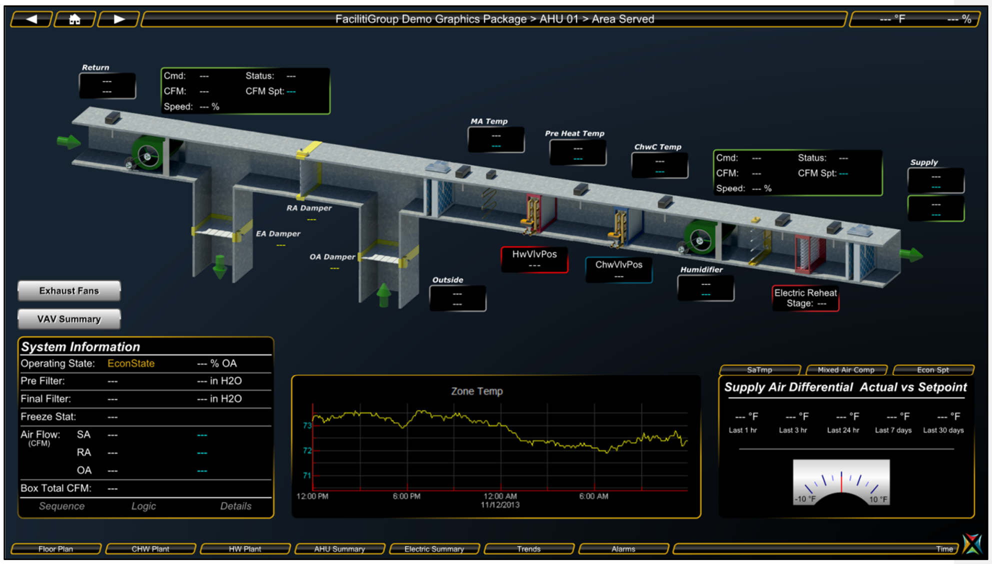
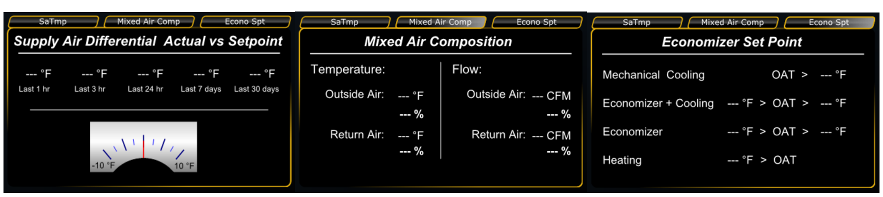


Figure 37: Air Handling Unit (Representation 1)

Note the box at the lower right of the graphic panel changing when the buttons above are clicked. This functionality or similar shall be implemented when applicable.



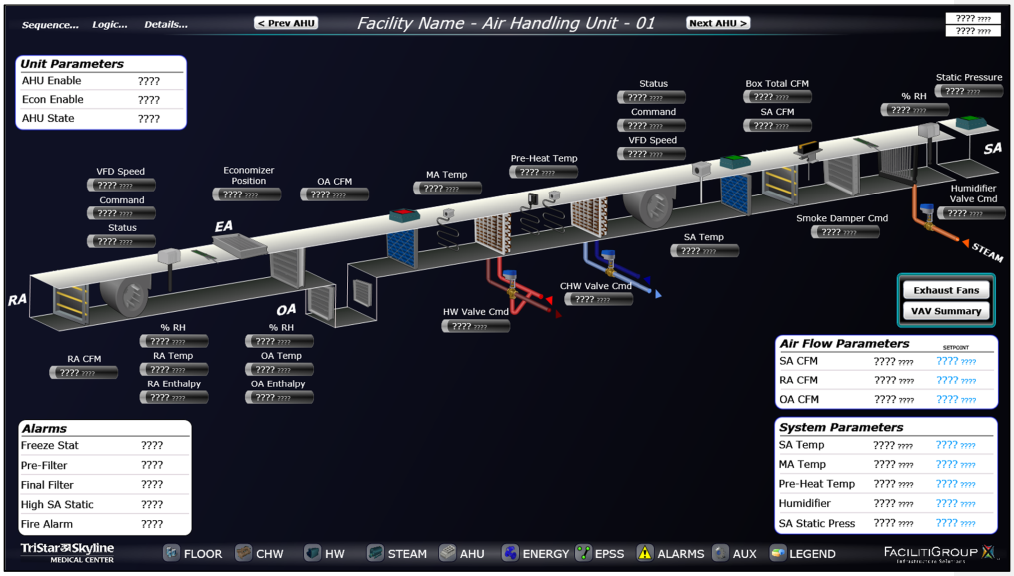


Figure 38: Air Handling Unit (Representation 2)

E. AHU Sequence of Operations

1. The AHU Sequence of Operations panel is to briefly describe the programming logic using both static text and live point values. This panel may also contain buttons/links to actual programming login if the BAS is capable.
2. The following sequence descriptions and points shall be present for applicable equipment.
    a. Descriptions of the Finite States
    b. Supply Fan/Return Fan Tracking
    c. Humidifier Operation
    d. Dehumidification: Glycol CHW coil and associated chiller
    e. Applicable Reset Schedules

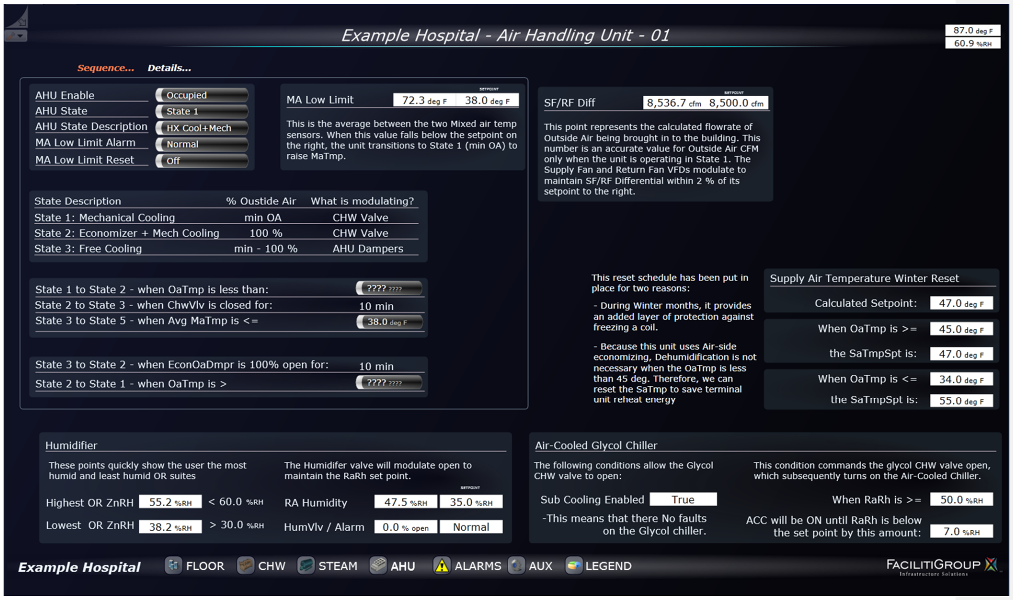


Figure 39: AHU Sequence of Operations (Representation 1)

F. CV / VAV Summary

1. The CV / VAV Summary panel is to be a table of available data from all units. This table shall show alarms, warnings and overrides and be sortable if functionality exists. Multiple pages may be used for large amounts of units. In addition to this table, information for the chiller and boiler plants and AHU serving the units shall be shown.

2. The following points shall be present.

   a. Supply Airflow
   b. Supply Airflow Setpoint
   c. Damper Position
   d. HW Valve Position
   e. Discharge Air Temp
   f. Discharge Air Temp Setpoint
   g. Zone Temp
   h. Zone Temp Setpoint

i. System Mode
j. AHU - Economizer State
k. AHU - Supply Air Temp
l. AHU - Return Air Temp
m. AHU - CHW Valve Position
n. AHU - Preheat / HW Valve Position
o. AHU - Return Air RH
p. AHU - Box Total CFM
q. AHU - Load
r. CHW - Chiller Status
s. CHW - Chiller % FLA
t. CHW - CHW Supply Temp
u. CHW - CHW Return Temp
v. CHW - CHW Flow
w. CHW - CHW Loop Load
x. HW - Boiler Status
y. HW - Boiler % Firing Range
z. HW - HX Valve Position
aa. HW - HW Supply Temp
bb. HW - HW Return Temp
cc. HW - HW Flow
dd. HW - HW Loop Load

3. The following links shall be present.
   a. AHU info box
   b. Chiller Plant Chiller Plant info box
   c. Boiler Plant Boiler Plant info box

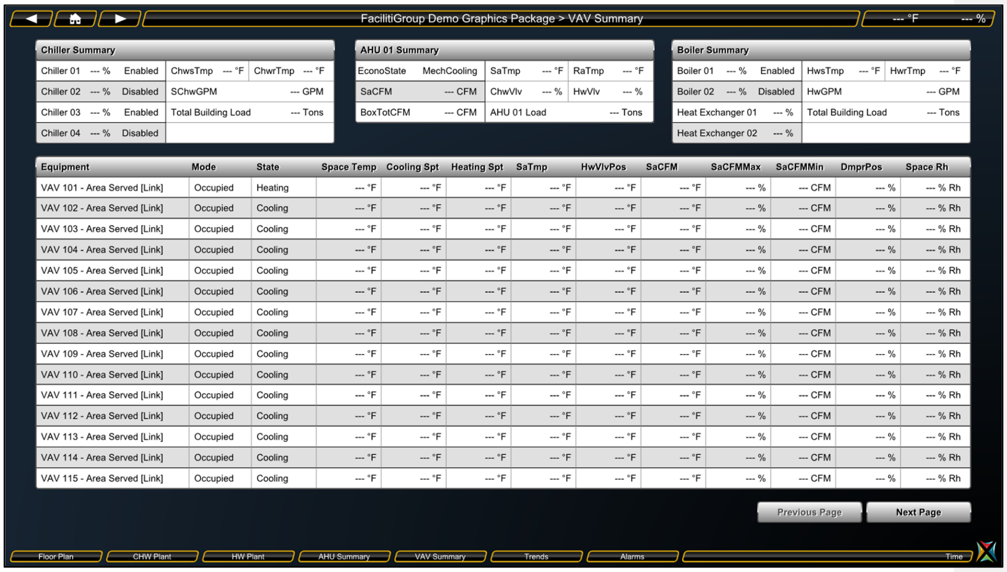


Figure 40: VAV Summary (Representation 1)

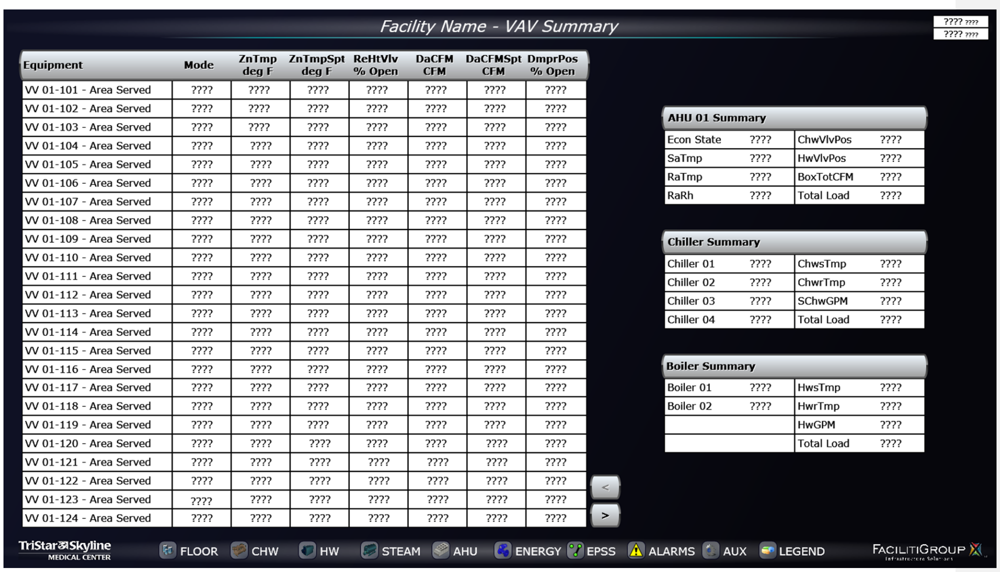


Figure 41: VAV Summary (Representation 2)

G. CV / VAV Unit

1. The CV / VAV unit shall show a representation of the actual unit. AHU and HW points shall be shown apart from the unit unless the points are measured at the unit.
2. The following points shall be present.
   a. AHU - Supply Air Temp
   b. AHU - Supply Air Temp Setpoint
   c. AHU - Supply Air Static Pressure
   d. AHU - Supply Air Static Pressure Setpoint
   e. HW - HW Supply Temp
   f. Supply Airflow
   g. Supply Airflow Setpoint
   h. Damper Position
   i. HW Valve Position
   j. Discharge Air Temp
   k. Discharge Air Temp Setpoint
   l. Zone Temp
   m. Zone Temp Setpoint
   n. System Mode
3. The following links shall be present.

a. Sequence of Operations	*Sequence…*
b. Control Drawings	*Details…*
c. Mechanical Drawings	*Details…*
d. AHU served from	Button
e. Heat Exchanger Detail	Button

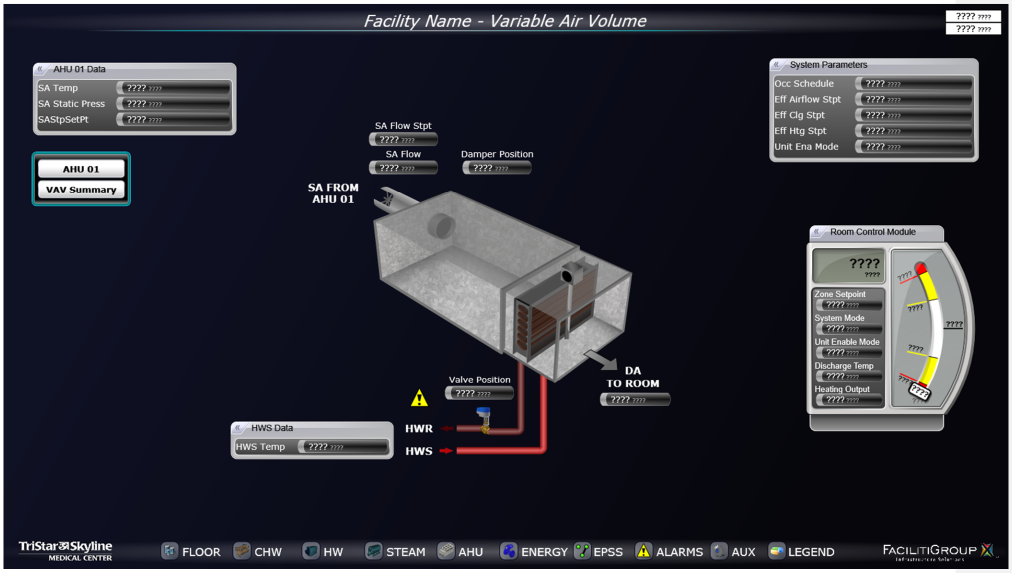


Figure 42: VAV Unit (Representation 2)

H. DX Unit

1. Stand-alone units that are controlled or can be read by the BAS must be represented in the GUI regardless of size. Any and all points that can be read back shall be included in this panel as well as nameplate data from the equipment such as manufacturer, nominal capacity and install date. These units can be represented in a graphical form (see CV / VAV unit graphic panels) or in tables (see CV / VAV Summary graphic panel).
2. The following points shall be present.
    a. Supply Airflow
    b. Supply Airflow Setpoint
    c. Discharge Air Temp
    d. Discharge Air Temp Setpoint
    e. Zone Temp
    f. Zone Temp Setpoint
    g. System Mode

3. The following links shall be present.
    a. DX Sequence of Operations *Sequence…*
    b. DX Control Drawings *Details…*
    c. DX Mechanical Drawings *Details…*

Figure 43: Sample Graphic Not Available

3.8 Energy Systems

A. All piping, wiring and equipment configurations must match actual installations.

B. Utility Feed Meters
1. The Utility Feed Meters panel is to show all incoming and outgoing metered utilities. This panel shall give indication to total usage and demand compared to previous periods.
2. The following points shall be present.
    a. Location Served
    b. Current demand/usage
    c. 24 hour Peak Demand/usage
    d. 24 hour Usage
    e. 30 day Usage
    f. Extra parameters (such as voltage and current)
    g. Meter model
3. The following links shall be present.
    a. Meter detail On equipment, model
    b. Electric System Electric feed
    c. Boiler Plant Natural Gas feed

Figure 44: Utility Feed Meters (Representation 1)

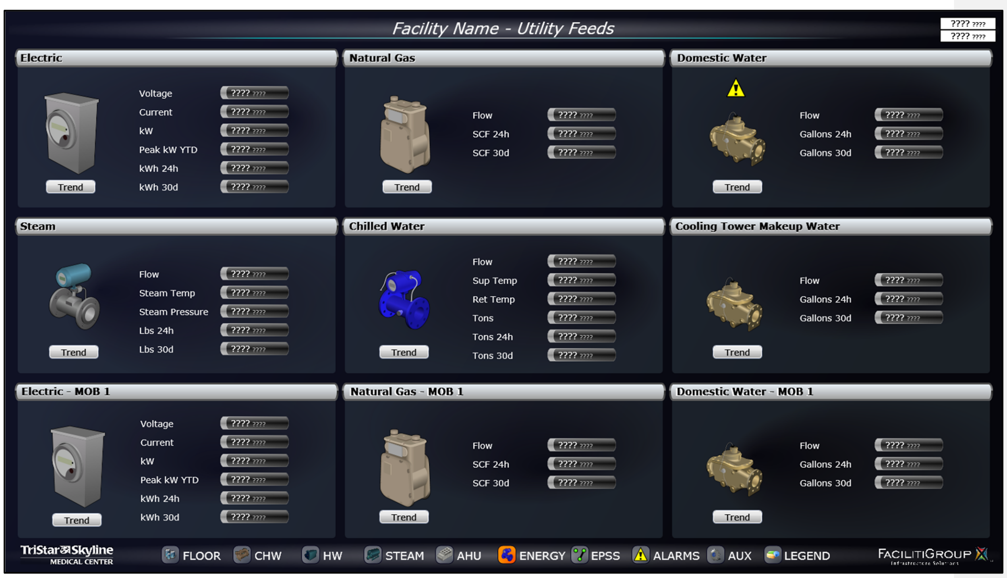


Figure 45: Utility Feed Meters (Representation 2)

C. Electric System

1. The Electric System Panel is to be a graphical representation of the facility's utility and emergency power systems resembling an electrical one-line diagram. This page shall show utility feeds, ATS, circuit protection, downstream metering, generators, and generator fuel tanks.
2. The following points shall be present.
    a. Power Meter - Voltage
    b. Power Meter - Current
    c. Power Meter - Power
    d. Power Meter - Power Factor
    e. Power Meter - Frequency
    f. ATS - Command
    g. ATS - Status
    h. Generator - Command
    i. Generator - Status
    j. Generator - Nominal Capacity
    k. Fuel Tank - Capacity
    l. Fuel Tank - Fuel Remaining
    m. Fuel Tank - Estimated Remaining Runtime
3. The following links shall be present.

a.	Sequence of Operations	*Sequence…*
b.	Control Drawings	*Details…*
c.	Electric One-line Drawings	*Details…*
d.	ATS Detail	On equipment
e.	Generator Detail	On equipment
f.	Metered Equipment	On meter

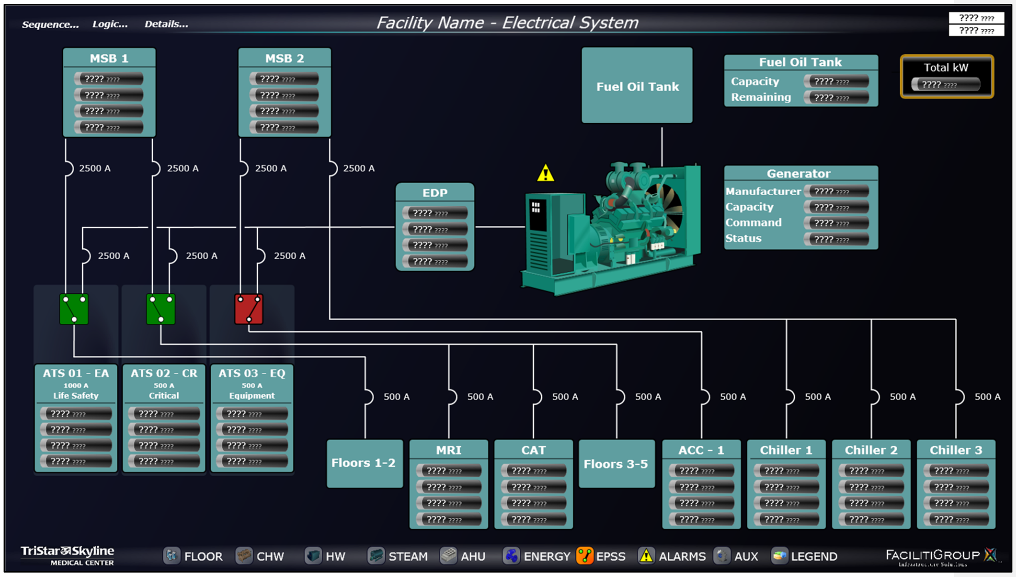


Figure 46: Electric System (Representation 2)

D. ATS Summary

1. For larger electrical systems with many transfer switches, an ATS Summary may be necessary.
2. Static Information on this panel should include:
    a. Manufacturer
    b. Rating
    c. Transition – Open/Closed
    d. Bypass – Yes/No
    e. The Generator that the switch is served by
3. Points listed on this panel should include:
    a. Position – Normal, Emergency, Test
    b. Volts
    c. Amps
    d. Load
    e. Frequency

f. kW
g. kVA
h. kVAR
i. Power Factor
j. Line-Line Voltage (a-b), (b-c), (c-a), average
k. Line-Neutral Voltage (a-n), (b-n), (c-n), average
l. Line Current(a), (b), (c), average

4. Links that should be present:

a. Individual Generator Detail Panels	Button
b. Additional ATS Summary Panels	Button(s)
c. Individual ATS Detail Panels	Links

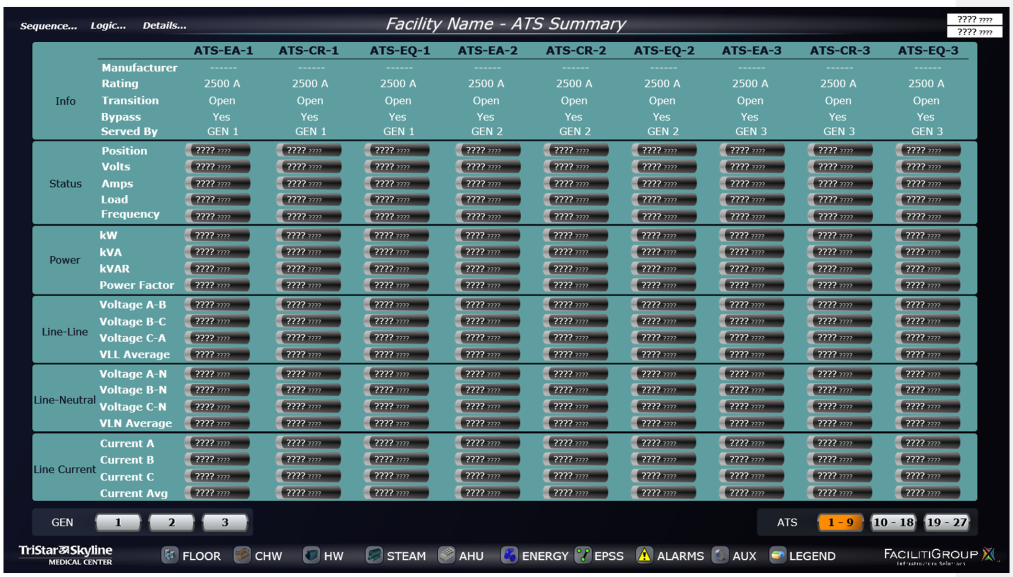


Figure 47: ATS Summary (Representation 2)

E. ATS Detail

1. ATS Detail panel shall represent any point that can be communicated from the ATS, nameplate data and any feeds entering or exiting. Multiple ATS may be shown on one panel.

2. The following points shall be present.
    a. Any point that can be communicated from the ATS
    b. Any feeds entering or exiting
    c. Nameplate data
3. The following links shall be present.
    a. Sequence of Operations *Sequence…*
    b. Control Drawings *Details…*
    c. Mechanical Drawings *Details…*
    d. O & M Manual *Details…*
    e. Electric Systems Button
    f. Generator Detail Button

Figure 48: ATS Detail (Representation 1)

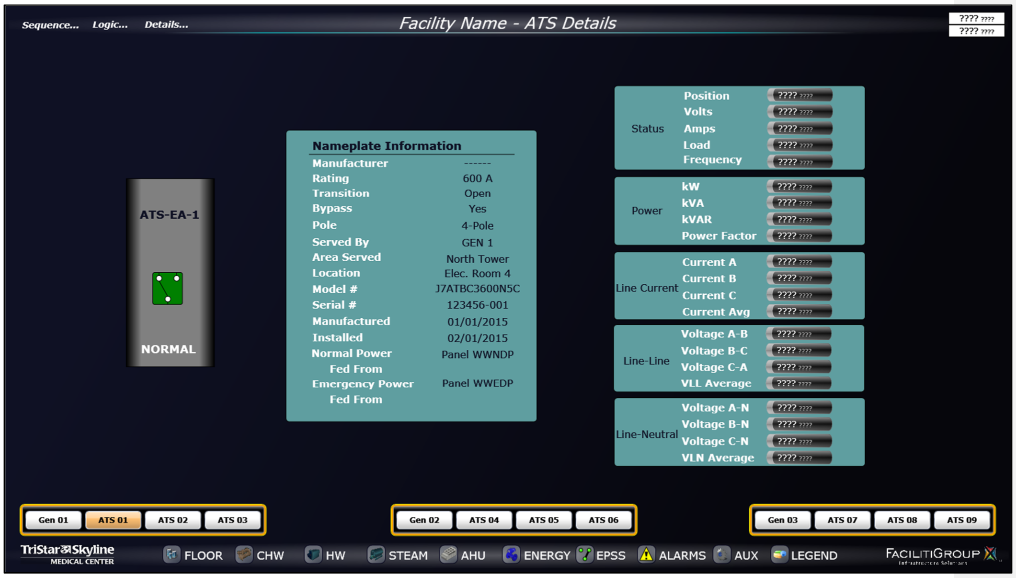


Figure 49: ATS Detail (Representation 2)

F. Generator Detail

1. Generator Detail panel shall represent any point that can be communicated from the generator, nameplate data and any feeds entering or exiting. Fuel Tank and Fuel delivery/conditioning system shall be represented on this panel.
2. The following points shall be present.
   a. Any point that can be communicated from the generator
   b. Any feeds entering or exiting
   c. Nameplate data
3. The following links shall be present.
   a. Sequence of Operations *Sequence…*
   b. Control Drawings *Details…*
   c. Mechanical Drawings *Details…*
   d. O & M Manual *Details…*
   e. Electric Systems Button

f. ATS Detail Button

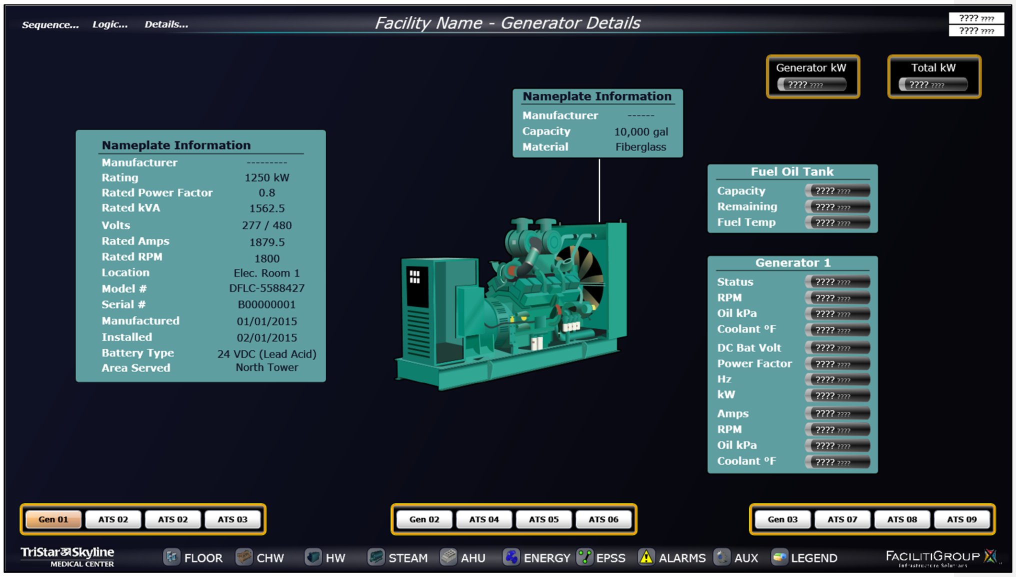


Figure 50: Generator Detail (Representation 2)

G. Other Metered Utilities

1. The Other Metered Utilities panel is to represent other systems that may be encountered at facilities such as domestic water with a storage tank buffer or solar cells. These panels shall relay useful information about the system. It is very important on this panel that equipment piping and wiring be shown accurately. Equipment shown on this and all panels shall represent actual equipment as closely as possible. Equipment shall be labeled/numbered according to what is present at the facility.

3.9 Auxiliary Systems

A. Panels for auxiliary systems not mentioned in sections 01 through 04 are included in this category. These panels shall relay useful information about the system. It is very important on this panel that equipment piping and wiring be shown accurately. Equipment shown on this and all panels shall represent actual equipment as closely as possible. Equipment shall be labeled/numbered according to what is present at the facility. Any associated setpoints, high / low limits or fault conditions shall be represented in the GUI.

B. Auxiliary Systems may include the following pages.

1. 06.01 Water Softener
2. 06.02 Chemical Treatment
3. 06.03 Medical Gas
4. 06.04 Medical Air

3.10 Details And Explanations

APPENDIX B-8: BAS GRAPHICS – PROGRAMMERS' GUIDE

Refer to Appendix B-8 BAS Graphics Programmers' Guide.PDF

APPENDIX C: MODULAR CENTRAL ENERGY PLANT (MCEP) DESIGN GUIDELINES

Part 1 - General

1.1 The Modular Central Energy Plant (MCEP) concept is intended to provide improved design consistency across all HCA facilities, while providing a turnkey factory-assembled utility plant for and combination of electrical, process, air conditioning, and heating applications. The benefits of the MCEP are: single-source performance responsibility, optimized energy efficiency, improved implementation schedule, reduced overall project cost, and expedited installation and commissioning time.

1.2 It is the responsibility of the design team, with the help of HCA Design & Construction and HCA FacilitiGroup to assess whether or not an MCEP is a good fit for the project.

1.3 It is critical that the design and construction teams take full advantage of the benefits of the MCEP delivery model by clearly defining the scope of all parties to avoid overlap. Additionally, the schedule benefits of the parallel path (site prep and MCEP fabrication) must be fully assessed during design and exploited during construction.

1.4 Whenever the team determines the application of a Modular Central Plant is appropriate, that is to be the basis of design. A traditional "stick-built" arrangement may be offered as a VE by the contractor but only after the impact to time and schedule is assessed for ALL trades.

1.5 Modular Central Energy Plants (MCEP) and Packaged MEP Systems shall offer complete flexibility and customization at HCA negotiated equipment pricing levels per all existing Innovation Memos. MCEP equipment (i.e. water cooled chillers, boilers, generators, air compressors, medical support equipment, etc) and supporting equipment shall be factory-integrated. Manufacturer is responsible for internal controls to interface with owner BAS and MEP systems. The MCEP envelope is intended to consistently conform to the requirements of the design engineer and the owner.

1.6 This MCEP Guideline is provided as an overview to packaged equipment systems. Requirements for individual MEP components and systems are described in other sections of this Guidelines. Please contact FacilitiGroup with any discrepancies or if clarification is required...

1.7 The MCEPs can include structural supports for external components (i.e. cooling towers, fire water storage, fuel tanks, etc.). MCEPs shall be completely self-contained and designed for outdoor or indoor use.

1.8 MCEP shall be manufactured in a controlled environment. Consulting Engineers may specify the factory packaged solution with assurance that original design intent is maintained.

1.9 MCEP s standard configurations shall be single or multiple width modules. Customized options will be available as required for each project.

1.10 MCEP s shall be designed to include the flexibility to allow for future expansion without the interruption of the current services or compromising room for serviceability or operation. MCEP s shall be designed with the capability of relocating to future sites. MCEP wall design must allow for removal and reuse of perimeter walls at the time of future expansion. Expansion shall allow for a continuous mechanical room as it relates to the room service (one chiller room, one boiler room, etc.). Separate mechanical rooms within expansion designs will adhere to local code requirements.

1.11 The MCEP s shall be designed to maintain accessibility and serviceability to all critical and non-critical components.

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

1.12 The Design Engineer shall retain ownership and approval of MCEP s. The MCEP s manufacturer shall provide engineering support required for the engineering design and submittals process. Refer to Appendix C-1 for recommended roles and responsibilities of stakeholders in design, fabrication, and installation phases.

1.13 The MCEP s shall be factory tested to ensure proper installation, startup, and commissioning. All piping shall be hydrostatically or pneumatically pressure tested prior to leaving the manufacturing facility.

1.14 In accordance with ASHRAE 15 and current model building codes, locate chillers and associated pumps in a separate room from other equipment such as boilers, heat exchangers, and plumbing equipment. Air condition the chiller room to minimize sweating on cold surfaces. Provide a dedicated AHU or Fan Coil Unit (FCU) with only the minimum outside air to condition the space. Unit may be hung from the structure as long as adequate access for filter and coil maintenance is provided. When determining the required cooling capacity, consider heat gains from open drive chiller motors, VFDs, pump motor inefficiencies, walls and roofs.

1.15 Provide Refrigerant Gas Leak Monitoring and emergency ventilation of the chiller room in accordance with ASHRAE 15 and Mechanical Code requirements.

1.16 MCEP equipment shall meet the minimum ANSI/ASHRAE 90.1 Energy Efficiency Standard for Buildings. The complete MCEP system shall be designed to optimize energy efficiency based on site specific climatic conditions.

Part 2-Products

2.1 Acceptable Manufacturers;

A. JCI, EnviroSep, and Systecon

2.2 Ratings and Certifications

A. ASHRAE 15 - Safety Standard for Refrigeration Systems

B. NEC / NFPA 70 Electrical Power and Controls Wiring

C. MCEP assembly shall be UL listed and manufacturer shall be the holder of the ASME certificate of authorization. Manufacturer shall have an ASME quality assurance program in place. Quality assurance manual shall be available for the owner upon request.

2.3 MCEP Description

A. MCEP s shall be factory assembled and pre-engineered to the performance levels specified within the design intentions of the Design Engineer.

B. Multiple modules shall be assembled to provide an entire plant design as an open room facility wherever possible and local code allows.

C. MCEP s shall be factory tested. Provide customer-witnessed full flow and functional tests at factory. Factory chiller operation is not necessarily required.

D. Fans and drives shall be designed and balanced to limit vibration (displacement in mils) at operating speeds. Performance will be based on sea level conditions.

E. All internal components specified in MCEP shall be factory furnished and installed. MCEP shall be completely factory assembled, as much as practical, in order to minimize field assembly.

F. MCEP shall ship in as few pieces as practical. Lifting lugs shall be supplied on each side of a shipping split and at all MCEP corners to facilitate rigging and aid in joining shipped sections. Lifting lugs shall be suitable for rigging without additional support frames.

G. Preferred height shall be as low as possible with the following provisions:

1. All equipment shall be removable through equipment maintenance access doorway.
2. Emergency personnel egress shall comply with local codes and requirements.

Part 3 - Execution

3.1 Skid and Rigging Mechanism

A. MCEP Modules shall be designed to maintain structural integrity during rigging and installation.

B.

3.2 MCEP Structural Frame and Supports

A. The MCEP construction shall consist of a completely welded structural frame and removable panels with full perimeter curbing.

B. Structural members shall be welded steel with reinforcement as required. Structural design shall meet local code requirements including wind, seismic, rain, and snow load requirements tube with ¼" gussets.

C. MCEP vertical and horizontal structural framing and supports (bolted) shall be located in place for securing wall and roof panels and to facilitate easy removal for future expansion from single width to multiple width modules.

D. MCEP vertical and horizontal structural framing and supports (welded) shall be designed to remain in place for roof structural support.

E. Manufacturer shall comply with AHJ structural requirements including providing sealed drawings from a Registered Professional Engineer as required.

3.3 MCEP Enclosure

A. MCEP enclosure shall be specifically designed for use in an outdoor application.

B. MCEP wall and roof panels shall be completely sealed prior to shipment and shall be completely removable for equipment access and removal of components. Panels shall be bolted and screwed into place with weather stripping to provide protection against adverse weather conditions.

C. The MCEP shall be supplied with insulated double walls (as specified) for walls and roof. Wall and roof insulation rating shall meet local environmental conditions. System shall maintain 80 deg F in summer and 60 deg F in winter. Wall and Roof panels shall be moisture and mold-resistant.

   1. The module outer walls shall be constructed of sheet steel and painted.
   2. Exterior casing screws shall be rust-resistant.

D. MCEP floors shall be constructed of 1/4″ epoxy coated diamond tread plate with recessed welded floor drains to provide at most L/240 deflection based on 300 lb. concentrated load at mid-span. Coating finish shall be Grey ANSI 151 grade coating.

E. MCEP shall be supplied with pitched roof (per module) to promote drainage of precipitation and prevent standing water. Roof drainage shall be provided with gutters and downspouts.

F. MCEP roof construction shall be designed for a minimum snow-load of 30 lb/ft^2. Design Engineer shall confirm this minimum snow-load meets or exceeds local codes.

G. MCEP skid vibration isolation shall be the responsibility of the installing contractor. Vibration isolation of interior equipment and components shall be provided by MCEP manufacturer, as required.

H. Maintenance access panels shall be two-leaf full-height hinged doors to match the wall panels. Screwed or bolted panels shall not be acceptable. These type doors are preferred over roll-up type doors for ease of maintenance.

3.4 MCEP Roof and Access Cap

A. Each MCEP module shall be designed for individual rain management.
B. Each MCEP module roof shall be continuously welded along the length and side seams for eliminating water leakage possibility.
C. MCEP module roof shall be pitched a minimum of ¼″ x 12″ slope for easy rain runoff.
D. Access to roof mounted equipment is preferred via an access ladder or stair on the outside of the enclosure rather than through a roof panel.

3.5 MCEP Finishes

A. MCEP wall and roof panels be provided with 20-year coating. All exposed MCEP carbon steel shall be coated with high solids epoxy, for interior and exterior surfaces, prior to shipment.
B. All painted surfaces shall follow manufacturer recommendations for preparation and applying finishes.
C. Physical sample of selected exterior panel color and finish shall be delivered to facility and owner for review and approval prior to commencement of manufacturing
D. The finish shall meet or exceed 500-hour salt spray solution (5%) without any sign of red rust when tested in accordance with ASTM B-117. Concealed wall and roof panel fasteners shall be coated-carbon steel or 410 stainless steel, self-drilling type.
   1. Gloss shall meet ASTM D-523
   2. MCEP exterior finishes shall be federal standard colors.

3.6 MCEP Electrical and Control Wiring Distribution

A. Where allowed by AHJ, it is preferred that power and control cabling may be routed in overhead cable tray.
B. Power and control wiring drops are to be routed to equipment in separate conduits.
C. The modular plant manufacturer shall provide and install termination blocks close to each piece of equipment as required.
D. Modular plant manufacturer shall provide power and communications cabling and hardware for all connections that terminate (both ends) within the footprint of the plant.

3.7 MCEP Electrical Power

A. Multiple point power per module (Standard Configuration)

1. Power shall be provided individually for major mechanical equipment and MCC for ancillary components.
2. There shall be a single main disconnect switch for the ancillary components on the MCC.
3. All major mechanical equipment (chillers, boilers, etc) shall each be provided with main disconnect switch.

3.8 Other Electrical

A. Grounding

1. Grounding shall be provided by the installing contractor.
2. Ground each modular skid as applicable per NEC.
3. Main disconnect shall be provided as a disconnecting means for all equipment. Larger mechanical equipment shall include independent disconnects.

B. MCEP shall be equipped with factory mounted and wired power panel and motor starter panels serving the motors, as required. The motor starter panels and all associated components shall be U.L. listed & rated.

C. Energy efficient LED lighting shall be provided for interior and exterior. Emergency/Exit LED lighting shall be provided in MCEP.

D. GFCI convenience receptacles shall be provided and shown on electrical plans provided by MCP manufacturer. No location shall be more than 25’ from receptacle, inclusive of:

1. One by chemical treatment station
2. One by drives and control panel

3.9 Exterior Modular Plant Components

Note: External component power is independent of modular plant incoming power configurations. Typical examples are included below.

A. Cooling Tower(s)

1. Cooling tower fan motor variable speed drive(s) shall be provided within the MCEP module.

B. Jobsite Cooling Tower location & water treatment chemical composition must be taken into account when planning the plant layout. Coordinate layout and space requirements for cooling tower chemical treatment systems, including filtration and water softener, with site specific chemical treatment vendor.Fire Sprinkler

   1. Every jurisdiction has unique requirements regarding the design and installation of fire sprinkler systems. It is the responsibility of the design engineer to properly coordinate the scopes of work between the MCP manufacturer, the fire sprinkler contractor, and his own design to avoid scope gaps and overlaps.
   2. The licensed fire protection engineer shall provide permit drawings with the overall MEP package that describes the sprinkler system within the MCP.
   3. The awarded fire sprinkler contractor shall generate final permit drawings. These drawings are to be properly coordinated with the MCP manufacturer to reflect the installed condition.
   4. The typical base project bid shall have the MCP manufacturer installing the sprinkler distribution piping in strict accordance with the permitted contractor drawings. Heads shall be shipped to the site loose. The fire sprinkler contractor shall inspect the piping, make final connections, and install heads. Deviations in piping installation from the permitted drawings shall be at the expense of the MCP manufacturer.
   5. As an alternate, the MCP manufacturer shall coordinate requirements with sprinkler contractor, but omit fire sprinkler installation. The contractor shall provide and install the piping and heads and make final connections in the field. This delivery method is not preferred and is only to be used where contractor is unwilling to accept piping installation by other parties due to liability.

C. Fire Pump(s)

   1. Typical fire pump skid configurations include automatic transfer switching onboard.
   2. Main & emergency power to fire pump skid shall be provided separately by other electrical means.

D. Water Treatment

   1. 120V/1Ph/60Hz power feed included as standard within auxiliary load center.
   2. Wiring to equipment by installing contractor.

3. Coordinate water treatment requirements with current site vendor including power, water, pipe taps, and lighting.
4. Provide location for water testing.

E. Hydronic Heat Tracing

1. Optional: 120V/1Ph/60Hz or 3-phase power feed for heat tracing included within Auxiliary Loadcenter or Panelboard.
2. Wiring to equipment by installing contractor.

3.10 MCEP Internal / Environmental Requirements

A. The MCEP shall be provided with a ventilation evacuation system that meets or exceeds ASHRAE Standard 15. The system shall include refrigerant monitoring, exhaust fans, intake louvers, and visual and audible alarms.

B. The MCEP shall be equipped with HVAC units to satisfy the cooling/heating loads within the MCEP.

3.11 MCEP Controls

A. The MCEP shall be provided with stand-alone direct digital control system (DDC). Basis of design shall be Johnson Controls Metasys unless the existing facility has another system currently in place. When in doubt, consult FacilitiGroup engineer. All controls communications shall communicate via BACnet MSTP. No proprietary communications will be allowed. The current building automation system (BAS) vendor will be responsible for integrating the MCEP control points. The DDC system shall monitor and control all mechanical equipment within the MCP.

B. Network Communication switch enclosure shall be installed in the MCEP and equipment network communication devices shall be pre-wired. MCEP manufacturer shall coordinate with HCA IT&S. Network Communication switch enclosure shall be provided by HCA IT&S.

C. Power Monitoring

1. Power monitoring shall be retrieved from the major equipment where available.
2.

    a. System required controls points list shall be provided by the Design Engineer. Sequence of operations for the MCEP shall meet HCA Design Guidelines.
    b. The MCEP instrumentation and control devices (sensors, meters, etc.) shall adhere to HCA MEP Design Guidelines.

c.

3.12 Shipping & Rigging

A. All shipping and rigging procedures shall be per manufacturer's recommendations.
B. Job specific rigging diagrams must be provided detailing all rigging requirements (center of gravity, point loads, etc.)
C. Each module shall be completely wrapped in heat shrink for protection during transportation. Module tarping for shipment in addition to heat shrink is optional, but modules must be protected to prevent paint damage.
D. Modules must be structurally supported uniformly for shipment. End supports alone are not acceptable.
E. Rigging modules to offsite locations or other shipping means is not recommended (i.e. rigger's yard, alternate trailers, etc.). In specific cases, where offsite storage is required, each module must be packaged for long term outdoor storage.

3.13 Storage and Handling

A. All storage and handling procedures shall be per manufacturer's recommendations.
B. Upon receipt of all equipment, installing contractor shall be responsible for verifying module(s) shipment conditions and prepare claim forms for shipping damages & repairs accordingly. Repairs shall be made on an approved situational basis.
C. Protection of the MCEP for avoidance of general aesthetic damages shall be handled on the job site by the contractor (vandalism, rusting, etc.).
D. MCEP shall be stored in a place protected from construction traffic and handled carefully to avoid damage to components, enclosure, and finishes.
E. All safety warning labels shall be clearly marked.
F. All loose-shipped items shall be packed, protected and secured with the module. Onsite contractor is responsible for accurately documenting receipt of all items.
G. Motor control devices shall be factory mounted as selected and indicated on the drawings.

H. Motors shall be protected and inspected in accordance with the manufactures specific instructions regarding periods of long storage.

3.14 Installation and Onsite requirement

A. A manufacturer's representative shall supervise on site during the installation of the MCEP s.

B. General Installation requirements for onsite construction shall include a house pad that includes space for the entire MCEP with a 36″ walking perimeter. House pads shall be constructed level to maintain proper equipment operations. The Design Engineer shall be responsible for the layout of the concrete pad.

C. Mechanical Requirements

1. Installing contractor shall install and reassemble the modular plant(s), including components and controls required for operation, in accordance with manufacturer's written instructions, drawings and recommendations.
2. The installing contractor shall read and be familiar with the handling and installation instructions prior to unloading and handling the modules.
3. Removal of protective wrapping, wood crating and packing as required.
4. Hoisting and rigging the section(s) from the delivery truck(s) into final location.
5. Join the modules as necessary per the instruction supplied with the unit.
6. Leveling and shimming of modules as needed.
7. Re-install any equipment, piping, stacks, exterior lighting & controls, exit signs or enclosure trim shipped separate due to the shipping constraints.
8. Tighten all electrical and mechanical connections that may have vibrated loose during shipping.
9. Insulate spool pieces and other non-insulated components per scope of work.

10. Receive and install cooling towers, cooling tower structure and cooling tower piping per Manufacturer's instructions.
11. Install field provided or separately equipment included in scope of work.
12. Touch up and paint any scratches, dents, etc. associated with the installation.
13. Installing contractor shall terminate all field connections to the plant including piping, electrical and drainage.
14. Connect all utilities needed for the system.
15. Make all external hydronic connections.
16. Reconnect hose bibb removed for shipment and connect floor drain to sanitary sewer or authorized location.
17. Chiller barrel refrigerant relief valve connections and refrigerant relief piping shall be pre-installed by MCEP manufacturer. External connection may require reassembly if removed for shipment.
18. Completely flush and clean "house" piping and equipment per HCA standard section 23 25 00.
19. Flush and fill all hydronic systems in accordance with Guidelines.
20. Obtain all permits and schedule AHJ inspections required for startup & commissioning of system.
21. Assist Manufacturer's authorized startup personnel as required.
22. Water balance to verify system flow as required.
23. Coordinate initial chemical services as required to maintain water quality.
24. Prior to final acceptance Contractor shall clean the interior and exterior of the unit.

D. Electrical Requirements

Installing contractor shall be responsible for all of the following:

1. Grounding each module and plant.
2. A qualified electrician shall be responsible for connecting power supplies from customer provided source(s).
3. A qualified electrician shall be required to verify all electrical connections are secure prior to commissioning.

4. Any 3rd party electrical system verifications of power connections, continuity, etc.
5. Pull wire and terminate all electrical connections removed for shipment.
6. Pull wire and terminate all electrical connections located exterior to the modular plant (cooling tower fans, etc.).
7. Installing any electrical items or devices shipped separately (interior or exterior).
8. External component installation

E. Cooling Tower & Support Configurations

1. If Cooling Towers are provided with the MCEP as a turnkey package, please refer to the following installation guidelines and manufacturer's recommendations.
2. Provided With Cooling Tower Supports located above or adjacent to the MCEP.
3. Manufacturer responsible for providing installing contractor with instructions and drawings for cooling tower support assembly onsite.
4. Installing contactor shall receive and erect cooling tower supports.
5. Installing contactor shall receive and install cooling tower.
6. Installing contractor shall connect piping between Cooling Tower(s) and MCEP.
7. Manufacturer shall provide piping.
8. Installing contractor shall be responsible as required for some field provided and fabricated pieces based on final locations of the respective equipment.
9. Cooling tower water treatment is provided by local installing contractor or water treatment specialist. Manufacturer is responsible for providing a power feed for any low voltage water treatment equipment. MCEP manufacturer is responsible for coordinating all chemical treatment locations and equipment prior to delivery on site.

F. Equipment Testing

1. Major components, as defined by the Design Engineer shall be tested at the individual manufacturing facility.

2. Performance testing, as defined by the Design Engineer shall be performed at the associated manufacturing plant. A full flow run test shall be conducted at the factory for all pumping systems.
3. All piping shall be hydrostatically or pneumatically pressure tested in accordance with the design requirements and HCA Guidelines.
4. All electrical connections shall be tested in accordance with the design requirements and HCA Guidelines. This shall include an electrical point to point test and confirm proper phase rotation.
5. All electrical motors shall be “bumped” to confirm proper phase rotation at the modular manufacturing plant.
6. A point to point testing shall be performed on the MCEP direct digital control system. Functional testing shall be performed at the factory and verfication of all controls reconnections shall be performed on site prior to system startup...
7. Multiple modules shall be pre-assembled at the modular manufacturing plant prior to shipment to ensure a smooth onsite installation process.

G. Commissioning, Startup, Operation and Maintenance

1. MCEP manufacturer to provide a factory service technician(s) familiar with all aspects of the major equipment commissioning and start up.
2. Technician(s) shall adhere to all associated equipment codes and safety standards during commissioning and startup procedures.
3. Provide guidance on the installation of the unit and perform startup and commissioning of the unit.
4. The installing contractor shall provide all necessary labor, tools, and materials (specific to the startup of the unit) necessary to accomplish the tasks listed above.
5. The Commissioning Agent shall be responsible for the development and implementation of the Commissioning plan as defined in HCA Commissioning Specification section 01 91 13.
6. The MCEP manufacture shall provide operation and maintenance training for all of the equipment provided in the MCEP s in accordance with the HCA MEP Design Guidelines.

APPENDIX C-1: MCP ROLES AND RESPONSIBILITIES MATRIX

Refer to Appendix C-1 MCP Roles and Resp Assignment Matrix.xlsx

APPENDIX D: STANDARD DETAIL DRAWINGS

Refer to the following supplemental documents:

- Standard Detail Drawings.PDF
- Standard Details 1.dwg
- Standard Details 2.dwg
- Standard Details 3.dwg
- Standard Details 4.dwg

APPENDIX E: Owner Project Requirements (OPR)

APPENDIX E-1: HCA ACUTE CARE MEP OPR TEMPLATE

Part 1 - General

1.1 The OPR document presented here represents the starting point for new "greenfield" construction acute care hospital. This document will have to be tailored for the actual project scope and requirements. This is not intended to be the final design direction.

1.2 For renovations and expansions in existing facilities, the requirements of this document may be adapted to match current conditions.

1.3 The ultimate goal will be to standardize the most optimized design as much as practical across the enterprise.

1.4 When faced with a design decision, the design team is to consider the following hierarchy of HCA requirements in order of importance:

A. Safety and health of patients, doctors, and staff [most important]

B. Comfort of patients, doctors, and staff

C. Durability and reliability

D. Low life cycle cost

E. Maintainability

F. Low first cost

G. Speed to market

H. Energy efficiency

I. Aesthetics [least important]

1.5 The owner should be consulted on any discrepancy between this document and the MEP Guidelines or code requirements.

1.6 LEED Projects Only [Identified by Owner]

A. LEED projects are to be identified by HCA early in the design and planning

B. The commissioning agent is to be engaged as soon as possible in the design process but no later than the start of Design Development

C. The LEED charrette or kickoff design meeting is required with the entire design team and the owner's representative

1.7 Design process

A. The MEP design team shall start with this OPR baseline design and adjust as needed to meet specific site, climatic, operational and jurisdiction requirements

B. For all LEED designs, a basis of design document shall be submitted to the owner and Cx agent for review and comment

C. The mechanical engineer of record or a third-party agent acting under the engineer shall be responsible for calculating cooling and heating requirements along the way.

D. An energy model shall be required for projects meeting the criteria below. The energy model shall use the systems described in the OPR, modified as needed for code compliance, as the baseline. At least two alternatives shall be modelled for comparison. Any of the following criteria shall require an energy model:

1. LEED projects
    a. Baseline - ASHRAE 90.1 Appendix G
    b. Alternative 1 – Design based on OPR document
    c. Two additional alternatives
2. New construction
3. Renovation projects where building envelope is changed

1.8 All designs must meet the following requirements or the engineer must address with FacilitiGroup Engineer in advance:

A. HCA MEP Guidelines

B. Applicable building codes

C. FGI Guidelines

D. Applicable energy code

E. Associated Innovation Memos

1.9 The following are the standard requirements for MEP systems and equipment. These provide a description of the base case from which the design may deviate only with sound engineering assessment and agreement from FacilitiGroup engineer.

A. Heating plant

1. Variable-speed primary pumping
2. Heat recovery chiller(s) for heating hot water
3. Preference for vertical inline pumps
4. Condensing (high-mass) hot water boilers for backup heat / preheat
5. Reset hot water temp to as low as possible where practical
6. Total (100%) redundancy required for heating system

B. Steam plant

1. Small steam boilers for humidification and sterilization located in mechanical plant
2. Total (100%) redundancy required for steam system

C. Cooling plant

1. Variable speed primary pumping
2. Magnetic bearing chillers are standard but traditional chiller is to be assessed for performance versus cost savings. Selection is to be optimized with the cooling tower selection for best cost and performance. (For example, the chiller may be selected at the "top" of the frame size for the best cost per ton and the cooling tower may be increased in size to improve chiller efficiency.)
3. Manifolded chilled water pumps are preferred for redundancy
4. Provide sufficient redundancy that the loss of a single chiller will leave the building of campus with cooling required for no less than about 70% of the peak building load.
5. It is HCAs preference for vertical inline pumps

6. Waterside economizer is preferred over airside economizer. Economizers are to be applied as follows:
    a. Required in ASHRAE Zone 3 and above
    b. Recommended in ASHRAE Zone 2
    c. No economizer in ASHRAE Zone 1

D. Heat rejection
1. Manifolded cooling tower pumps are preferred for redundancy
2. It is HCAs preference for vertical inline pumps
3. Oversize cooling towers for greatest

E. Air side systems
1. No airside economizer
2. OR air handlers
    a. Provide sub-cooling or other mechanical dehumidification to meet OR temperature and humidity requirements. Preference is for cooling/dehumidification to be located in outside air path.
    b. Cromer cycle systems (CDQ) are not permitted due to "wet sneaker syndrome"

F. Mechanical controls
1. Provide optimization loop for chiller plant
2. Critical zone DP setpoint reset for chilled water and hot water pumping systems
3. Provide AHU discharge temperature reset scheme along with AHU static pressure reset
4. Provide occupancy sensors for offices and conference rooms/classrooms/auditoriums
5. Provide room setback on each OR:
    a. Two occupancy sensors
    b. CT on boom light
    c. Air valves only as required per Guidelines

G. Building electrical systems
1. Provide two service feeds from separate substations with automatic throw-over

2. Quick connects for temporary generator
3. Where calculated size is at or below 1,250kW, provide a single generator; above 1,250 kW, provide two with paralleling gear
4. One chiller, pump, and tower are to be put on emergency power when conditions merit (trauma level, utility reliability, hurricane-prone areas, etc.) Where in doubt, this is to be discussed prior with FacilitiGroup engineer
5. Coordination and arc-flash studies are required along with labeling and training
6. TVSS is to be provided on all main switchboards, distribution boards, and life safety branch panels
7. Lightning protection is to be provided in accordance with underwriter requirements
8. LED type lighting is to be provided as standard. It is the responsibility of the design engineer to seek out rebates available from the utility company
9. Lighting controls are to be provided in accordance with applicable energy code

H. Plumbing

1. Where practical, condensing hot water boilers are required for domestic water systems. Temperature setpoint is to be 120˚F.
2. Domestic hot water is not to be stored.
3. Recirculating systems are preferred. Careful design is of utmost importance to keep water flowing as much as possible through the entire system to reduce stagnant areas and biological growth.
4. Where domestic water is required to be distributed higher than 120˚F, mixing valves shall be provided to maintain safe temperatures at the fixtures.

I. Fire Protection

1. Facilities are to be fully sprinklered

J. Metering

1. Metering is to be provided in strict accordance with the MEP Guidelines. This is never to be reduced in scope or value engineered out.

1.10 The following is a list of some concepts to explore for life cycle cost reduction or improved building performance:

A. High-performance envelopes and glazing
B. Active building shading or high-thermal mass zones
C. AHU condensate reclamation for cooling tower makeup
D. Water-cooled coolers/freezers
E. Modular heat recovery chillers
F. Geothermal / thermal storage
G. Distributed pumping systems
H. Strategic use of automatic flow-limiting valves
I. Active chilled beam (in non-patient care areas)
J. Displacement ventilation systems
K. Dedicated outside air system for preconditioning outside air for interior AHUs – particularly for seacoast environments where outside unit could be sacrificial
L. Demand-response programs (load-shedding)
M. Photovoltaics where rebates and incentives make a sound business caseFlow-through plumbing fixtures for reduced infection risk in patient bathroom groups

APPENDIX E-2: HCA FSER MEP OPR TEMPLATE

Part 1 - General

1.1 The OPR document presented here represents the starting point for a typical construction project for a free-standing emergency room (FSER). However, this design has been developed to be generally applicable to sites all across the country with little or no need for modifications. Deviate from these requirements only with written approval from HCA FacilitiGroup.

1.2 Ultimate goal will be to standardize the most optimized design as much as practical across the enterprise.

1.3 The design team is to pay special attention to the hierarchy of owner requirements in MEP Guidelines:

A. Safety and health of patients, doctors, and staff
B. Comfort of patients, doctors, and staff
C. Speed to market

D. Low first cost
E. Standardization (repeatability of design)
F. Reliability
G. Maintainability
H. Aesthetics
I. Low life cycle cost
J. Energy efficiency
    1. Although relatively low on the priority list, reliability and maintainability are both important in the overall design of the FSERs. The typical FSER has no on-site maintenance staff on duty. It is serviced by plant operations personnel at its associated parent hospital, typically around 15 miles away, only as needed for preventative maintenance tasks and service requests. Often, few or no additional staff will be added to the hospital team for infrastructure maintenance of the FSER.
    2. The owner should be consulted on any discrepancy between this document and the MEP Guidelines or code requirements.

1.4 Design Requirements

A. Follow latest version of FSER Design Guide
B. MEP Guidelines
C. Meet applicable building codes
D. Meet FGI Guidelines
E. Meet energy code
F. Follow Innovation Memos

1.5 Baseline MEP Systems Requirements

A. Mechanical
    1. The central HVAC system will be a 60-ton York/JCI air-cooled packaged unit on the roof. Variable air volume (VAV) and Constant air volume (CAV) boxes with hot-water reheat will be installed for all occupied spaces. Packaged controls are acceptable to communicate to the BAS through Bacnet MS/TP with read write permissions to all controlling variables. There is to be no heat installed in the rooftop unit unless engineer determines mixed air conditions warrant.
    2. MERV 11 filtration is required upstream of the cooling coil.

3. A Multi-zone split (VRF) system will be installed for the mechanical, electrical, vacuum pump, and IT Room. For the IT room, provide a 3 ton indoor unit on the VRF system. Provide a second dedicated 3-ton split system for the IT room to mitigate risk of equipment failure. Stage the temperature setpoints in the room between the two units to avoid short-cycling.
4. Six exhaust fans will be installed for the various spaces as outlined in the ROOM STANDARDS below.
5. The hot water boiler system will be dual fuel (natural gas and propane) and serve the reheat terminal units and provide domestic hot water through a heat exchanger. Condensing boilers are preferred where appropriate for hot water reheat.
6. If natural gas is readily available and reliable, and the design engineer determines the cost of gas is more economical than electricity, the preferred heating system is circulated hot water reheat. Otherwise, electric reheat should be applied.
7. All outdoor equipment will be mounted on the roof.

B. Mechanical controls

1. The Building Automation System needs to be an extension of the BAS of its associated hospital (the facility whose plant operations department serves it). It is not to be a stand-alone system.
2. Where the FSER is not associated with a hospital, the BAS is to be Metasys by Johnson Controls.
3. If the associated hospital BAS is Metasys by Johnson Controls, the FSER is to be Metasys by Johnson Controls.
4. If the associated hospital BAS is Siemens Apogee, the FSER is to be Siemens Apogee.
5. If the associated hospital BAS is Schneider StruxureWare, the FSER is to be Schneider StruxureWare.
6. For all other BAS systems, please contact the FacilitiGroup Engineer for direction.
7. The following systems shall be controlled and/or monitored by the BAS:
   a. Rooftop packaged DX units – (manufacturer controls) enabled, setpoints controlled, and monitored by BAS.

1.6 Supply fan is to be controlled on static pressure. No airflow monitor is required for supply, return, or outside air.

A. Test and balance contractor is to set damper position and confirm that the building is positively pressurized across entire range (all VAV boxes at 100% and all VAV boxes at min.)

B. Dual enthalpy is standard – this is to be user-selectable at BAS to switch to dry bulb economizer.

C. Provide building differential pressure monitor transducer installed on RTU with indoor tube terminating in core of building at nurse's station.

D. Provide hot gas bypass on last compressor stage.

E. Provide discharge air temp reset on RTU – max. 60˚F (adj.) and limit return air humidity to 55% RH maximum.

    1. VAV boxes – (full DDC) controlled and monitored. All VAV boxes are to be setup for dual-PID loop control.
    2. Boilers – (mfr controls) enabled and monitored. Provide hot water loop temperature reset scheme based on outside air temperature.
    3. Boiler circulating pumps – controlled by boiler controller
    4. Pumps – enabled and monitored by BAS. Hot water loop pump control is to be constant volume with 3-way valves throughout.
    5. Exhaust fans – enabled and monitored for status by BAS. Fans are to be interlocked to RTU and also to fire alarm for emergency shutdown.
    6. Domestic water heaters – enabled, monitored, and trended by BAS. Provide discharge water temp sensor tied to BAS.
    7. Domestic recirculation systems
    8. Other items:
    9. Room pressurization monitors
    10. Room temp / humidity

F. Electrical

    1. The facility will be served underground by a 500 amp, 277/480 volt electrical service from a utility transformer. Mechanical system equipment will be served at 480 volts, and lighting and receptacles will be served at 120 volts. The system will be divided into normal and essential systems. The essential system consist of the life safety system, critical system, and equipment system. A 350 kW diesel generator will provide emergency power for the essential systems via 3 automatic transfer switches.

G. Plumbing

1. The FSER will be supplied by a single source 2.5” domestic water entrance protected with two, parallel backflow prevention devices.
2. A domestic hot water heat exchanger with 120 gallon storage tank and recirculation pump will be the source of hot water to all plumbing fixtures. The water heater is to be condensing type.
3. The hot water design temperature is to be 140° when stored.
4. Propane from a 1,000 gallon underground storage tank and natural gas will be supplied to the boiler system.
5. All plumbing fixtures shall be HCA Standard Plumbing fixtures provided by Ferguson.
6. Storm drainage shall be through parapet scuppers except for the rain water leaders at the two canopies.
7. The sanitary waste will exit the building in two locations through two, 4” pipes.
8. 119 DECON will be tied to a 1,000 gallon holding tank located underground on site.
9. PEX, PVC, and CPVC are permitted where permitted by AHJ.

H. Medical Gas

1. Oxygen and Medical Air will be provided throughout the FSER as noted below in the ROOM STANDARDS.

I. Fire Protection

1. An automatic wet sprinkler system shall serve all indoor spaces of the FSER and a dry sprinkler system shall serve the canopies. Both risers shall be located in 153 FIRE RISER.
2. The double check valve assembly, fire department connection, and post indicating valve will be located on the site.

J. Metering

1. Electrical power metering shall be limited to the emergency power generator and the automatic transfer switches and shall be in accordance with Appendix F.
2. Where utility meters such as water, gas, or electric have the capability of sending a signal back to the BAS at no additional equipment cost, then those services shall be metered as well. No additional meters are to be installed for the purpose of tracking usage of those services.

1.7 Sequences of Operations FSER (Free Standing Emergency Room)

A. Roof Top Unit with EF (JCI YPAL Series 100)

1. General

   a. Self-contained roof top air handling unit will be controlled by a standalone micro-processor based direct digital controller (DDC) and integrate with the building management system (BMS) via BACnet MS/TP. Central controller to have at the minimum the following capabilities: monitor unit operation, reset of unit discharge air temperature, scheduling and diagnostics.

   b. Naming convention used in this sequence (YPAL_INTEGRATED_POINT_NAMES / HCAStandardNames)

2. Unit Enable

   a. The RTU fans will be energized from the BAS with the network unit enable command (UNIT_STOP = Run).

3. Supply Fan Control

   a. The supply fan's variable frequency drive (VFD) shall operate to maintain the duct static pressure (SaStP / DCT_STAT_PRS) at the supply duct static pressure set point (SaStPSptVar / ACT_DSP_SP, 1.5"w.c., adjustable). SaStP will alarm the BMS if its measured pressure is either too high or too low.

4. Exhaust Fan Control Sequences

   a. The variable volume powered exhaust system consist of an Exhaust Fan driven by a Variable Frequency Drive (VFD), controlled by the DDC. The DDC monitors the pressure within the building. If the Building Pressure rises, the Exhaust Damper is proportionally controlled open and the Exhaust Fan is controlled ON. If the Building Pressure falls, the Exhaust Damper is proportionally controlled closed and the Exhaust Fan is controlled OFF. The position of the Exhaust Damper in which the Exhaust Fan is controlled ON and OFF as well as the Building Pressure setpoint is user selectable

   b. When the fan is on, the VFD is controlled to increase Exhaust Fan speed. As the pressure falls, the VFD is controlled to decrease Exhaust Fan speed.

5. Ventilation Control Sequences

   a. When the unit goes into the Occupied mode of operation (OCCUPNCY_CMD = Occ), the DDC shall open the Outside Air damper to a fixed position as determined by T&B (20%, Economizer Minimum Position, adjustable). .

6. Cooling Operation
   a. In the OCCUPIED mode the DDC monitors the return air temperature (RET_AIR_TEMP) and compares it to the return air temperature setpoint (RAT_COOL_SP). A closed loop staging algorithm is used to stage compressors up and down as required to maintain the desired supply temperature setpoint (ACT_SAT_SP). The ACT_SAT_SP is reset between 52-55°F (SAT_LOW_LIM, SAT_HIGH_LIM) to maintain the RAT_COOL_SP which is reset between from 70-76°F (RAT_HIGH_SAT, RAT_LOW_SAT).
   b. In the UNOCCUPIED mode the DDC monitors the average zone temperature, ZONE_TMP_BAS, and compares it to the UNOCC ZONE COOLING SETPOINT. The UNOCC ZONE COOLING SETPOINT is set through the SET POINTS key, COOLING subsection of the YPAL User Interface. If the zone temperature is equal to or greater than the setpoint temperature plus 0.5°F the DDC will place the unit in the UNOCCUPIED COOLING mode. The unit will remain in the UNOCCUPIED COOLING mode until the zone temperature is equal to or less than the setpoint minus 0.5°F.
   c. Outside Air conditions are continuously monitored by the control to determine if conditions are suitable for economizing. If conditions are suitable for economizing, the DDC will modulate the Outside Air damper in addition to staging compressors up and down to maintain the zone temperature setpoint.
   d. If the Outside Air temperature falls to or below the Low Ambient Lockout temperature (MECH_LCK_TMP, 50°F, adjustable) mechanical cooling is prevented from operating
7. Economizer Operation
   a. With dual enthalpy economizer, the DDC monitors and compares the Outside Air and Return Air enthalpies in addition to comparing the Outside Air temperature to the reference temperature setting. Outside Air is deemed suitable for economizing when the Outside Air enthalpy is determined to be less than the Return Air enthalpy and the Outside Air temperature is less than the reference temperature setting (OA_ENTH_LIMT, 22 BTU/LB, adjustable). Alternatively, Dry Bulb economizer can be selected at the RTU control panel.

8. Filters
    a. All filters will have a differential pressure switch (FinFltrSts & PrFltrSts) measuring the pressure drop across the filter banks. Each will generate a common alarm (FILTER_STATS) the BMS system whenever the pressure drop across the filter is excessive indicating a dirty filter.
9. Fire Alarm Shutdown
    a. Whenever the fire alarm system senses smoke/fire, the fire alarm system will signal the DDC system via a hardwired fire alarm system command module.
    b. The DDC system is to de-energize the unit and will perform the following.
        i. Shutdown the supply air fan.
        ii. Shutdown the return air fan.
        iii. Shutdown any associated exhaust fans.
        iv. Close the relief air damper (EaDmpr).
        v. Close the outside air dampers (OaDmpr) and Open the return air damper.
    c. Any Fire/Smoke Damper command relay provided by BMS is not for life safety operation. Fire system provides life safety FSD control and testing where applicable
10. Discharge Temp Reset Sequence
    a. When enabled (DATReset-EN) a discharge temperature setpoint reset strategy will be used. The BAS will monitor common area VAV supply boxes and reset the discharge temperature setpoint between 50°F (DATMin-SP, adjustable) and 60°F (DATMax-SP, adjustable). The setpoint will decrease if 1 (DATMaxVAV-SP, adjustable) box cooling command is greater than a cooling setpoint of 95%. The setpoint will increase when the box's cooling command drops below a 10% differential. The setpoint will also decrease if the return air humidity exceeds Return Air Humidity setpoint of 59%RH (RaRhSptVar, adjustable). The discharge air temperature setpoint will be adjusted by 0.2°F (DAT-STEP, adjustable) every 5 minutes. If the reset is not enabled, the DATMin-SP will be used.

B. Hot Water System

1. General
    a. The hot water system consists of one (two) boiler(s) and two constant speed pumps in a lead/lag configuration. With the system enabled (HwsEna = enable), the hot water system will automatically start the pumps and control the system to meet the hot water temperature setpoint.
2. Hot Water Pump Control:
    a. The hot water pumps will be energized/de-energized from a hand-off-automatic switch, mounted in starter cover, in hand position, or by the DDC system when in automatic position.
    b. In automatic and when enabled, the pump with the lowest runtime total shall be commanded (HwPXXCmd) on. After the boiler is commanded off, the pump will continue to run for a short time to dissipate the heat.
    c. If the pump status (HwPXXSts) does not match the command, an alarm will be generated (HwPXXAlm) and the pump will be stopped and the lag pump will be started. A software reset (SYS-RESET) will be required to re-enable the pump.
    d. Terminal unit valves shall not open unless the hot water pump is energized.
3. Boiler Control:
    a. The boiler(s) will be controlled via its own internal controls and integrated with the building management system (BMS) via BACnet MS/TP. The boiler will be energized/de-energized from the boiler control panel switch in hand position or by the DDC system when in automatic mode. The internal controls includes an outdoor air temperature sensor and discharge water temperature sensor to modulate burner as required to maintain discharge water temperature as indicated by a temperature reset schedule.
    b. In automatic, upon confirmation of pump status, the boiler will be commanded on (Blr01Ena).
4. Additional Points Monitored By the BMS:
    a. Boiler XX Status (BlrXXSts), and runtime (BlrXXRunTimeTot)
    b. Boiler XX Alarm (BlrXXAlm)
    c. Hot Water pump Runtime (HwPXXRunTimeTot)

d. Primary HW Supply Temperature (HwsTmp)

e. Primary HW Return Temperature (HwrTmp)

C. Decontamination Tank High Water Alarm Control

1. General

a. The float switch installed within decontamination holding tank will sense a high water level, alarm at the BAS and initiate audio visual alarm at the nurses' station. Local alarm at nurse station may be silenced at local reset. The operator must initiate a system reset (SYS-RESET = Reset) to clear the alarm.

D. Exhaust Fans

1. Exhaust fans not designated as 24/7 operation will be energized/de-energized from a hand-off-automatic switch, mounted in starter cover, in hand position, or by the DDC system when in automatic position. In automatic, fans will start and stop in conjunction with the RTU.

2. Fans will shut down from a signal from the fire alarm panel thru a hardwired fire alarm relay.

3. A current sensing relay will monitor fan status. If loss of fan status is detected, the BAS will generate a Fan Alarm (EFAlm) at the front-end.

E. VAV with Reheat

1. Unit Enable:

a. A network unit enable (UNITEN-MODE) signal will control the mode of the box. Occupancy mode will be controlled via a network input (OCC-SCHEDULE).

2. Temperature Setting:

Location	Low Range	High Range	Default Setpoint	Occ Deadband +/-	Unocc Low	UnOcc High	Alarm Low	Alarm High	Warning Offset
General	66	78	72	2	61	82	55	90	5
OR	62	72	68	0.5	62	72	55	75	2
Critical	66	78	72	0.5	61	82	55	90	5

General; Patient Rooms, Lobby, corridor, Nurse Stations,..

Critical Spaces; PACU, NICU, …

3. Occupied Mode:

a. When the zone temperature (ZN-T) is between the occupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) setpoints (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the cooling setpoint (EFFCLG-SP), the primary air damper (DPR-O) will increase the supply air flow (SA-F) (between CLGOCC-MINFLOW to CLG-MAXFLOW) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the heating setpoint (EFFHTG-SP), the reheat coil will modulate to maintain the discharge air temperature setpoint. The discharge air temperature setpoint will be reset as the zone temperature (ZN-T) changes. After the discharge air temperature setpoint reaches the high limit setpoint, the box flow is increased to the heating max flow setpoint (HTG-MAXFLOW).

4. Unoccupied Mode:
    a. When in this mode, while the zone temperature (ZN-T) is between the unoccupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) setpoints (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the unoccupied cooling setpoint (EFFCLG-SP), the primary air damper (DPR-O) will increase the supply air flow (SA-F) (between CLGUNOCC-MINFLOW to CLG-MAXFLOW) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the unoccupied heating setpoint (EFFHTG-SP), the reheat coil will be used to maintain the zone temperature (ZN-T) and the primary air damper (DPR-O) will be at the minimum CFM (SA-F).
5. Network Warmup-Cooldown:
    a. Warm-up and Cooldown modes will be activated by a network command (WC-C). When the zone temperature (ZN-T) is below the effective heating setpoint (EFFHTG-SP), the box will use warm air flow, then reheat coil to maintain the zone temperature (ZN-T). When the box is satisfied the flow will remain at the warm-up minimum position until the warm command has been removed.
6. Remote Temperature Sensor
    a. Provide remote temperature sensor mounted in return grille behind security grille to control VAV 1-6. Thermostat to be mounted outside secure hold to provide setpoint adjustment and remote temperature display. Label thermostat "secure hold

temperature adjustment".

F. Fire Smoke Dampers

1. General

a. Smoke dampers will open and close via a BMS controlled relay based on the fan operation serving the respective supply or exhaust duct. The damper command relay provided by BMS is not for life safety operation. Fire system provides life safety FSD control and testing where applicable

G. Domestic Hot Water monitoring

1. General

a. Domestic hot water plate frame is controlled by its internal controls.

b. The BMS will monitor the domestic hot water supply and alarm if it is too high or too low.

H. Isolation Room monitoring

1. General

a. The positive or negative pressurization of the rooms will be monitored by a dedicated monitoring panel. A remote monitoring panel will be located at the nurses' station. The monitor will interface to the BMS over the network.

b. Isolation exhaust fans will not shut in the event of a fire.

I. VRF AC Unit monitoring

1. General

a. AC units controlled by internal controls

b. The AC unit will interface to the BMS over the network.

Part 2-Products

2.1 HCA is electing at this time not to provide guidelines.

Part 3 - Execution

3.1 HCA is electing at this time not to provide guidelines.

APPENDIX F: ENERGY AND RESOURCE METERING

APPENDIX F-1: ENERGY AND RESOURCE METERING

Part 1 - General

1.1 Metering of energy consumption and other resources shall be provided for HCA facilities as described in the specification. ALL metering specified herein must become available to the HCA Corporate, FacilitiGroup, Energy Service Center (ESC) facilities VLAN (Dedicated to "All Things Energy") network for remote monitoring for use in their energy saving control strategies and integrate fully to the Schneider Electric Power Monitoring Expert and Enterprise Energy Manager.

1.2 Electrical Metering: Electrical metering, as described in this specification, shall be provided and installed by the Electrical Contractor to provide the required resource measurements and interface to the HCA facility VLAN (Dedicated to "All Things Energy") network. New equipment shall be supplied, and existing equipment retrofit, with metering provisions only, equipment status contacts, and generator controller communications as follows:

A. Normal Power Service Mains - Electrical metering for new and existing service entrance mains shall be provided in separate enclosed, Metering Panels provided and installed by the Electrical Contractor.

1. New power equipment shall be provided with factory installed customer metering "provisions only" including: appropriate sized, ANSI metering class current transformers (CTs) installed on each phase, CT shorting block, 3-phase voltage connection to line–side terminals of main disconnect wired to a 3-phase fused disconnect. Voltage transformers shall be provided for systems above 600 Volts. Customer connections must be accessible from the front of the equipment and include barriers from any exposed conductors. Refer to Appendix F-2 for other requirements and installation details.
2. Existing power equipment shall be retrofit with Contractor supplied current transformers (CTs) and a 3-phase voltage connection with disconnecting means wired to the metering. The Electrical Contractor is responsible for the proper selection of instrument transformers and shall verify each size and type are appropriate for the application and compliant with this specification. The metering retrofit must include: installation and wiring of CTs on each phase, a CT shorting block, 3-phase voltage connection to line–side terminals of main disconnect connected to a 3-phase fused disconnect or circuit breaker. Voltage transformers shall be provided for systems above 600 Volts. All instrument transformers, disconnects, terminals, and wiring are to be

provided and field installed by the Electrical Contractor. Refer to Appendix F-2 for other requirements and installation details.

B. Emergency Generator Mains - Electrical metering for new and existing generator mains shall be provided in separate enclosed Metering Panels provided and installed by the Electrical Contractor.

1. New power equipment shall be provided with factory installed customer metering “provisions only” including: appropriate sized, ANSI metering class current transformers (CTs) installed on each phase, CT shorting block, 3-phase voltage connection to line–side terminals of main disconnect wired to a 3-phase fused disconnect. Voltage transformers shall be provided for systems above 600 Volts. Customer connections must be accessible from the front of the equipment and include barriers from any exposed conductors. Refer to Appendix F-2 for other requirements and installation details.

2. Existing power equipment shall be retrofit with Contractor supplied current transformers (CTs) and a 3-phase voltage connection with disconnecting means wired to the metering. The Electrical Contractor is responsible for the proper selection of instrument transformers and shall verify each size and type are appropriate for the application and compliant with this specification. The metering retrofit must include: installation and wiring of CTs on each phase, a CT shorting block, 3-phase voltage connection to line–side terminals of main disconnect connected to a 3-phase fused disconnect or circuit breaker. Voltage transformers shall be provided for systems above 600 Volts. All instrument transformers, disconnects, terminals, and wiring are to be provided and field installed by the Electrical Contractor. Refer to Appendix F-2 for other requirements and installation details.

C. Emergency Generators - Generator running/stopped status and real-time readings shall be remotely monitored for new and existing emergency generators. The Electrical Contractor shall wire status contacts and Gen Controller communications from each Generator to the Gen Main Meter Panel.

1. New generators shall be provided with factory installed Gen Running/Stopped relay contact available for customer monitoring. A generator controller with communications capability must be provided allowing remote customer monitoring of all NFPA110 parameters via Modbus RTU or Modbus TCP protocol. Refer to PART 2 of this specification and Appendix F-2 for other requirements and installation details.

2. Existing generators shall have the Gen Running/Stopped status contact wired by the Electrical Contractor to the Gen Main Meter Panel. Communications cabling shall be installed and connected to the existing generator controller's communications port allowing remote customer monitoring of all NFPA110 parameters via Modbus RTU or Modbus TCP protocol. Where that communications port or status contact are not available the cabling will be installed and made available for future use. Refer to Appendix F-2 for other requirements and installation details.

D. Automatic Transfer Switches (ATS) - Electrical metering for new and existing ATS shall be provided in separate enclosed, Metering Panels provided and installed by the Electrical Contractor.

1. New ATS shall be provided with factory installed customer metering "provisions only" including: appropriate sized, ANSI metering class current transformers (CTs) installed on each phase, CT shorting block, 3-phase voltage connection to line–side terminals of main disconnect wired to a 3-phase fused disconnect. Customer connections must be accessible from the front of the equipment and include barriers from any exposed conductors. Status contacts indicating the ATS switch position and a remote test input are wired from the ATS to the Metering Panels. Refer to PART 2 of this specification and Appendix F-2 for other requirements and installation details.
2. Existing ATS shall be retrofit with Contractor supplied current transformers (CTs) and a 3-phase voltage connection with disconnecting means wired to the metering. The Electrical Contractor is responsible for the proper selection of instrument transformers and shall verify each size and type are appropriate for the application and compliant with this specification. The metering retrofit must include: installation and wiring of CTs on each ATS load-side phase, a CT shorting block, 3-phase voltage connection to load–side terminals of the ATS and wired connected to a 3-phase fused disconnect or circuit breaker. Voltage transformers shall be provided for systems above 600 Volts. All instrument transformers, disconnects, terminals, and wiring are to be provided and field installed by the Electrical Contractor. Refer to Appendix F-2 for other requirements and installation details.
3. Status contacts indicating the ATS switch position (on normal / on emergency) and a remote test input are wired from the ATS to the ATS Metering Panels. Refer to Appendix F-2 for other requirements and installation details.

E. Chiller Sub-metering - Electrical metering for new and existing chillers shall be provided in separate enclosed Metering Panels provided and installed by the Electrical Contractor.

  1. New and existing chillers shall have electrical metering field installed with Contractor supplied current transformers (CTs) and a 3-phase voltage connection with disconnecting means wired to the metering. The Electrical Contractor is responsible for the proper selection of instrument transformers and shall verify each size and type are appropriate for the application and compliant with this specification. The metering installation must include: installation and wiring of CTs on each phase, a CT shorting block, 3-phase voltage connection to line–side terminals of chiller main disconnect connected to a 3-phase fused disconnect or circuit breaker. Voltage transformers shall be provided for systems above 600 Volts. All instrument transformers, disconnects, terminals, and wiring are to be provided and field installed by the Electrical Contractor. Refer to Appendix F-2 for other requirements and installation details.

F. Sub-metering for Separate Business Entities (Non acute-care): - Electrical sub-metering to measure power delivered to separate business entities shall be provided in separate enclosed Metering Panels provided and installed by the Electrical Contractor.

  1. New power equipment shall be provided with factory installed customer metering "provisions only" including: appropriate sized, ANSI metering class current transformers (CTs) installed on each phase, CT shorting block, 3-phase voltage connection to line–side terminals of sub-metered circuit wired to a 3-phase fused disconnect. Voltage transformers shall be provided for systems above 600 Volts. Customer connections must be accessible from the front of the equipment and include barriers from any exposed conductors. Refer to Appendix F-2 for other requirements and installation details.

  2. Existing power equipment shall be retrofit with Contractor supplied current transformers (CTs) and a 3-phase voltage connection with disconnecting means wired to the metering. The Electrical Contractor is responsible for the proper selection of instrument transformers and shall verify each size and type are appropriate for the application and compliant with this specification. The metering retrofit must include: installation and wiring of CTs on each phase, a CT shorting block, 3-phase voltage connection to line–side terminals of sub-metered circuit connected to a 3-phase fused disconnect or circuit breaker. Voltage transformers shall be provided for systems above 600 Volts. All

instrument transformers, disconnects, terminals, and wiring are to be provided and field installed by the Electrical Contractor. Refer to Appendix F-2 for other requirements and installation details.

G. Any other electrical metering requirement that is not described by Section 1. 2 is remotely monitored by the HCA Energy Service Center (ESC) unless stated otherwise on the project drawings or documents.

1.3 Mechanical Metering: New mechanical metering described in this specification shall provide the required resource measurements and interface to the HCA facility VLAN (Dedicated to "All Things Energy") network either directly where pre-approved by HCA IT&S or via the W.A.G.E.S. Panel. A Process and Instrumentation Diagram (PNID) and Mechanical Meter Schedule should be provided by the design consultant for each site project.

A. Where meter selections have BACnet IP communications available and have been approved by HCA IT&S with an ISA on file then these meters shall use BACnet IP communications where meter readings are available as digital outputs, analog outputs or BACnet MS/TP communications with the meter output signal must be wired directly to a "W.A.G.E.S." (Water, Air, Gas, Electric, Steam) Monitoring Panel for logging and remote communications. It is preferred to use BACnet MS/TP in this scenario whenever possible.

B. A "W.A.G.E.S. "(Water, Air, Gas, Electric, Steam) Monitoring Panel shall be provided and installed by the Controls Contractor and shall comply fully with the requirements of Section 2.4. The W.A.G.E.S. panel shall be connected to the HCA IP network and reside on VLAN (Dedicated to "All Things Energy").

C. COORDINATION: It is the general contractor's responsibility to ensure coordination between the mechanical, controls, and electrical contractors. This is critical to ensure there is no overlap in scope or path of meter communications intent. The controls contractor shall plan to bring their mechanical meters directly to the BACnet IP level, where previously approved by HCA IT&S, or the W.A.G.E.S. Panel (for metering not available or approved with BACnet IP communications).

1.4 Protocol Standardizaton: It is the intent for meter communications to be as follows:

A. All electrical metering shall use Modbus protocol.

1. Normal Power Mains, Emergency Power Mains and ATS Metering Panels shall be provided with Modbus TCP Ethernet communication capabilities.
2. All other electrical sub-metering shall communicate with Modbus TCP Ethernet or over a Modbus RTU (RS485) daisy-chain connected to a

Serial-to-Ethernet "gateway". Serial daisy-chains should not exceed 16 devices to assure communications performance. The Modbus Ethernet "gateway" may be an add-on meter module, built-in meter comms port or separate communications device. All Modbus "gateways" must be HCA pre-approved products.

B. All BTU Meters to communicate via BACnet IP

C. All Mechanical metering described in this specification shall be available to both Modbus TCP and BACnet IP based systems via the W.A.G.E.S. Panel All mechanical metering in described in this specification shall be connected directly to the W.A.G.E.S. Panel via BACnet IP, BACnet MS/TP, MODBUS TCP, MODBUS RTU, hardwired digital input, or hardwired analog input. Additional mechanical metering not described in this specification but required by other specifications or drawings shall be connected the facility BAS and made available to the W.A.G.E.S. Panel via BACnet IP.

D. Equipment VFD's controlled by the facility BAS shall communicate to the facility BAS system directly via BACnet MS/TP. (This does not replace the required hardwired points of the DDC control specification and drawings.) All energy and operating data shall be made available via BACnet IP from the facility BAS to the W.A.G.E.S. Panel.

E. Facility BAS Systems shall have necessary drivers installed to allow for BACnet IP communications to the W.A.G.E.S. panel this will allow for the BAS to have access to specific electrical and mechanical metering data via the W.A.G.E.S. panel. The communications is to be bi-directional so the W.A.G.E.S. Panel can also have access via BACnet IP to selected BAS data points.

F. The W.A.G.E.S. panel shall make specific Electrical and Mechanical meter data accessible via BACnet IP for auto discovery by the facility BAS. The meter data made available via this communication shall include all physical points of measurement and calculated values of summation. The W.A.G.E.S. panel shall also make all Electrical and Mechanical metering data including any BAS points mapped into the W.A.G.E.S. panel available via MODBUS TCP for integration to the Schneider Electric Power Monitoring Expert (PME) and Enterprise Energy Manager (EEM) software.

G. Additional metering points required by project documents not described in this specification shall be connected directly to the facility BAS.

H. IP Addresses for HCA VLAN (Dedicated to "All Things Energy network") connected meters will be furnished to the installing contractor prior to startup of metering devices.

1.5 Commissioning –Startup & Commissioning of metering by a qualified technician is required to verify the accuracy of meter readings and integration into the remote monitoring system.

A. Startup & Commissioning Services are provided as follows:

1. Electrical Meters shall have startup & commissioning services provided as part of the bid. Acceptable electrical metering startup & commissioning providers: Schneider Electric, Power Management & Controls Division or an HCA Certified Metering Contractor. See Appendix F-3 - Electrical Metering Commissioning for additional information
2. WAGES panels shall have the commissioning services provided as part of the bid. Acceptable WAGES Panel startup & commissioning provider: Schneider Electric, Power Management & Controls Division. See Appendix F-3
3. Mechanical meters are to have startup & commissioning services provided by the Controls Contactor

B. Commissioning documentation is to be furnished to the HCA FacilitiGroup, Energy Service Center shall include:

1. Meter startup data (Date, Model, Serial, Name, Location, Type of communication, etc.)
2. Meter configuration data (IP Address, Subnet Mask, Default Gateway, Modbus ID, configuration settings, etc.)
3. Record Power Main size, ATS Size, Chiller FLA, Branch Main size, voltage, CT type and size, Area Served, breaker label, model, type, and serial number.
4. Record Main Switchgear, ATS, and equipment metered manufacturer, model, serial, name, location, type of communication, and area served.
5. Ensure CT shorting blocks have been installed on all CT's associated to all meters associated to this scope of work.
6. Ensure voltage connections have been made correctly and at the proper circuit location (i.e. line-side versus load-side).
7. Ensure status signals to and from the metering panels are properly terminated and operation witnessed under actually operating conditions (not simulated conditions).
8. Meter / WAGES *(water, air, gas, electric, steam)* points including points list for miscellaneous connected meters.

9. Certification that meter has been installed, communicating and operating according to the manufacture's specification. All miscellaneous metering connected via a meter used as a W.A.G.E.S. Panel shall be included in this certification. This certification shall include verification methods, initial readings, and technician name & company
10. A schedule of all mechanical metering indicating where meters are located and what type, size, capacity, flow rates, multipliers, etc. that the meter installation is associated to.

1.6 Interpreting Project Drawings: The intended scope includes electrical and mechanical metering of all CORE systems.

A. ELECTRICAL METERING of all new normal and emergency main power equipment, emergency standby generators, automatic transfer switches, chillers and utility systems supplied under this contract and retrofit metering as indicated on the drawings. Where metering defined below is not represented on the project drawings then question should be made to the design engineer to ensure the goals of HCA Corporate FacilitiGroup are met.

B. MECHANICAL METERING of the following to the extent of being able to accurately determine system efficiency on a real time basis.

1. Chilled Water System (Electric metering per chiller and overall BTU measurement of the CHWS "LOAD")
2. Hot Water Boiler System (Natural Gas entering the hot water boiler system (Meaning that where possible use only one NG meter per HW Boiler system) or Individual HW Boiler NG Meters where required and overall BTU measurement of HW Boiler system "LOAD")
3. Steam Boiler System (Natural Gas entering the steam boiler system (Meaning that where possible use only one NG meter per Steam Boiler system) or Individual Steam Boiler NG Meters where required and (Preferred) steam flow measurement per boiler where piping configurations will allow for it or (Alternate) Measurement of Boiler Feed water per boiler, DA Tank Make up water.)
    a. Clarification: When steam is used to generate reheat water for reheat systems then BTU measurement of the Hot Water Reheat Systems are NOT REQUIRED.

C. Sub-metering of ancillary buildings such as MOB's is required when core services are furnished through the main facility systems and utilities. The systems to be sub metered under these circumstances are:

1. Chilled Water (BTU Meter)

2. Hot Water for Reheat Purposes (BTU Meter)
3. Steam (Steam Flow Meter (Required) and Condensate Return metering where possible)
4. Domestic Water (Flow Meter)
5. Domestic Hot Water (BTU Meter)
6. Electricity (Total Load Metering to be captured)

1.7 Applying These Guidelines: The scope includes all new equipment and systems supplied under this contract and retrofit metering as indicated on the drawings.

A. Include the metering devices as defined in the sections
B. Identify the installation location and coordination requirements on a system one-line diagram for each type of system (Electrical, CHW, HW, CW, Steam, Natural Gas, Domestic Water, Make up Water, etc.)
C. Include design considerations that allow for the servicing and maintenance of all new equipment.
D. Identify the electrical power source, equipment status contacts and meter communications cabling requirements for all new or existing metering devices.
E. Coordinate with power equipment and meter manufacturers to identify the termination points for all metered equipment. Refer to Appendix F-4 – Meter System Design Documents for *EPSS Meter Readiness Forms* to document new and existing ATS and Generator status wiring and communication connections.
F. Provide a narrative, network diagram and schedule of meters demonstrating how the proposed metering will be integrated to the HCA FacilitiGroup, Energy Service Center. Refer to Appendix F-4 for Sample Design Documents.

1.8 Substitutions

A. WAGES Panels and Electrical Meters and their enclosures specified in this section are by Schneider Electric. The meters are to be purchased through Graybar with an approved engineered solution from Schneider Electric as a complete package. Exclusion of any part of the metering package is not permissible. Alternate meter selection, **PRIOR TO BID**, can be submitted to HCA Corporate, FacilitiGroup for consideration. HCA Corporate FacilitiGroup must provide written approval prior to the acceptance of an alternate meter selection. **PRIOR TO BID**.

B. Alternate mechanical meter selection, **PRIOR TO BID**, can be submitted to HCA Corporate, FacilitiGroup for consideration. HCA Corporate FacilitiGroup must provide written approval prior to the acceptance of an alternate meter selection. **PRIOR TO BID**.

1.9 For Existing Sites – Meter retrofits for existing equipment must be coordinated with the equipment manufacturer representatives to determine the "metering readiness" and any deficiencies identified PRIOR TO BID. See Appendix F-3 - Meter Readiness Forms

A. Where "metering provisions" are verified to exist on existing systems (including status contacts) the contractor connections for meter inputs shall be indicated on the project drawings.

B. Where "metering "provisions" do not exist on existing systems (including status contacts) the equipment manufacturer's representative must provide a proposal for corrections / modifications and the proposed connections points for metering inputs. This information shall also be provided on the project drawings.

C. When meters, which meet these specifications, already exist then it is preferred to incorporate these meters into use within this survey. All meter inputs (including status) contacts must be provided on the project drawings.

1. Example 1: If a Flow meter of the correct type exist (Turbine Type Meters are not Acceptable), in the correct location, but there is no Btu meter then add a Btu meter and matched sensors and reuse the existing flow meter (Contractor to verify existing flow meter is functioning properly and accurately) If existing flow meters is of the hot tap type installation and has to be changed to meet the standards described herein then the hot tap assembly is intended to be reused if possible.
2. Example 2: If an electric meter exists on an ATS, then confirm the meter can meet the required specifications below and that it has the necessary peripheral components to obtain the data required and connect it to the new energy monitoring system as described herein. Provide additional details to assist in planning for the integration with submittal and commissioning documentation.
3. Example 3: If existing electrical or mechanical metering is currently connected to the facility BAS, then confirm the existing metering can fully meet the specifications below and clearly define the type of communications, Modbus RTU, Modbus IP, Bacnet MS/TP, Bacnet IP, hardwired interface of digital points, etc., being used to integrate to the facility BAS. Special consideration needs to be provided to integrate these points to a BACnet IP protocol for discovery by the WAGES panel

from the facility BAS. If this cannot be accomplished via the BAS then it is required that the metering be rerouted through a WAGES panel then the data will be available to the facility BAS via BACnet IP.

1.10 Related Divisions

A. Division 22 – Plumbing
B. Division 23 – Mechanical
C. Division 26 - Plumbing

1.11 References

A. The system shall comply with the applicable portions of NEMA standards. In addition, the control unit shall comply with FCC Emission Standards specified in Part 15, Sub-part J for Class A application
B. Electric Metering - All Power Meters shall be UL 508 Listed, CSA approved, and have CE marking. They shall also have certified revenue accuracy as per ANSI C12.20 and IEC 60687 class 0.5S or better.
C. Flow Metering – Construction Inspection (ANSI/ASME B31.3), Materials (NACE MR-01-75[90])
D. BTU Meters and Temperature Sensors - shall be bath-calibrated and matched (NIST traceable)

1.12 Submittals For Review/Approval

A. Drawings shall show all field monitoring devices, key networking components, and cabling required to complete the remote monitoring system. Drawings shall identify network connections and protocols. Drawings shall identify device room location and recommended installation notations. Specific locations and mounting details are subject to the discretion and responsibilities of the installation Contractor
B. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and performance, electrical characteristics, and connection requirements of each device supplied under the Metering scope of work
C. Verify compatibility with Energy Service Center (ESC) and complete compliance with this section.
D. Electrical Meters, assembled metering panels and commissioning services specified in this section are by Schneider Electric. The equipment and services are to be purchased through Graybar Electric Supply with an approved engineered solution from Schneider Electric as a complete package. Exclusion of any part of the metering package is not permissible. Alternate meter

selection, **PRIOR TO BID**, can be submitted to HCA Corporate, FacilitiGroup for consideration. HCA Corporate FacilitiGroup must provide written approval prior to the acceptance of an alternate meter selection. **PRIOR TO BID**.

1. Recommended point of contact to acquire this product:

   Jess Hoover | Account Manager
   825 8th Ave South | Nashville, TN 37203 | Office (615) 743-3232 | Fax (615) 254-4337 | Cell (239) 494-2088 | jess.hoover@graybar.com or NATN.HCA@graybar.com

E. WAGES Panels and commissioning services described in this specification are by Schneider Electric and are to be purchased through Graybar Electric Supply with an approved engineered solution from Schneider Electric as a complete package. Exclusion of any part of the WAGES Panel package is not permissible.

1.13 Qualifications

A. The METER vendor shall be ISO 9000 registered to demonstrate quality compliance.

B. The METER vendor shall be tested and approved for Energy Service Center (ESC) compatibility.

C. The METER vendor or their representative must provide on-site support services within 100 miles of project locations.

Part 2-Products

2.1 Electric Meters

A. Electrical Normal & Emergency Power Mains - The Main Metering Panels are factory assembled, wired and tested with NEMA type 12 enclosure suitable for indoor installations. Power Meter, input disconnect, fuses, control power transformer, CT shorting block and onboard UPS are provided. The UPS provides continuous meter control power and requires a single phase input circuits from an emergency power circuit (wired by the E.C.). The advanced meters shall be ANSI C12.20 0.2% accuracy meters with power measurement, power quality, sag/swell detection, and waveform capture. All information shall be available to remote monitoring systems using Modbus TCP Ethernet. Readings shall be available continuously as well as logged onboard the in non-volatile memory include: kWh, kW per phase and total, kW minimum, kW maximum, kVAR, kVA, pf per phase, V, L-L, L-N per phase and average, Current, per phase and average, Harmonic power flow down to the 63rd harmonic, Sags/swell disturbance monitoring. The metering supplied shall be capable of automatic interval data logging and event capture automatically uploaded to the ESC energy management servers. Approved

Manufacturer: Schneider Electric Enclosure Series #9761HC**.** See *Appendix F-2 - Electric Metering Examples* for more information.

B. Generator Controls – Generator controllers must be capable of NFPA110 metering with both local displayed readings as well as remote monitoring to the HCA Energy Service Center via Modbus RTU or Modbus TCP communications. The following stats and readings shall be provided via communications to the HCA Energy Service Center.

1. Generator Current, per-phase
2. Generator Voltage, phase-to-phase & phase-neutral
3. Generator Real Power (kW), per phase & three-phase total
4. Generator Reactive Power (kVAR), per phase & three phase total
5. Generator Apparent Power (kVA), per phase & three phase total
6. Generator Power Factor (true), per-phase & three-phase total
7. Generator Frequency readings
8. Engine RPM
9. Engine Oil Pressure
10. Engine Oil Temperature
11. Engine Coolant Temperature
12. Engine Run Hours
13. Battery Voltage
14. Engine Exhaust Temperature
15. Note: Gen Run/Stopped status contacts always required and wired to the Gen Main Meter digital input.

C. Automatic Transfer Switches (ATS) - The ATS Monitoring Panels are factory assembled, wired and tested with NEMA type 12 enclosure suitable for indoor installations. Power Meters, input disconnect, fuses, control power transformer, CT shorting block, sequence event recorder (SER) and control power UPS are provided. Sequence event recorder (SER) capability is provided allowing ATS status to be remotely monitored and time stamped. A "remote test" selector switch is also provided on the panel door for each ATS. The "remote test" selector switch allows ATS tests to be initiated from the meter panel (requires the selector switch contact and status contacts to be wired between the ATS Monitoring Panel and the ATS by the Electrical Contractor). The Power Meters is to be rated ANSI C12.20, 0.5S class or better accuracy and continuously provide real-time readings and log (onboard the meter in non-volatile memory) 15 minute interval data for the following parameters: instantaneous power, max power, demand power, peak demand power, energy, power factor, amps, and volts. All readings shall be available per phase and total. Min/Max readings shall have time/date stamping available from the meter display and via communications. The ATS Monitoring Panels shall communicate over Modbus TCP Ethernet. Approved manufacturer: Schneider Electric Enclosure Series #9761HC. See *Appendix F-2 - Electric Metering Examples* for more information.

D. ATS Controls – ATS switches must be capable of providing discrete status contacts and remote test initiation via wired input discrete contact signal:

    1. ATS Connected to Normal Source
    2. ATS Connected to Emergency Source
    3. Remote Test Input (Allowing a remote contact closure to initiate an ATS test)

E. Chiller Sub-metering: The Chiller sub-metering panels include Power Meter, input disconnect, fuses, control power transformer and CT shorting block. Power Meters shall be rated ANSI C12.20, 0.5S class or better accuracy and continuously provide real-time readings and log 15-minute interval data for the following parameters: instantaneous power, max power, demand power, peak demand, energy, power factor, amps, and volts. All readings shall be available per phase and total. Min/Max readings shall have time/date stamping available from the meter display and via communications. The meter shall utilize Modbus communications and have direct Ethernet connectivity onboard or serially connecting to a Modbus "Ethernet Gateway" enabled device. Approved manufacturer: Schneider Electric Model #5560. See *Appendix F-2 - Electric Metering Examples* for more information.

F. Sub-metering for Separate Business Entities (Non acute-care) - Separate business entities receiving powered from the hospital's power system must be sub-metered to identify the energy use. The Sub-metering panels include Power Meter, input disconnect, fuses, control power transformer and CT shorting block. Power Meters shall be rated ANSI C12.20, 0.5S class or better accuracy and continuously provide real-time readings and log 15-minute interval data for the following parameters: instantaneous power, max power, demand power, peak demand, energy, power factor, amps, and volts. All readings shall be available per phase and total. Min/Max readings shall have time/date stamping available from the meter display and via communications. The meter shall utilize Modbus communications and have direct Ethernet connectivity onboard or serially connecting to a Modbus "Ethernet Gateway" enabled device. Approved manufacturer: Schneider Electric Model #5560. See *Appendix F-2 - Electric Metering Examples* for more information

G. Instrument Transformers

1. Current Transformers (CTs):

    a. Factory installed current transformers (CTs) shall be UL Listed, 60Hz, ANSI metering class rated for the system voltage with a 1% accuracy or better at 100% rated current. The CT primary is selected based upon the maximum circuit current and a secondary output of 5 Amps at 100% at rated current. The CT selection should ensure the typical CT loading is greater than 20% of the primary rating. CTs shall be solid-core type mounted inside power equipment using approved brackets and wired to CT shorting block accessible from the front of the equipment. Approved manufacturers: Schneider Electric or equal.

    b. Field installed current transformers (CTs) shall be 60Hz, ANSI metering class rated for the system voltage with a 2% accuracy or better at 100% rated current. The CT primary is selected based upon the maximum circuit current and a secondary output of 5 Amps at 100% rated current. The CT selection should ensure the typical CT loading is greater than 20% of the primary rating. CTs shall be field installed inside power equipment and secured in accordance with manufacturers' recommendations and best practices. Acceptable field installed CTs types include: solid-core, split-core or Rogowski coils "rope CTs" (with appropriate amplifier for 5 Amp outputs). Solid and Split-core CTs are to be wired to CT shorting block accessible from the front of the equipment. Approved manufacturers: Schneider Electric or equal.

2. Voltage Transformers (VTs):

    a. Factory installed VTs for metering are required for applications greater than 600 Volts and shall be ANSI metering class, appropriately rated for the voltage class and system type. Primary and secondary fusing in accordance with NEC are required as well as an isolation and disconnecting means. Primary ratings shall be selected based on the voltage class and secondary at 100% voltage shall be 120Volts. VT connections shall be available to the customer from terminal blocks located in a compartment accessible front the front of the switchgear and isolated from high voltage bussing. Approved manufacturers: Schneider Electric or equal.

b. Field installation of metering voltage transformers (VTs) for equipment greater than 600 Volts shall be coordinated with the original equipment manufacturers to assure proper clearances and equipment serviceability is preserved. VT connections shall be available to the customer from terminal blocks located in a compartment accessible front the front of the switchgear and isolated from high voltage bussing. Approved providers: Schneider Electric or equal.

2.2 Flow Meters

A. Domestic Cold Water (Water Service Entrance)

1. **FOR PIPE SIZES UNDER 3”** (Typical DLJ Type Meter) – ONLY REQUIRED when the facility irrigates the landscaping – Provide Turbine Flow Meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand insert able up to 227 psi. The flow meter shall have a metering insert containing the turbine rotor. The liquid pressure drives the turbine rotor rate proportional to the volumetric flow rate. The rotor’s rotation is magnetically coupled to a hermetically sealed indicator/reed switch contacts. Wetted metal components shall be nickel-plated brass 3/4”-1-1/2”, and epoxy coated cast iron 2”-10”). The operating temperature shall be 30 to 250 degrees F. Accuracy shall be within ± 1.0% of rate at the calibrated velocity, and within ± 1% of rate over a 32:1 turndown (3/4” – 2”) and 55:1 turndown (2”-10”). The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V or Isolated Dry Contact Pulse signal output for connection to W.A.G.E.S Panel (Refer to Section 2.4). **Note: If a separate business entity receives water this needs to be separately measured.**

2. **FOR PIPE SIZES OVER 3”**) – ONLY REQUIRED when the facility irrigates the landscaping – Provide an Insertion Electromagnetic Flow Meter. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed

80:1. Output signals shall be completely isolated and shall consist of the following: (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter, (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable and (1) scalable dry contact output for totalization. Each flow meter shall be covered by the manufacturer's two-year warranty. **Note: If a separate business entity receives water this needs to be separately measured.**

3. When Domestic Cold Water is supplied directly to a non-acute care building such as a medical office building then a flow meter is required is required to capture the usage of that building independently.
4. When Domestic Hot Water is supplied directly to a non-acute care building such as a medical office building then a BTU Meter is required to capture the usage of that building and its energy independently.

B. Irrigation Water (Typical DLJ Type Meter) - Provide Turbine Flow Meter. The flow meter shall have a metering insert containing the turbine rotor. The liquid pressure drives the turbine rotor rate proportional to the volumetric flow rate. The rotor's rotation is magnetically coupled to a hermetically sealed indicator/reed switch contacts. Wetted metal components shall be nickel-plated brass 3/4"-1-1/2", and epoxy coated cast iron 2"-10"). The operating temperature shall be 30 to 250 degrees F. Accuracy shall be within ± 1.0% of rate at the calibrated velocity, and within ± 1% of rate over a 32:1 turndown (3/4" – 2") and 55:1 turndown (2"-10"). The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V or Isolated Dry Contact Pulse signal output for connection to W.A.G.E.S Panel (Refer to Section 2.4).

C. Cooling Tower Make-up Water, Cooling Tower Blow down, and DA Tank Make up Water (Typical DLJ Type Meter) - Provide Turbine Flow Meter The flow meter shall have a metering insert containing the turbine rotor. The liquid pressure drives the turbine rotor rate proportional to the volumetric flow rate. The rotor's rotation is magnetically coupled to a hermetically sealed indicator/reed switch contacts. Wetted metal components shall be nickel-plated brass 3/4"-1-1/2", and epoxy coated cast iron 2"-10"). The operating temperature shall be 30 to 250 degrees F. Accuracy shall be within ± 1.0% of rate at the calibrated velocity, and within ± 1% of rate over a 32:1 turndown (3/4" – 2") and 55:1 turndown (2"-10"). The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V or Isolated Dry Contact Pulse signal output for connection to W.A.G.E.S Panel (Refer to Section 2.4).

1. Make-up Water meters to be provided for each system; Cooling Tower, and Steam De-aerator.
2. Blow-down metering to be provided for each Cooling Tower system

D. Boiler Feed Water (Typical DLJ Type Meter) - **Must be High temperature rated**. Provide Turbine Flow Meter. The flow meter shall have a metering insert containing the turbine rotor. The liquid pressure drives the turbine rotor rate proportional to the volumetric flow rate. The rotor's rotation is magnetically coupled to a hermetically sealed indicator/reed switch contacts. Wetted metal components shall be nickel-plated brass 3/4"-1-1/2", and epoxy coated cast iron 2"-10"). The operating temperature shall be 30 to 250 degrees F. Accuracy shall be within ± 1.0% of rate at the calibrated velocity, and within ± 1% of rate over a 32:1 turndown (3/4" – 2") and 55:1 turndown (2"-10"). The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V or Isolated Dry Contact Pulse signal output for connection to W.A.G.E.S Panel (Refer to Section 2.4).

   1. Boiler Feed Water metering to be provided for each steam boiler

E. When Boiler Feed Water Lines are over 3" then an alternate meter type can be used provided it is properly rated in temperature. Consider using a hot tap insertion type meter as described in the Domestic Cold Water section above.

F. Plant Steam Production Measurements- Furnish and install a Vortex Mass Flow Meter(s) complete with integral density compensation to provide direct mass steam flow output. The flow meter shall calculate mass flow corrected for density with real time calculations based on temperature measured by an integral 1000 ohm platinum RTD. Mass flow inferred from specified steam pressure or calculated externally to the flow meter will not be acceptable. The flow meter shall be sized by the manufacturer for each specific application and installed according to manufacturer's recommendations. Provide a flow straightener, if required to meet the manufacturer's minimum upstream straight pipe run requirement. Provide lateral and horizontal supports as required to minimize vibration at the meter location. Each flow meter shall be individually calibrated at five points from 0-250 ft/s against the manufacturer's flow standards. The manufacturer shall provide a certificate of calibration for each meter. The flow meter shall be programmed by the manufacturer for each specific application and shall be ready to use upon delivery. Mass flow accuracy shall be within ± 1.5% of actual reading over the range of the meter, including all errors associated with velocity measurement, temperature and/or pressure measurement, and density compensation. The meter shall be provided with ANSI class 150 or class 300 flanges as required to meet system requirements. The maximum operating temperature shall be 4600 F. The flow meter body shall be constructed of

300 series stainless steel and include a weather-tight NEMA-4 aluminum electronics enclosure. The meter shall display steam mass flow rate and mass flow total with an integral LCD display and support field programming of all parameters. The meter shall also have integral diagnostics to verify installation conditions and the proper operation of the meter. The meter shall provide a loop-powered 4-20 mA output signal calibrated in direct mass flow rate units for connection to the Energy Monitoring System. In addition, an integral pulse output for steam mass flow totalizing shall be provided. All outputs shall be linear with mass flow rate.

1. Steam Flow Metering to be provided for each steam boiler. Steam flow meters are to be sized according to the boiler total capacity and manufactures recommendation.
2. Record Boiler size, manufacturer, model, type, and serial number and include with your survey.
3. Steam flow measuring at each steam boiler may not be practical due to existing piping configuration not allowing for sufficient straight line piping to accommodate meters. When this is encountered investigate to determine if there is a location where the total steam production can be measured as a system. ONLY WHEN PIPING CONSTRAINTS require this should it be considered.
4. When Steam is supplied directly to a non-acute care building such as a medical office building then a Flow Meter is required to capture the usage of that building independently. The Condensate Return from the associated building shall also be metered.

G. Service Gas Meters – when available from the utility company gas meter integrate the output signal from that meter to the W.A.G.E.S. Panel via the meter output signals of 0-10 vdc or 4-20mA for rate and/or a scalable pulse for total (active 24VDC pulse, 500ms duration) (Dedicated to "All Things Energy")

H. Boiler Gas Metering and misc. gas sub-meters **-** A thermal mass flow meter utilizing hybrid analog/digital sensing circuitry with no moving parts shall be provided for continuous measuring and indicating the accurate measurement of natural gas. The sensor design measures mass flow directly and does not require additional pressure or temperature compensation to deliver accurate flow data. The meter shall be capable of handling clean, dry gases at constant or variable flow rates. Meter accuracy is as follows: ± 1.0% of reading from 500 – 7000 SFPM and ± 2.0 % of reading from 100 – 500 SFPM. The flow meter shall be individually wet calibrated in a flow laboratory against standards that are directly traceable to N.I.S.T. A certificate of calibration shall accompany every meter. The Meter shall continuously display a special calibration value that provides a fast, easy way to confirm that the calibration is valid. The meters may be used satisfactorily at pressures up to the full maximum allowable operating pressure of 500 psi. The gas meters are insertion type in pipes >1” and can be installed without disrupting service if local codes allow. The meter material of constructions are as follows: Wetted metal components - 316L stainless steel, Sensor head - Platinum windings encapsulated in 316L stainless steel, Electronics enclosure - Powder coat painted cast aluminum, Remote mount enclosure - Cast aluminum. The enclosure is rated Weather tight, NEMA 4 (All versions). The meter ambient operating temperature range is -5 F to 150 F while the gas temperature s range is from -40 F to 200F. The maximum allowable operating pressure rating is 500 psig. The meter output signals are analog 4-20mA for rate and a scalable pulse for total (active 24VDC pulse, 500ms duration Basis of Design Onicon F-5100 Thermal Mass flow meter connected to Onicon D-100 communicating via BACnet MS/TP to the W.A.G.E.S. Panel.

1. Gas Sub metering to be provided for each system; Hot Water Boiler System and Steam Boiler System. A separate gas meter for each boiler is not required when each system can be measured with a single meter and only one boiler operates at a time.
2. When Natural Gas piping will allow for a single meter to meter the system as a whole please provide a cost comparison between a single meter vs. individual meters within a system.
3. When there are existing natural gas meters then their control signals shall be connected to the W.A.G.E.S. Panel and their value made available via BACnet IP from the W.A.G.E.S. Panel. Connection of existing natural gas meter to the W.A.G.E.S. Panel is preferred to be via BACnet MS/TP. If BACnet MS/TP is not available then connection of the meter output signals of 0-10 vdc or 4-20mA for rate and a scalable pulse for total (active 24VDC pulse, 500ms duration) is acceptable.
4. When Natural Gas is supplied directly to a non-acute care building such as a medical office building then Flow Meter is required to capture the usage of that building independently.
5. Take care not to over meter the application but ensure the primary systems are properly isolated and metered.

2.3 Energy BTU Measurement

A. The entire Energy Measurement System shall be built and calibrated by a single manufacturer and shall consist of a flow meter, two temperature sensors and remote display module. The basis of design is the Onicon System

10 BTU Meter, with factory matched temperature sensors and the Onicon F3500 Hot tap insertion type flow meter.

1. The BTU meter shall be connected to the HCA Network on VLAN dedicated to all things energy and communicate via BACnet IP. A dual network card is optional and acceptable to provide simultaneous communication.
2. The Btu Meter's flow and temperature sensors shall be installed in a manner to capture the entire building load. NO BTU METER SENSORS SHALL BE INSTALLED IN THE PRIMARY LOOP OF A PRIMARY SECONDARY SYSTEM.
3. **BTU Meter's, Flow Sensors, and Temperature Sensors are required in the following applications:**
    a. Total Chilled Water Load Measurement of the building is required. In existing buildings this may require more than one BTU Meter per Chilled Water System. Special consideration should be made to limit the number of BTU meters per system and consider if the use of a full bore MAG meter such as the Onicon F3100 is a better option due to piping constraints.
    b. When Hot Water Boilers are used for building reheat then Total Hot Water Load Measurement of the building is required. In existing buildings this may require more than one BTU Meter per Hot Water System. Special consideration should be made to limit the number of BTU meters per system and consider if the use of a full bore MAG meter such as the Onicon F3100 is a better option due to piping constraints.
    c. When Hot Water or Chilled Water is supplied directly to a non-acute care building such as a medical office building then a BTU meter is required for each system to capture the total load of that building independently.
    d. When Domestic Hot Water is supplied directly to a non-acute care building such as a medical office building then a BTU meter on the domestic Hot water serving this load is required.
    e. When hot water reheat is provided via a steam to water heat exchanger a BTU meter is not required on the hot water side.

B. A BTU meter, temperature thermo-wells, and all required mechanical installation hardware. A certificate of NIST* traceable calibration shall be provided with each system. All equipment shall be covered by the manufacturer's two year warranty. BTU Meter: The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be BACnet IP. Each BTU meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).

1. Temperature sensors: (Either hot tap installation version or with thermo well for serviceability) Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST* traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within +0.15˚F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).
2. Flow Meter: (Hot Tap Version Only – Even when installed in new construction) ONLY Insertion Electromagnetic Type meter is to be used with a BTU meter. The flow meter shall be installed either in the supply or return (Preferred) pipe of the system to be measured following the manufacturer’s instructions with particular attention to upstream and downstream straight pipe runs. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown and shall be hand insert able up to 400 psi. ONLY WHEN PIPING CONSTRAINTS prevent the installation of a hand insert able meter an in-line mag meter may be considered.
3. Insertion Electromagnetic Type: Provide an Insertion Electromagnetic Flow Meter. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 80:1. Output signals shall be completely isolated and shall consist of the following: (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter, (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable and (1) scalable dry contact output for totalization. Each flow meter shall be covered by the manufacturer’s two-year warranty.

2.4 W.A.G.E.S. (Water, Air Gas, Electric, Steam) Monitoring Panel -All new mechanical metering shall be interfaced to a "W.A.G.E.S." Monitoring Panel supplied and installed by the Controls Contractor. The WAGES Panel shall be NEMA type 1 enclosed with the capability of accepting preprogrammed input channels: (16) meter inputs directly wired to the WAGES Panel as well as (8) meters via BACnet IP or BACnet MSTP communications. The panel shall be factory configured to automatically calculate flow and consumption once meter scaling and serial addressing are configured. The W.A.G.E.S. Monitoring Panel shall be # 9761HCSXWAUTSVRENC by Schneider Electric.

A. WAGES Integrated Points

1. The W.A.G.E.S. Panel shall receive from the facility BAS via BACnet IP to following points

a. All Central Plant Equipment Status points to include but not be limited to; Chiller status, Primary CHWP status, Secondary CHWP status, Condenser Water Pump Status, Cooling Tower Fan status, Steam Boiler status, Hot Water Boiler status, Hot Water Pump status, Tertiary Pump status's, Booster Pump status's, etc.

b. When Central plant equipment (Chillers, Boilers, Cooling Towers, etc.) or VFD's communicate to the facility BAS then their energy and operating data, when available, including but not limited to the following shall be communicated to the W.A.G.E.S. panel via BACnet IP; operating volts, amps, kW, kWd, PF, current speed, BTU/hr, current production values, current energy consumption values, status, speed, command, alarm state, etc.

B. The Wages Panel shall be capable of allowing electrical and mechanical meter data be accessible via BACnet IP for auto discovery by the facility BAS. The meter data made available via this communication shall include all physical points of measurement and calculated values of summation. The W.A.G.E.S. panel shall also make all Electrical and Mechanical metering data including any BAS points mapped into the W.A.G.E.S. panel available via MODBUS TCP for integration to the Schneider Electric Power Monitoring Expert and Enterprise Energy Manager software.

C. This data shall be provided from a standard *WAGES & BAS Register & Trending Template* see complete list in Appendix F-5.

D. The W.A.G.E.S. Panels shall include the following features:

1. StruxureWare Automation Server with support for BacNet MSTP, BACnet IP, Modbus RTU, Modbus TCP and LonWorks
2. UI-16 Universal Digital Input Module
3. PS-24 power supply & dedicated 96VA control power transformer
4. Additional 120-24VAC , 96VA control power transformer for powering field devices
5. 24" x 24" x 10" Type 1 Enclosure
6. "HCA WAGES Template" program factory loaded with site specific IP address

E. WAGES Standard Input Assignments:

AS WAGES Register & Trending Template				
AS Input	**Application**	**Name**	**Meter Type**	**Meter Signal**
1	CT Make-Up Water Meter	CT MU WATER -1	Existing or New - Mfg: DLJ	Pulse
2	CT Make-Up Water Meter	CT MU WATER -2	Existing or New - Mfg: DLJ	Pulse
3	CT Blow-down Water Meter	CT BD WATER -1	Existing or New - Mfg: DLJ	Pulse
4	CT Blow-down Water Meter	CT BD WATER - 2	Existing or New - Mfg: DLJ	Pulse
5	DA Tank Make-up Water Meter	DA TANK MU WATER	Existing or New - Mfg: DLJ	Pulse
6	Boiler Feed Water Meter	BLR FW - 1	Existing or New - Mfg: DLJ	Pulse
7	BoilerFeed Water Meter	BLR FW - 2	Existing or New - Mfg: DLJ	Pulse
8	Boiler Feed Water Meter	BLR FW - 3	Existing or New - Mfg: DLJ	Pulse
9	Boiler Natural Gas Meter	BLR NG -1	Existing Mfg	Analog (4-20mA)
10	Boiler Natural Gas Meter	BLR NG - 2	Existing Mfg	Analog (4-20mA)
11	Boiler Natural Gas Meter	BLR NG - 3	Existing Mfg	Analog (4-20mA)
12	Steam Flow Measurement	STEAM FLOW -1	Existing Mfg	Analog (4-20mA)
13	Steam Flow Measurement	STEAM FLOW -2	Existing Mfg	Analog (4-20mA)
14	Steam Flow Measurement	STEAM FLOW -3	Existing Mfg	Analog (4-20mA)
15	Domestic Cold Water Meter -1	DCW -1	Existing or New - Mfg: DLJ	Pulse
16	Domestic Cold Water Meter -2	DCW -2	Existing or New - Mfg: DLJ	Pulse
Comms 1	Boiler Natural Gas Meter	BLR NG -4	Existing or new -Onicon F5200 via D100	BACNET MS/TP
Comms 2	Boiler Natural Gas Meter	BLR NG - 5	Existing or new -Onicon F5200 via D100	BACNET MS/TP
Comms 3	Boiler Natural Gas Meter	BLR NG - 6	Existing or new -Onicon F5200 via D100	BACNET MS/TP
Comms 4	Steam Flow Measurement	STEAM FLOW -4	Existing or New - Onicon F2700	BACNET MS/TP
Comms 5	Steam Flow Measurement	STEAM FLOW -5	Existing or New - Onicon F2700	BACNET MS/TP
Comms 6	Steam Flow Measurement	STEAM FLOW -6	Existing or New - Onicon F2700	BACNET MS/TP
Comms 7	Chilled Water BTU Meter	CHILLED WATER BTU - 1	Existing or new ONICON SYSTEM 10	BACNET IP
Comms 8	Chilled Water BTU Meter	CHILLED WATER BTU - 2	Existing or new ONICON SYSTEM 10	BACNET IP
Comms 9	Chilled Water BTU Meter	CHILLED WATER BTU - 3	Existing or new ONICON SYSTEM 10	BACNET IP
Comms 10	Hot Water BTU Meter	HOT WATER BTU-1	Existing or new ONICON SYSTEM 10	BACNET IP
Comms 11	Hot Water BTU Meter	HOT WATER BTU-2	Existing or new ONICON SYSTEM 10	BACNET IP
Comms 12	Hot Water BTU Meter	HOT WATER BTU-3	Existing or new ONICON SYSTEM 10	BACNET IP

Part 3 - Execution

3.1 Installation

A. All Electrical and Mechanical Meters shall be installed, wired and tested by a qualified contractor.

B. All control power, current transformer, potential transformer, voltage tap and data communications wire shall be wired and installed in accordance with applicable codes & standards and comply with HCA guidelines.

C. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.

D. All wiring required to externally connect equipment lineups shall be installed by the electrical contractor.

E. Contractor interconnection wiring requirements shall be clearly identified on the system drawings.

F. Mechanical metering where meters are powered and by less than 110 VAC shall be the responsibility of the controls contractor / mechanical contractor to ensure proper power source and wiring is furnished and installed. This is to include the low voltage communication wiring respectively.

3.2 System Start-Up & Commissioning

A. The metering start-up and commissioning by factory authorized technicians or HCA Certified Metering Contractors for the electrical and mechanical meters is required as indicated in this section. <u>The Contractors shall be present during on-site commissioning to assist factory technicians and correct any installation issues identified.</u>

1. The *Electrical Metering Prestart-up Check List* must be completed by the Electrical Contractor prior to scheduling a start-up. See Appendix F-3 for
2. The *Mechanical Metering Schedule* must be verified by the Mechanical Contractor prior to scheduling a WAGES Panel start-up.
3. The *BAS/WAGES Schedule* must be verified by the Controls Contractor prior to scheduling a WAGES Panel start-up.
4. Start-up & commissioning shall include a complete working demonstration of the meter system with simulation of possible operating conditions that may be encountered and verified remote communications to the HCA Energy Service Center. Projects involving the Emergency Power Supply System (EPSS) shall also include a full witnessed EPSS system testing by the Contractor and Schneider Electric technician. The metering system must provide EPSS test reporting that accurately records generator and ATS status event time

stamping, generator electrical one minute interval readings, and engine control one minute interval readings. An EPSS test report shall be provided demonstrating these capabilities. Any discrepancies in the metering system and EPSS reporting must be investigated and fully resolved. Corrective actions shall include:

a. Correct wiring related to inaccurate reading or status and retesting affected equipment
b. Correct communication cabling connections to correct issues and retesting affected equipment
c. Identify status signal not properly operating on new equipment, coordinate manufacturer repairs and retesting affected equipment
d. Identify communications port not communicating properly, have equipment manufacturer correct issues and retesting affected equipment
e. Identify status signal not properly operating on existing equipment, coordinate manufacturer quote for repairs, and retesting affected equipment upon repairs being completed.
f. Identify communications port not communicating properly, coordinate manufacturer quote for repairs, and retesting affected equipment upon repairs being completed.

5. Existing meters that are incorporated require verification for accuracy of readings and compatibility of the meter communications. Note: commissioning documentation is required for reused meters.
6. Emergency Power Supply System (EPSS) metering must be verified "witnessed" under actual test conditions including generator loading and ATS transfer and retransfer operations for all affected equipment.
7. For Factory installed Electrical Metering - The Electrical Contractor's project bid shall include at minimum 1 day's on-site commissioning assistance for every 10 meters involved and be present for the EPSS Witness Testing.
8. For projects that include any Retrofit Electrical Metering - The Electrical Contractor's project bid shall also include an onsite preconstruction meeting with Schneider Electric to review the retrofit installation requirements and *Prestart-up Check List (refer to Appendix F-3).*

B. Meter commissioning documents with location, configuration settings, verification methods, initial readings, and technician name & company shall be provided with record documents. Commissioning documentation to be furnished to the HCA FacilitiGroup, Energy Service Center shall include:

1. Electrical Metering Commissioning SHALL be included in the electrical contractor's bid
    a. Meter startup data (Date, Model, Serial, Name, Location, Type of communication, etc.)
    b. Meter configuration data (IP Address, Subnet Mask, Default Gateway, Modbus ID, configuration settings, etc.)
    c. Status Monitoring points confirmed for ATS switches and Generators.
    d. Record Power Main size, ATS Size, Chiller FLA, Branch Main size, voltage, CT type and size, Area Served, breaker label, model, type, and serial number.
    e. Record Main Switchgear, ATS, and equipment metered manufacturer, model, serial, name, location, type of communication, and area served.
    f. Ensure CT shorting blocks have been installed on all CT's associated to all meters associated to this scope of work.
    g. Certification that meter has been installed, communicating and operating according to the manufacture's specification. All EPSS status monitoring shall be included in this certification. This certification shall include verification methods, verified readings and technician name & company
2. Mechanical Metering – SHALL be included in the mechanical contractor's bid:
    a. Meter startup data (Date, Model, Serial, Name, Location, Type of communication, etc.)
    b. Meter configuration data (IP Address, Subnet Mask, Default Gateway, Modbus ID, configuration settings, etc.)
    c. Record line sizes, piping material, design flow rates, pulse weights for flow calculations (where necessary), etc.
    d. Record Equipment served; Boiler, chiller, etc. model, serial, name, location, type of communication, and area served.
        i. Ensure meters are properly connected to their respective W.A.G.E.S. Panel or the HCA Network (where approved)
        ii. Ensure meters have been properly insulated where required

iii. Certification that meter has been installed, communicating and operating according to the manufacture's specification. This certification shall include verification methods, verified readings, and technician name & company.

3. ESC Software Commissioning Requirements – SHALL be included in the electrical contractor's bid. Approved ESC Software Commissioning provider: Schneider Electric, Power Monitoring & Controls Division.
   a. Software commissioning services are required for all meters involved in this specification. Software commissioning services include both existing Power Monitoring Expert (PME) and Enterprise Energy Management (EEM) software. Software commissioning services required are detailed in Appendix F-3 - Commissioning Requirements.
   b. Acceptance of the Energy Monitoring System shall require complete system connectivity to the HCA FacilitiGroup, Energy Service Center (ESC). For this process the ESC can be reached at Energy@HCAHealthcare.com and by phone at 615-344-5068.

3.3 Operation & Maintenance

A. Meter Data sheets, Installation Manual, and Operation Manual shall be included in the Operation and Maintenance (O&M) documents provided for each meter type.

B. Demonstration of each meter type display is to be provided to the facility manager and his / her staff.

APPENDIX F-2: ELECTRIC METERING EXAMPLES

Part 1 - General

1.1 Normal Power – Main Metering

A. Single Main

1. Separate Metering Panel "1M" mounted and wired by the Electrical Contractor for both new and existing Normal Power Main. A separate Metering Panel is to be the basis of design. (See *Diagram 1: Normal Power - Single Main*)
2. New switchgear:
   a. Customer Metering Provisions: Provisions for connection to the "1M" Metering Panel are to be provided with the switchgear

including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections on the line-side of the main (include voltage transformers when above 600v) and wired to a fused disconnect.

b. Integrated Metering: Alternate option to supply the required metering as factory installed, wired and tested in new switchgear shall be permitted. Intelligent trip units that are supplied should also be wired for communications when this option is selected. UPS power for communicating equipment in the switchboard must also be provided. (See *Diagram 2: Integrated Normal Main*)

3. Existing switchgear:
   a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be retrofit by the Electrical Contractor into the existing power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required on the line-side of the disconnect (include voltage transformers when above 600v) and are wired to a fused disconnect. (See *Diagram 1: Normal Power - Single Main*)
   b. Existing Compliant Metering: Where Mains metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (See *Diagram 3: Re-use of Existing Meter Inputs*)
4. Continuous Control Power Requirements (Not Required for FSEDs): Main metering devices shall have a UPS incorporated providing continuous 120Vac control power to metering equipment. The Electrical Contractor shall wire the UPS input from an emergency power circuit. If the emergency power source is greater than 120Vac then a control power transformer (CPT) shall also be provided to transform the supplied voltage to 120Vac.

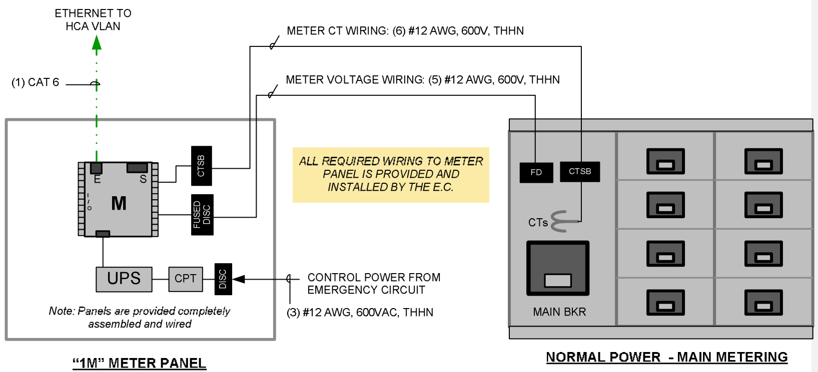


DIAGRAM 1: NORMAL POWER - SINGLE MAIN

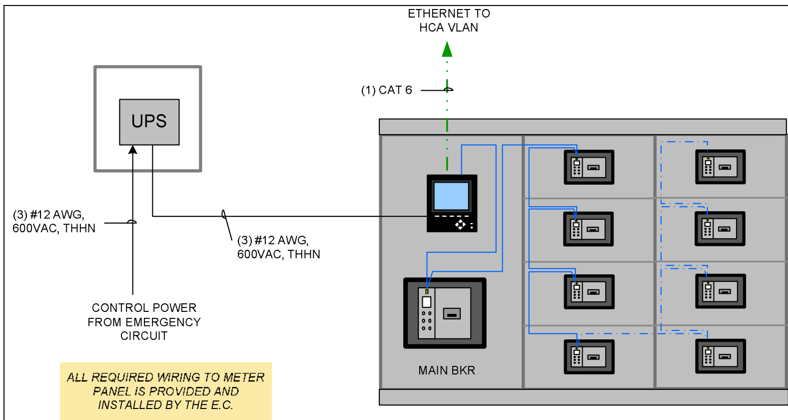


DIAGRAM 2: INTEGRATED NORMAL MAIN

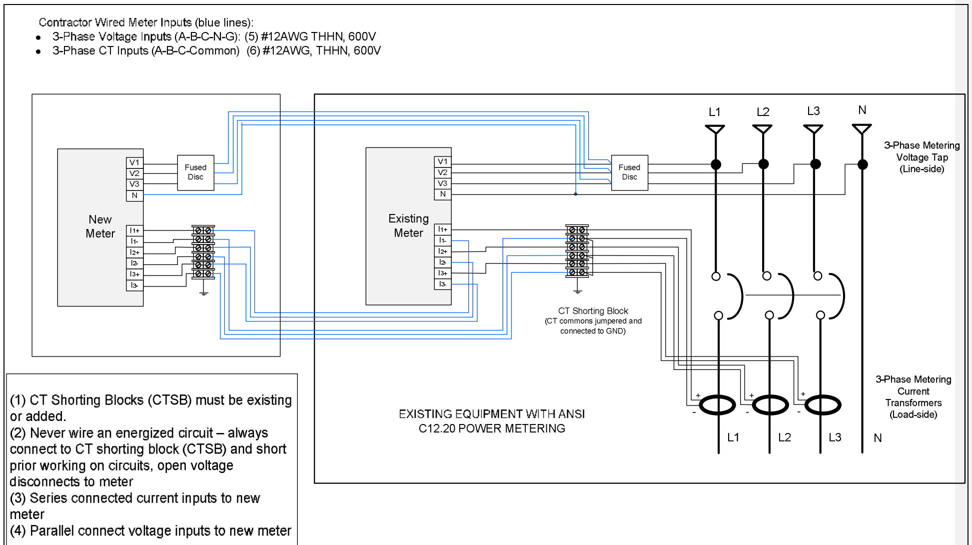


DIAGRAM 3: RE-USE OF EXISTING METER INPUTS

B. Normal Power – Multiple Mains

1. Metering Panel for 2, 3 or 4 Normal Mains ("2M", "3M, "4M" Metering Panels respectively) are mounted and wired by the Electrical Contractor for both new and existing Normal Power Mains. A separate Metering Panel is to be the basis of design. (See *Diagram 4: Normal Power – Multiple Mains*).

   a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be provided with the switchgear including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections on the line-side of the main (include voltage transformers when above 600v) and wired to a fused disconnect.

   b. Integrated Metering: Alternate option to supply the required metering as factory installed, wired and tested in new switchgear shall be permitted. Intelligent trip units that are supplied should also be wired for communications when this option is selected. UPS power for communicating equipment in the switchboard must also be provided. (See *Diagram 2: Integrated Normal Main* – typical approach for each Normal Main)

2. Existing switchgear:
    a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be retrofit by the Electrical Contractor into the power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required on the line-side of the disconnect (include voltage transformers when above 600v) and are wired to a fused disconnect. Note: reuse existing metering class current transformers and metering voltage taps when possible. Shorting blocks for CTs and terminal blocks for VTs shall be added by the Electrical Contractor if not currently existing. (See *Diagram 4: Normal Power - Multiple Mains*)
    b. Existing Compliant Metering: Where Mains metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (*See Diagram 3: Re-use of Existing Meter Inputs*)
3. Continuous Control Power Requirements (Not required for FSED): Main metering devices shall have a UPS incorporated providing continuous 120Vac control power to metering equipment. The Electrical Contractor shall wire the UPS input from an emergency power circuit. If the emergency power source is greater than 120Vac then a control power transformer (CPT) shall also be provided to transform the supplied voltage to 120Vac.

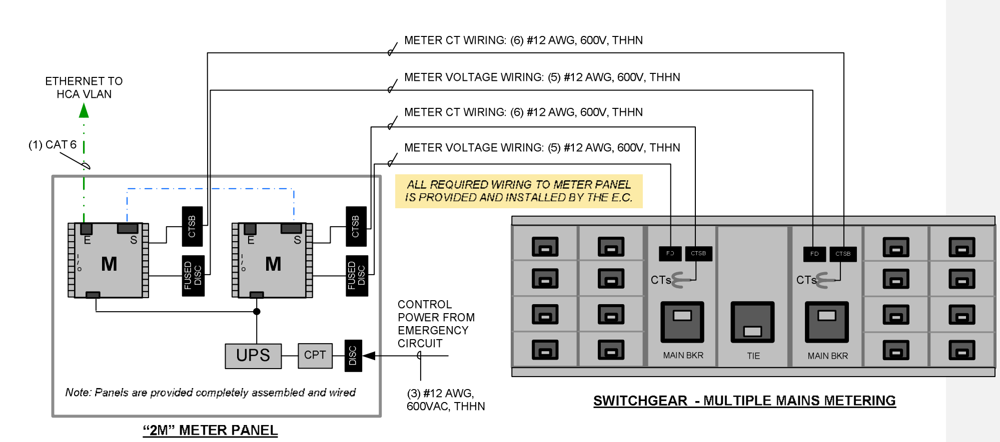


DIAGRAM 4: NORMAL POWER - MULTIPLE MAINS

1.2 Emergency Gen Mains Metering

A. Single Gen Main Metering

1. Separate Metering Panel "1G" mounted and wired by the Electrical Contractor for both new and existing Emergency Power Mains and Generator Engine Controller. A separate Metering Panel is to be the basis of design. (See *Diagram 5: Emergency Power - Single Gen Set*)
2. New switchgear:
   a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be provided with the switchgear including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections on the line-side of the main (include voltage transformers when above 600v) and wired to a fused disconnect.
   b. Integrated Metering: Alternate option to supply the required metering as factory installed, wired and tested in new switchgear shall be permitted. Intelligent trip units that are supplied should also be wired for communications when this option is selected. UPS power for communicating equipment in the switchboard must also be provided. (*See Diagram 6: Integrated Gen Main*)
3. Existing switchgear:

a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be retrofit by the Electrical Contractor into the existing power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required on the line-side of the disconnect (include voltage transformers when above 600v) and are wired to a fused disconnect. (See *Diagram 5: Emergency Power - Single Gen Set*)

b. Existing Compliant Metering: Where Mains metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (See *Diagram 3: Re-use of Existing Meter Inputs*)

4. Continuous Control Power Requirements (Not required for FSEDs): Main metering devices shall have a UPS incorporated providing continuous 120Vac control power to metering equipment. The Electrical Contractor shall wire the UPS input from an emergency power circuit. If the emergency power source is greater than 120Vac then a control power transformer (CPT) shall also be provided to transform the supplied voltage to 120Vac.

5. Generator engine controller communications wiring and generator running/stopped status signal are to be wired from gen controller to Meter Panel by Electrical Contractor.

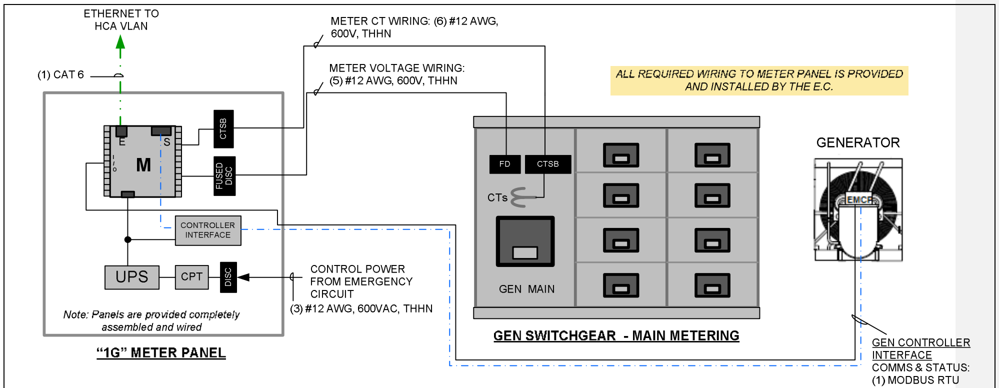


DIAGRAM 5: EMERGENCY POWER - SINGLE GEN SET

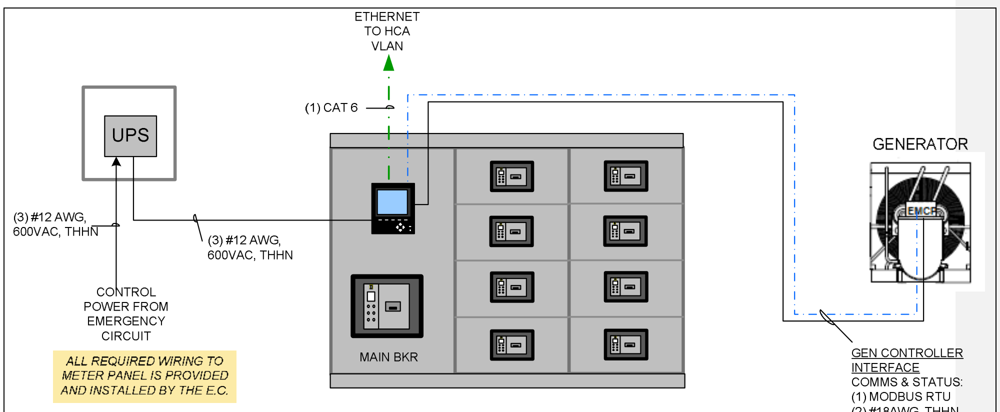


DIAGRAM 6: INTEGRATED EMERGENCY MAIN

B. Multiple Gen Mains Metering

1. Separate Metering Panels for 2 and 3 generator systems ("2G" and "3G" Metering Panels respectively) are to be mounted and wired by the Electrical Contractor for both new and existing Emergency Power Mains and Generator Engine Controller. A separate Metering Panel is to be the basis of design. (See *Diagram 7: Emergency Power – Multiple Gen Set Mains*)

2. New switchgear:
   a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be provided with the switchgear including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections on the line-side of the main (include voltage transformers when above 600v) and wired to a fused disconnect.
   b. Integrated Metering: Alternate option to supply the required metering as factory installed, wired and tested in new switchgear shall be permitted. Intelligent trip units that are supplied should also be wired for communications when this option is selected. UPS power for communicating equipment in the switchboard must also be provided. (See *Diagram 6: Integrated Gen Main* – typical approach for each Generator Main)
3. Existing switchgear:
   a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be retrofit by the Electrical Contractor into the existing power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required on the line-side of the disconnect (include voltage transformers when above 600v) and are wired to a fused disconnect. (See *Diagram 7: Emergency Power - Multiple Gen Set Mains*)
   b. Existing Compliant Metering: Where Mains metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (See *Diagram 3: Re-use of Existing Meter Inputs*)
4. Continuous Control Power Requirements (Not required for FSEDs): Main metering devices shall have a UPS incorporated providing continuous 120Vac control power to metering equipment. The Electrical Contractor shall wire the UPS input from an emergency power circuit. If the emergency power source is greater than 120Vac then a control power transformer (CPT) shall also be provided to transform the supplied voltage to 120Vac.

5. Generator engine controller communications wiring and generator running/stopped status signal are to be wired from each gen controller to corresponding meter in the Gen Meter Panel by Electrical Contractor.

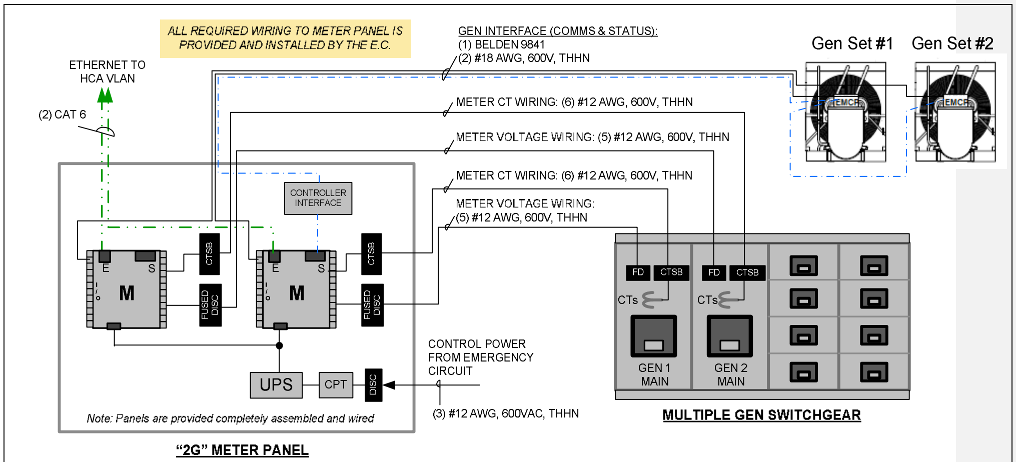


DIAGRAM 7: EMERGENCY POWER – MULTIPLE GEN SETS MAIN

1.3 Automatic Transfer Switches

A. Single ATS Monitoring

1. Separate Metering Panel "1-ATS" mounted and wired by the Electrical Contractor for both new and existing Automatic Transfer Switches (ATS). A separate Metering Panel is to be the basis of design. (See *Diagram 8: Single ATS Metering*)

2. New ATS Switch:

   a. Customer Metering Provisions: Provisions for connection to the ATS Metering Panel are to be provided with the ATS including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections on the load-side of the main and wired to a fused disconnect.

3. Existing ATS Switch:

   a. Customer Metering Provisions: Provisions for connection to the ATS Metering Panel are to be retrofit by the Electrical Contractor into the existing power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. Three phase voltage connections are required on the load-side of the ATS and are wired to a fused disconnect. Note: The metering CTs and voltage connections may be made in the downstream panelboard fed by the ATS in the event that these components cannot be installed inside the ATS enclosure. (See *Diagram 8: Single ATS Metering*)

b. Existing Compliant Metering: Where ATS metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (See *Diagram 3: Re-use of Existing Meter Inputs*)

4. Continuous Control Power Requirements (Not required for FSEDs): ATS metering devices shall have a UPS incorporated providing continuous 120Vac control power to metering equipment. The Electrical Contractor shall wire the UPS input from an emergency power circuit. If the emergency power source is greater than 120Vac then a control power transformer (CPT) shall also be provided to transform the supplied voltage to 120Vac. Note: 1-ATS Meter Panels can be ordered with or without a UPS included.

5. ATS switch status and test control wiring shall be wired from the ATS Meter Panel to the corresponding ATS by the Electrical Contractor. The status contacts include: On Normal Source, On Emergency Source. The ATS Remote Test switch located on the ATS Metering Panel is wired to the corresponding ATS "remote test" input. Connections terminals should be conformed with the ATS manufacturers.

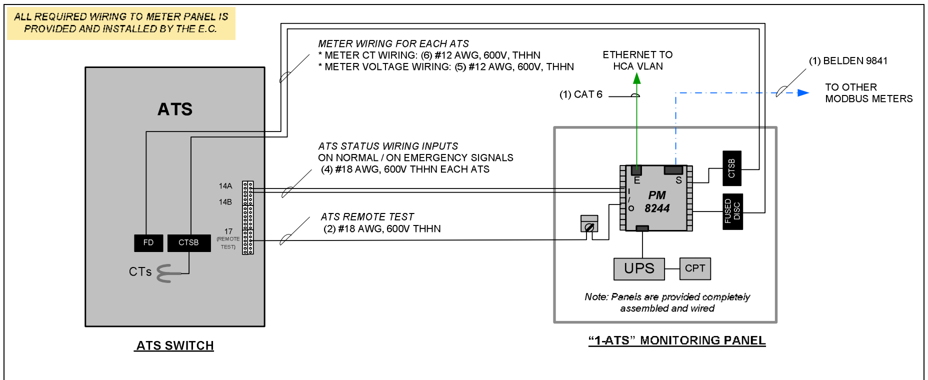


DIAGRAM 8: SINGLE ATS METERING

B. Multiple ATS Monitoring

1. Separate Metering Panels with 2-10 meters ("2-ATS" through "10-ATS") are mounted and wired by the Electrical Contractor for both new and existing Automatic Transfer Switches (ATS). A separate Metering Panel is to be the basis of design. (See *Diagram 9: Multiple ATS Metering*)
2. New ATS Switches:
    a. Customer Metering Provisions: Provisions for connection to the ATS Metering Panel are to be provided with the ATS including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections on the load-side of the main and wired to a fused disconnect.
3. Existing ATS Switch:
    a. Customer Metering Provisions: Provisions for connection to the ATS Metering Panel are to be retrofit by the Electrical Contractor into the existing power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required on the load-side of the and are wired to a fused disconnect. Note: The metering CTs and voltage connections may be made in the downstream panelboard fed by the ATS in the event that these components cannot be installed inside the ATS enclosure. (See *Diagram 9: Multiple ATS Metering*)

b. Existing Compliant Metering: Where ATS metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (See *Diagram 3: Re-use of Existing Meter Inputs*)

4. Continuous Control Power Requirements (Not required for FSEDs): ATS metering devices shall have a UPS incorporated providing continuous 120Vac control power to metering equipment. The Electrical Contractor shall wire the UPS input from an emergency power circuit. If the emergency power source is greater than 120Vac then a control power transformer (CPT) shall also be provided to transform the supplied voltage to 120Vac.

5. ATS switch status and test control wiring shall be wired from the ATS Meter Panel to the corresponding ATS by the Electrical Contractor. The status contacts include: On Normal Source, On Emergency Source. The ATS Remote Test switch located on the ATS Metering Panel is wired to the corresponding ATS "remote test" input. Connections terminals should be conformed with the ATS manufacturers.

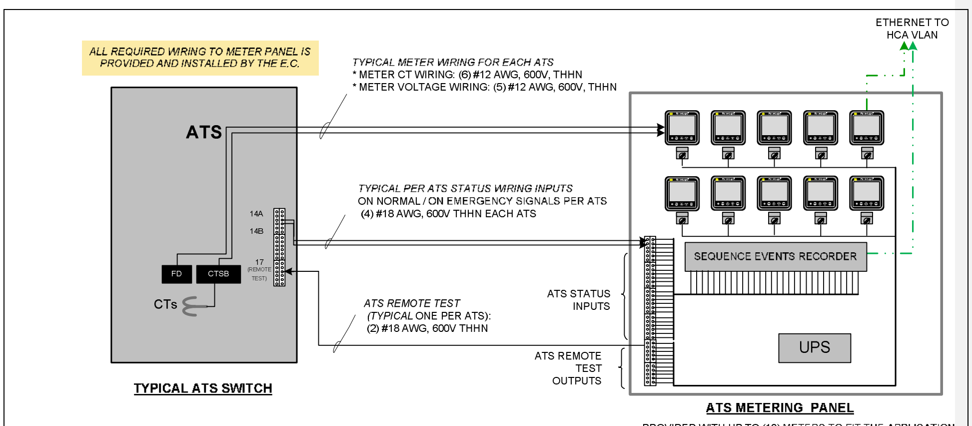
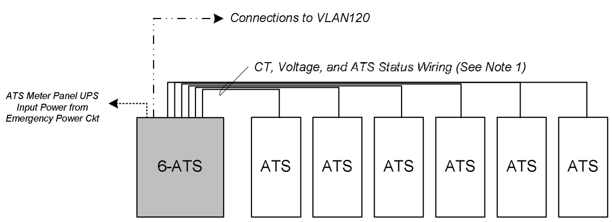
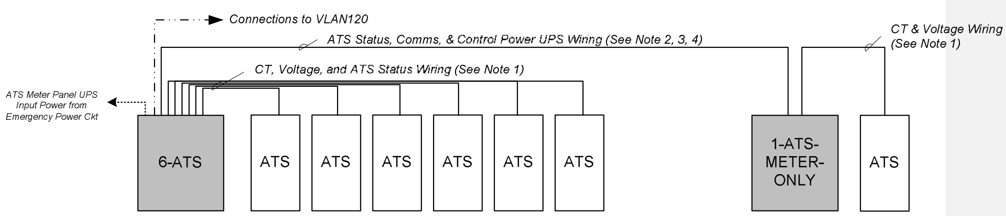


DIAGRAM 9: MUTLIPLE ATS METERING

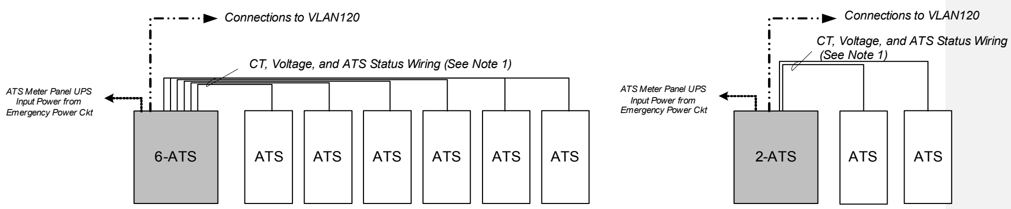
C. Grouping of the ATS Meters – Generally ATS switch metering is grouped in panels for 1-10 meters per panel based upon the equipment location and available space for mounting the ATS Metering Panels. Metering wiring should not exceed 100ft. Status wiring should not exceed 1000 ft. Modbus RTU comms wiring should not exceed 2,500 ft. The UPS typically supplied with ATS Meter Panels can power up to 10 meters. ATS switches that are remote from the ATS Metering Panel should be approached as shown in the following examples:



Example 1: ATS Multi-Metering Panel with ATS within 100ft



Example 2: ATS Multi-Metering with 1 ATS beyond 100ft



Example 3: ATS Multi-Metering with totally remote ATS (See Note 5)

Notes:

(1) Do not extend metering CT wire lengths beyond 100ft. Runs over 50 ft require #10 AWG wiring.

(2) 1 or 2 ATS beyond 100ft require a remote metering panel. When possible the ATS status contacts can be connected a the Standard Multi-meter enclosure as shown in Example 2.

(3) Remote meters (i.e.1-ATS-METER-ONLY or 2-ATS-METER-ONLY) can have meter communications connected to the HCA VLAN120 by using Modbus RTU comm wiring to the EGX in the Standard Meter Panel as shown in Example 2.

(4) Remote meters (i.e. 1-ATS-METER-ONLY or 2-ATS-METER-ONLY) can have continuous meter control power provided from the UPS in the Standard Meter Panel as shown in Example 2.

(5) 3 or more and totally remote ATS that cannot be wired as shown in Example 2 shall have standard ATS Meter panels added (i.e. 1-ATS thru 10-ATS)

1.4 Small EPSS Systems (FSER/FSED)

A. Small Emergency Power Systems with a single generator and three ATS switches can be monitored by a single metering “FSED Emergency” Meter panel mounted and wired by the electrical contractor (E.C.) for both new and existing emergency equipment power.

B. New power equipment: customer metering provisions are to be provided with the Gen Main Switchboard and ATS switches including 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks and 3 phase voltage connections and wire to a fused disconnect.

C. Existing power equipment: metering provisions are to be retrofit by the E.C. into the power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required (include voltage transformers when above 600v) and are wire to a fused disconnect. Note: reuse existing metering class current transformers and metering voltage taps when possible.

D. Contractor shall wire each ATS "on normal" & "on-emergency" status contacts and ATS remote test control + Gen Set running / stopped status wired from equipment to the meter panel

E. Generator controller comms are to be wired from gen controller to meter panel by Electrical Contractor.

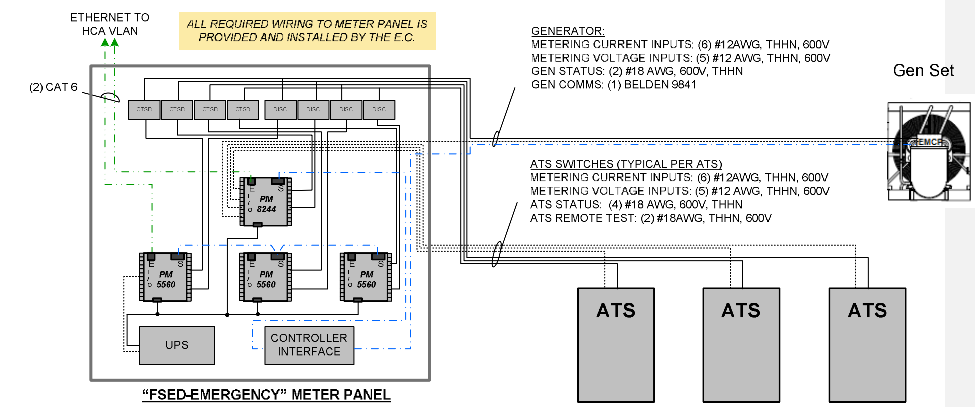


DIAGRAM 10: SMALL EMERGENCY POWER SYSTEM (FSER/FSED)

1.5 Chiller Sub-Metering

A. Chiller Mains

1. Separate Metering Panels for 1, 2, 3 and 4 Chiller systems ("1CH", "2CH", "3CH" and "4CH" respectively) shall be mounted and wired by the Electrical Contractor for both new and existing Chiller Mains. A separate Metering Panel is to be the basis of design. (See *Diagram 11: Chiller Main Metering*)

2. New Chiller Mains from Switchgear:

    a. Customer Metering Provisions: Provisions for connection to the Chiller Metering Panel is to be provided with any new switchgear including current transformers for the Chiller feeder circuits sized for the application and wired to CT shorting blocks, and 3 phase breaker provided for the meter voltage input for the Chiller Metering Panel (include voltage transformers when above 600v) and wired to a fused disconnect.

3. Existing Chiller Mains:

   a. Customer Metering Provisions: Provisions for connection to the Metering Panel are to be retrofit by the Electrical Contractor into the existing power equipment including contractor supplied, 3-phase metering class current transformers (CTs) sized for the application and wired to CT shorting blocks - the E.C. is responsible for verifying CT size and type for the installation requirements. 3 phase voltage connections are required on the line-side of the disconnect (include voltage transformers when above 600v) and are wired to a fused disconnect.

   b. Existing Compliant Metering: Where Chiller Main metering is existing it may be reused provided that it fully complies with Sections 1 and Sections 2 of the Metering Guidelines and readings can be verified accurate. If the metering does not comply then the instrument transformers can be shared to accommodate the separate metering panel. (See *Diagram 3: Re-use of Existing Meter Inputs*)

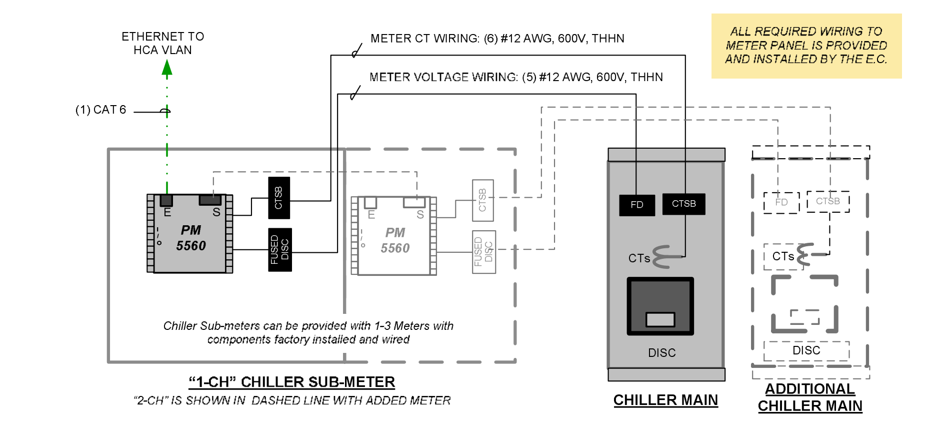


DIAGRAM 11: BASIC SUBMETERING (Chiller Mains, etc.)

APPENDIX F-3: METER COMMISSIONING

Part 1 - General

1.1 Summary of Activities – Electrical Metering Startup & System Commissioning

Summary of Activities	
On-Site Pre-Construction Visit (by Schneider Electric)	**Required for any project with Retro-fit metering.** Estimated time (inc travel time) to review metering scope at site with Contractor and detail installation and commissioning requirements.
On-Site Meter Configuration (by Schneider Electric)	**Required for all projects unless self-performed by Contractor that's been certified "HCA Qualified".** Estimated time (inc travel time) at the site to complete On-site Scope of Work (SoW). Requires Contractor to complete and return to Schneider Electric the Pre-Start-up Check List when scheduling visit.
On-Site Configuration (Self-Performed by Contractor)	**Only certified "HCA Qualified" Contractor may self-perform On-site Scope of Work (SoW) start-up tasks in lieu of Schneider Electric.** Does not include EPSS Witness Test which must be performed with SE on-site.
On-Site EPSS Witnessed Testing (by Schneider Electric)	**Required only for Hospital Project with EPSS scope**. On-Site EPSS Witness Testing to verify meter readings and event recording necessary to generate EPSS Test Report. This task is typically done during evening hours and a separate trip from meter on-site commissioning.
In-Office Project Management (by Schneider Electric)	**Required for all projects.** Professional project management services that include administration of orders, coordination & scheduling and managing Metering Scope of Work (SoW) activities.
In-Office Multi-Vendor Integration Design (by Schneider Electric)	Required for all projects. Estimated time to configure PME/EEM/AVM system and upload electric utility files (if applicable).
In-Office Multi-Vendor Integration Design (by Contractor)	ESC Approved Project Management
In-Office Hrs	Estimated time to configure PME/EEM/AVM system and upload electric utility files (if applicable).
Screen Development & Drawings Hrs	New or Updated PME Vista Screen work & Approval /Record Drawings
EPSS Config (In-Office) Hrs	Configure EPSS Reporting module
In-Office - EEM Modeling	Estimated time to organize and develop energy model for new circuits. Required for Normal power mains, chillers and boilers.
Project Management (Hrs)	ESC Approved Project Management

1.2 Startup & Commissioning Roles & Responsibilities

A. Typical Project Requirements:
   1. Information Gathered and Verified for Metering Integration(1)
   2. System Diagram Developed by Schneider Electric
   3. Pre-Start-up Check List (1)
   4. On-site Meter Start-up (2)
   5. EPSS Witnessed Testing (Not required for FSEDs)
   6. Marked up As-Builts with actual wiring and connections documented (1)
   7. Owner Meter Training (2)

[1] Performed by the Contractor with Schneider Electric assistance
[2] Can be performed by Schneider Electric <u>or</u> by a "Certified HCA Metering Contractor"

1.3 Pre-startup Check List

Pre-Startup Checklist

HCA Site:
Q2C#:

Network Comms Preparation & Coordination

Please confirm the following:

- Contact HCA Energy Service Center for IP Address assignments (energy@hcahealthcare.com)
- Verify all required Ethernet drops have been run to the appropriate locations and are connected to metering equipment and operational on the HCA Dedicated to "*All Things Energy*" VLAN network
- Documented Static or fixed IP addresses have been reserved for each POWERLOGIC Ethernet communications device. (Please list Ethernet IP addresses on As-Built document and send a copy to the Schneider Electric Project Manager.)

Metering Integration Preparation & Coordination

- Have an up to date one-line diagram for the site power system available
- Have power equipment as-builts available for any SWGR, Gen sets and ATS switches involved in the metering project

Local HCA Site Coordination

Confirm that during the trip to your site, there will be support personnel available, such as

- a network administrator should any networking issues arise
- an electrician or the Electrical Contractor familiar with the installation
- one or more customer representatives available for input and brief overview of the system
- Where the metering system includes Generators or ATS switches then a witnessed EPSS test is required. Please coordinate the test time and date with HCA personnel to assure the verification of status signals can be verified under actual operation (not simulated status contacts).

Pre-Startup Checklist

HCA Site:
Q2C#:

Provided by Electrical Contractor (Installer)

Meter Panel Installation and Wiring - Site Specific

Please confirm and check off the following:

___ All monitoring devices have control power and are energized

___ Verify all CTs and PTs are installed correctly on the conductors to be monitored

___ Electrical meters are connected to necessary instrument transformers (CTs/PTs) and CT shorting blocks and PT disconnect switches are properly installed on all meters.

___ Please record and provide all instrument transformer ratios for each circuit to be monitored.

___ Verify all electrical meters are properly mounted and installed, connected to suitable control power and are energized.

___ Any UPS supplied in panels is wired to other metering devices (Mains and EPSS meters) for continuous control power

___ All UPS input power is wired to an emergency power circuit as required in HCA metering guidelines and installation instructions

Gen & ATS (EPSS) Equipment

The site's emergency generators and automatic transfer switches (ATS) are monitored with power meters, sequence event monitoring and engine control panel communications. Please verify the following work is completed prior to the meter commissioning on-site visit:

___ Verify Generator status wired to new Emergency Power Metering Panel terminals and verified for each of the following: Gen Running, Gen Stopped status. Please refer to the HCA installation instructions for reference.

___ Verify ATS status wired to new Emergency Power Metering Panel terminals and verified for each of the following: ATS on Normal, ATS on Emergency, ATS Remote Test or Test Active. Please refer to the HCA installation instructions for reference.

___ Verify all EPSS meters are wired with UPS control power from new Emergency Power Metering Panels and the UPS input is wired to 120 Vac emergency power branch circuit.

___ Verify Generator Engine Control Panel (ECP) readings available via Modbus TCP. Note any exceptions where existing Gen Engine Control Panel does not support remote monitoring over Ethernet.

Schneider Electric Energy & Sustainability Services   Page 2 of 3

___ Verify all Normal Mains metering and EPSS equipment has the correct control power wired and is on UPS power as required in HCA metering guidelines

Please provide the following site documentation:

___ Record manufacturer of each Gen set, site location and equipment name, Gen model number, ratings kVA / kW, engine controller panel type and Gen Main electric meter installed (i.e. ION7650)

___ Record manufacturer of each ATS, site location and equipment name, ATS model number, Amp rating, in-phase transfer capability

Communications Wiring between Panels

Modbus RTU serial communications is used between meters for communications. Verify the and check off that the following requirements have been met:

___ All cable used to connect devices is Belden 9841 or equivalent

___ Cable is routed between lineups of switchgear or to any other devices to be included in the daisy chain.

___ Cable is routed from the first device on the daisy chain to the master device (i.e. Ethernet interface, etc.)

___ Cable routing is run serially (daisy chain) from device to device and not in a star configuration.

___ Last device on the daisy chain is terminated with a line terminator (MCTAS-485).

___ Less than 0.5 inch of exposed conductor at the termination point.

___ No "T" connections on any device

___ Shield wires attached to shield terminal at each device and are not shorted to any metallic device, such as an enclosure door.

___ There are no splices in the daisy chain wiring

Signature: ____________________________________ **Date:** __________

1.4 Electrical Metering Start-up & Commissioning

A. Scope of Work

1. As part of this project Scope of Work (SOW) Schneider Electric Application Engineers will perform on-site meter commissioning to assure the metering equipment performs to the requirements of HCA. This includes configuring power meter communications, settings for the meter instrument transformer ratios, onboard data logging, and meter alarming features. The success of the commissioning is dependent on the complete and correct installation of the equipment by the Electrical Contractor prior to the commissioning visit.

B. Prior To Startup

1. The Pre-startup Checklist and other preparation must be completed prior to the on-site commissioning by Schneider Electric. This includes:

    a. **Pre-startup Checklist** will be provided by the Electrical Contractor to verify the installer has followed Schneider Electric installation manuals and HCA installation guidelines. The Electrical Contractor must complete the actions on the Pre-startup Checklist and submit a signed copy to the Schneider Electric Project manager at least 10 business days prior to the scheduled startup date. It is critical that these items be completed to ensure that the Schneider Electric engineer will be able to perform all required work during the visit to your site. If all items on the Pre-startup Checklist are not completed prior to the engineer's arrival, the engineer will not be able complete your project during that visit. **Additional trips required as a result of the Pre-startup Checklist items not being completed may result in additional charges.**

    b. **Meter Network Diagram** will be provided by Schneider Electric as part of the approval process of this project. This information should be reviewed and marked-up by the Electrical Contractor to indicate the following:

        i. Local of network drops and the IP addresses assigned

        ii. Modbus serial wiring as-builts with the daisy-chain order with meter locations and names indicated

iii. Meter summary with equipment names (i.e. Hospital Main MSB-A), meter model#, power system types and sizes for current transformers and potential transformers.

C. Project / Order Management

1. A Schneider Electric Project Manager (PM) is assigned to this project to assure the ordering and start-up is efficient and productive for both Schneider Electric and the Electrical Contractor. The PM shall coordinate with other Schneider Electric plants and the Electrical Contractor's point of contact. The bill-of-materials will be reviewed and approval drawings generated for the contractor's review and signed approval for release to manufacturing. Point of Contact, shipping information and scheduling requirements should be provided at time of order.

D. Meter Startup

1. The Schneider Electric engineer will arrive on site at the agreed upon date and time. The engineer will conduct a quick review of the Scope of Work (SOW) with you to ensure that both parties are in agreement regarding the work to be performed. The following tasks will then be completed.

    a. Task #1 – Standard Meter Commissioning

        i. The standard meter templates will be loaded on to the meters that are included in the quoted project. The current transformer (CT) and potential transformer (PT) ratios and the System Type will be programmed into the devices. The Nominal Voltage and onboard clock will be configured on Schneider Electric meters. The meters will be analyzed to ensure that the CTs and PTs are properly wired to the meter. The Schneider Electric engineer will make any changes necessary to ensure that your meters are properly measuring voltage and current from the power system. The Schneider Electric engineer may require the assistance of site maintenance personnel if any CT or PT installation must be corrected.

    b. Task #2 – Communication Configuration and Verification

        i. The Schneider Electric engineer will establish communications between all devices quoted on the project and the remote HCA PME server. This includes configuring communication parameters on the devices and troubleshooting the wiring to ensure proper serial, Ethernet, or wireless communications. Network drops must be verified active prior to the site visit to avoid additional trips to the site. It is a good idea to have a network administrator available in order to troubleshoot any network problems that may arise with your LAN.

c. Task #3 – Firmware Update

   i. Powerlogic and ION meter firmware will be updated as required to ensure proper PME and system functionality.

d. Task #4 – Logging Setup

   i. The Schneider Electric engineer will configure a pre-specified list of quantities to be logged for each quoted device, which is device type dependent. Refer to "Appendix A – ION-E SSOW Logging Templates", for a complete list of the standard logging templates.

e. Task #5 – Alarming Setup

   i. Only onboard meter alarms will be configured for devices that are included in the quoted project. Refer to "Appendix B – ION-E SSOW Alarming Templates" for details about the alarms and setpoints.

f. Task #6 – Waveform Capture Configuration

   i. Waveform Capture (WFC) settings will be configured for devices that have WFC functionality. Refer to "Appendix B – ION-E SSOW Alarming Templates" for details regarding the standard WFC settings.

g. Task #7 – EPSS Hardware Startup

   i. The Schneider Electric engineer will attend an EPSS test on-site to be scheduled during the same trip as the rest of the metering start-up. The EPSS test can be conducted during either normal or evening working hours. The metering of generator and ATS loads will be observed along with Gen and ATS status event logs. The Electrical Contractor is responsible for making the required ATS and generator status connections and the Generator engines control panel communications interface. The Schneider Electric engineer will assist the Electrical Contractor to troubleshoot any metering and status monitoring issues identified during the test.

h. Task #8 – Customer Meter Orientation

   i. The Schneider Electric engineer while on-site will demonstrate meter display operation to the local staff and answer questions. Note: PME WebReach training is not included.

2. Basic PME Startup (Performed Remotely)

   a. Task #9 – Build the System

i. The Schneider Electric engineer will add all of the appropriate communication Sites and Devices into the PME software. Time Synchronization will be enabled and configured for devices that support this feature. Historical data will begin to be logged and saved in the software.

b. Task #10 – Database Maintenance Setup

   i. The ES engineer will work with you to setup an automated database backup and archive procedure for your PME system. By default, the Schneider Electric engineer will configure a weekly backup of the two databases associated with the PME software and will set the historical database to maintain 13 months of data before archiving.

c. Task #11 – System File Backup

   i. Backups of critical system files will be created by the Schneider Electric engineer. These files include: backups of the PME databases, copies of the Vista graphics screens, custom programming files, and a system diagnostics test. You will receive a copy of all of the backup files that the Schneider Electric engineer creates. It is important to safely store these files in case they are needed in the future.

d. Task #12 – PME Dashboard Configuration

   i. Three Dashboards will be configured in the PME Web Application. The purpose of the Dashboards is to provide a high level overview of the performance of the entire facility or building. The following three Dashboards will be included: Energy Consumption Dashboard, Facility Total Load Dashboard, and Power Quality Summary Dashboard. Additionally, the Schneider Electric engineer will create a Slideshow that will automatically rotate through the Dashboards when placed into the Slideshow View.

e. Task #13 – Graphic Screens Configuration and Verification

   i. Graphic screens ordered will be developed and configured using HCA approved background for normal power, emergency power and central plant one-lines. The functionality of the screens will be demonstrated to HCA to ensure that the metered quantities and statuses display properly. Screenshots of the properly configured graphic screens will be taken and saved as part of the project documentation.

f. Task #14 – EPSS Test Report Commissioning

i. Schneider Electric engineer shall use the *EPSS Configuration Utility* to configure the PME server for EPSS test reporting capabilities. This shall include adding new Gen mains metering & Gen status recording from ION7650 meters or PM8000 meters and ATS status recording from SER2408 modules or Power Meter digital inputs supplied in new Emergency Power Monitoring Panels. Where available, generator engine readings will be recorded from the engine control panels via Modbus TCP communications. A successful EPSS Test Report must be supplied to document this task.

3. Closeout
   a. Task #15 – Final Customer Signoff
      i. Prior to the Schneider Electric engineer leaving your site, you must sign off on project documentation indicating that the work has been performed according to this SOW. If all work on the project has not been completed, please sign off only on what work has been completed and note any outstanding issues.
   b. Task #16 Drawings + O&Ms
      i. Drawings and O&Ms for each site shall be provided to The Electrical Contractor in electronic format. The drawings shall include a system diagram indicating the network layout for the site's metering devices record drawings for custom meter enclosures. The O&Ms shall include product manuals for Schneider Electric monitoring devices supplied.

1.5 HCA Certified Electrical Metering Contractor:

A. Purpose of Certification:
   1. New approach starting in 2017 to allow qualified contractors to self-perform metering integration, start-up and integration tasks - if they choose.
   2. Intended to allow the Contractors to have more control/responsibility for the coordination and start-up of the electrical metering equipment
   3. Includes substantially lowered costs from Schneider Electric for the metering start-up & that is transferred to the Contractor scope

B. Contractor General Qualifications:
   1. Fully understand the electrical metering requirements on HCA projects

2. Demonstrated previous experienced with Schneider Electric metering equipment <u>and</u> other typical devices – e.g. Gen controllers, ATS controls
3. Capable of identifying the inter-connections for both new and existing monitored equipment from multiple vendors (with support from vendors)

C. Pathways for Certification:

1. PMU Certified Metering Installation Tech to be on-site during commissioning **+** Successfully completed previous HCA project with similar metering scope (e.g. Hospitals, FSED)
2. PMU Certified Metering Installation Tech with cross-trained personnel to be on-site during commissioning **+** Full HCA Project experience with similar scope (e.g. Hospital, FSED)
3. Successfully completed multiple HCA projects with similar metering scope (e.g. Hospital, FSED) with same personnel to be on-site for the project.

PMU – Power Management University offered by Schneider Electric

1.6 Electrical Metering Commissioning Estimator Worksheet:

HCA Project Name:		Sample Project	
Date:		**Location:**	

ELECTRICAL ONLY METERING - COMMISSIONING ESTIMATOR

STEP 1 of 3 - Project Type and Pre-Qualifications

Check only one Metering Project Type below

New Construction only		<- Check this box is all meters factory installed	Any Project Type with Meter Rerofits	X	<- Check this box is any meters for existing equipment

Check Contractor Certification Status for HCA Metering Start-ups

Certified HCA Metering Contractor	X	<- Check this box if Contractor Qualified to self perform meter Commissioning	Not Certified HCA Metering Contractor		<- Check this box is any meters for existing equipment

STEP 2 of 3 - Project Meter Counts

Meter Setup:		Certified Contractor Self Performed			Must be Performed by Schneider Electric				
Enter Meter Counts	Tasks ->	Meter Config On-Site (2)	EPSS Test Evening On-Site (3)	Multi-Vendor Coordination	Pre-Construction Site Visit (1)	Meter Config Daytime On-Site (2)	EPSS Test Evening On-Site (3)	Multi-Vendor Integration (4)	Project Management (5)
2	Utility Mains	2		1	8	2			2
2	Emergency Mains	4	0	1		4	0		2
2	Generators	4	8	2		4	8	4	2
6	ATS Switches	2	0.5	1		2	0.5	1	1
2	Chillers	0.5		0.5		0.5			1
0	Other Sub-meters	1		0.5		1			1
Total Estimated Hours -->		33	19	15	8	0	19	10.5	15

Include the following Metering Services in the Project Bid

Meter Start-up & Commissioning (Days) ->		Required On-site Meter Start-up work days by Contractor	In-Office by Contractor	Required On-site Meter Start-up work days performed by Schneider Electric	In-Office by Schneider Electric
On-site	Office	9	2	4	4

Metering Start-up Notes:

(1) No Schneider Electric pre-construction visit provided for new construction only projects
(2) No Schneider Electric on-site Meter start-up included if Certified HCA Metering Contractor is self-performing
(3) All projects include Hospital EPSS Witness Test when any Gen Set involved. Not Required for FSEDs
(4) Meter Integration to be included for EPSS projects unless performed by Certified HCA Metering Contractor
(5) Estimated PM reduced 25% for any Certified HCA Metering Contractor

STEP 3 of 3 - Software Commissioning Services

Only to be Performed by Schneider Electric

Meter Counts from Step 2		Tasks ->	PME Commissioning	Vista Screen Development	EPSS Commissioning	Utility DB Upload	EEM/AVM Commissioning	EEM Modeling
2	Utility Mains		1	2		1	4	2
2	Emergency Mains		1	2	1		1	
2	Generators		1	1	4		1	
3	ATS Switches		1	0.25	1		1	
2	Chillers		0.5	0.5			1	1
	Other Sub-meters		0.5	0.5			1	1
Total Estimated Hours (by Tasks) -->			10	11.75	13	2	17	6

Software Commissioning Services to be Include in the Project Bid

Schneider Electric Commissionig Services to be Include in the Project Bid ->	In-Office PME Commissioning	In-Office EPSS Commissioning	In-Office EEM Commissioning
	3	2	4

Commissioning Estimator – Step 1

Project Name & Location

Project Type

Contractor Type

HCA Project Name:			Sample Project		
Date:			**Location:**		
ELECTRICAL ONLY METERING - COMMISSIONING ESTIMATOR					
STEP 1 of 3 - Project Type and Pre-Qualifications					
Check only one Metering Project Type below					
New Construction only		<- Check this box is all meters factory installed	**Any Project Type with Meter Rerofits**	X	<- Check this box is any meters for existing equipment
Check Contractor Certification Status for HCA Metering Start-ups					
Certified HCA Metering Contractor	X	<- Check this box if Contractor Qualified to self perform meter Commissioning	**Not Certified HCA Metering Contractor**		<- Check this box is any meters for existing equipment

Certified Metering Contractor pricing (quoted through from Graybar) shifts scope responsibilities from Schneider Electric to the Contractor and lowers total quoted price

Commissioning Estimator – Step 2

Provide Equipment Counts for meters involved in the project

Meter Setup:		Certified Contractor Self Performed			Must be Performed by Schneider Electric				
Enter Meter Counts	**Tasks ->**	**Meter Config On-Site (2)**	**EPSS Test Evening On-Site (3)**	**Multi-Vendor Coordination**	**Pre-Construction Site Visit (1)**	**Meter Config Daytime On-Site (2)**	**EPSS Test Evening On-Site (3)**	**Multi-Vendor Integration (4)**	**Project Management (5)**
2	Utility Mains	2		1	8	2			2
2	Emergency Mains	4	0	1		4	0		2
2	Generators	4	8	2		4	8	4	2
6	ATS Switches	2	0.5	1		2	0.5	1	1
2	Chillers	0.5		0.5		0.5			1
0	Other Sub-meters	1		0.5		1			1
Total Estimated Hours -->		0	0	0	8	33	19	14	20
Include the following Metering Services in the Project Bid									
Meter Start-up & Commissioning (Days) ->		Required On-site Meter Start-up work days by Contractor		In-Office by Contractor	Required On-site Meter Start-up work days performed by Schneider Electric			In-Office by Schneider Electric	
On-site	Office	0		0	8			5	

Metering Start-up Notes:
(1) No Schneider Electric pre-construction visit provided for new construction only projects
(2) No Schneider Electric on-site Meter start-up included if Certified HCA Metering Contractor is self-performing
(3) All projects include Hospital EPSS Witness Test when any Gen Set involved. Not Required for FSEDs
(4) Meter Integration to be included for EPSS projects unless performed by Certified HCA Metering Contractor
(5) Estimated PM reduced 25% for any Certified HCA Metering Contractor

Meter Commissioning Services Provided by the Contractor instead of Schneider Electric

Required Meter Commissioning Services to be quoted by the Schneider Electric

Typical Startup & Commissioning Estimation (For Example Only)

Check only one Metering Project Type below					
New Construction only		<- Check this box is all meters factory installed	Any Project Type with Meter Retrofits	X	<- Check this box is any meters for existing equipment
Check Contractor Certification Status for HCA Metering Start-ups					
Certified HCA Metering Contractor		<- Check this box if Contractor Qualified to self perform meter Commissioning	Not Certified HCA Metering Contractor	X	<- Check this box is any meters for existing equipment

STEP 2 of 3 - Project Meter Counts

Meter Setup:		Certified Contractor Self Performed			Must be Performed by Schneider Electric				
Enter Meter Counts	Tasks ->	Meter Config On-Site [2]	EPSS Test Evening On-Site [2]	Multi-Vendor Coordination	Pre-Construction Site Visit [1]	Meter Config Daytime On-Site [2]	EPSS Test Evening On-Site [2]	Multi-Vendor Integration [4]	Project Management [4]
2	Utility Mains	2		1		2			2
2	Emergency Mains	4	0	1		4	0		2
2	Generators	4	8	2		4	8	4	2
6	ATS Switches	2	0.5	1	8	2	0.5	1	1
2	Chillers	0.5		0.5		0.5			1
0	Other Sub-meters	1		0.5		1			1
Total Estimated Hours -->		0	0	0	8	33	19	14	20

Include the following Metering Services in the Project Bid

Meter Start-up & Commissioning (Days) ->		Required On-site Meter Start-up work days by Contractor	In-Office by Contractor	Required On-site Meter Start-up work days performed by Schneider Electric	In-Office by Schneider Electric
On-site	Office	0	0	8	5

Contractor Self-Performing Estimation (For Example Only)

New Construction only		<- Check this box is all meters factory installed	Any Project Type with Meter Retrofits	X	<- Check this box is any meters for existing equipment
Check Contractor Certification Status for HCA Metering Start-ups					
Certified HCA Metering Contractor	X	<- Check this box if Contractor Qualified to self perform meter Commissioning	Not Certified HCA Metering Contractor		<- Check this box is any meters for existing equipment

STEP 2 of 3 - Project Meter Counts

Meter Setup:		Certified Contractor Self Performed			Must be Performed by Schneider Electric				
Enter Meter Counts	Tasks ->	Meter Config On-Site [2]	EPSS Test Evening On-Site [2]	Multi-Vendor Coordination	Pre-Construction Site Visit [1]	Meter Config Daytime On-Site [2]	EPSS Test Evening On-Site [2]	Multi-Vendor Integration [4]	Project Management [4]
2	Utility Mains	2		1		2			2
2	Emergency Mains	4	0	1		4	0		2
2	Generators	4	8	2		4	8	4	2
6	ATS Switches	2	0.5	1	8	2	0.5	1	1
2	Chillers	0.5		0.5		0.5			1
0	Other Sub-meters	1		0.5		1			1
Total Estimated Hours -->		33	19	15	8	0	19	10.5	15

Include the following Metering Services in the Project Bid

Meter Start-up & Commissioning (Days) ->		Required On-site Meter Start-up work days by Contractor	In-Office by Contractor	Required On-site Meter Start-up work days performed by Schneider Electric	In-Office by Schneider Electric
On-site	Office	9	2	4	4

APPENDIX F-4: METERING SYSTEM DESIGN DOCUMENTS

Part 1 - General

1.1 Sample Meter Schedule

POWERHOUSE

Normal Power Electrical Metering						Metering Inputs				Panel Requirements		Contractor Notes
Item #	Equipment Designation - Nameplate Data	Location / Drawing	Metering	Description	METER ENCLOSURE INFORMATION	# Meters	CT Amperage / Wiring (Per Meter)	Voltage Wiring (Per Meter)	Status Wiring (Per Meter)	UPS Input from Emergency Power Circuit	Required CAT 6 Drops	Installation Description
001	**"MSB-A"** - Square D Switchboard	POWERHOUSE / E1.0	**"2M" DUAL MAIN METER PANEL / #9761HC765UR0B2B1A**	**"2M" DUAL Main Meter:** UL Listed IndoorEnclosure with (2) 7650RD Metersinstalled. Ethernet comms to panel and UPS Included. (2) Voltage Source, Three-Phase - 277/480V WYE, (2) 3-Pole Fusible disconnect provided for protection of all meters in enclosure. Six pole CT shorting block to accommodate up to (3) CT's per Meter.	48" H X 36" W X 12" D.	2	Re-use existing CTs / Per Meter Requires: (6) #12 AWG, 600V,THHN	Per Meter Requires: (5) #12 AWG, 600V, THHN	N/A	(3) #12 AWG, 600VAC, THHN	1	Mount meter panel, install CTs, wire CTs and voltage conductors to meters, UPS requires input from emergency power ckt.
	"MSB-B"- Square D Switchboard						Re-use existing CTs / Per Meter Requires: (6) #12 AWG, 600V,THHN		N/A			

HCA The Women's Hospital of Texas - Electrical Metering Schedule

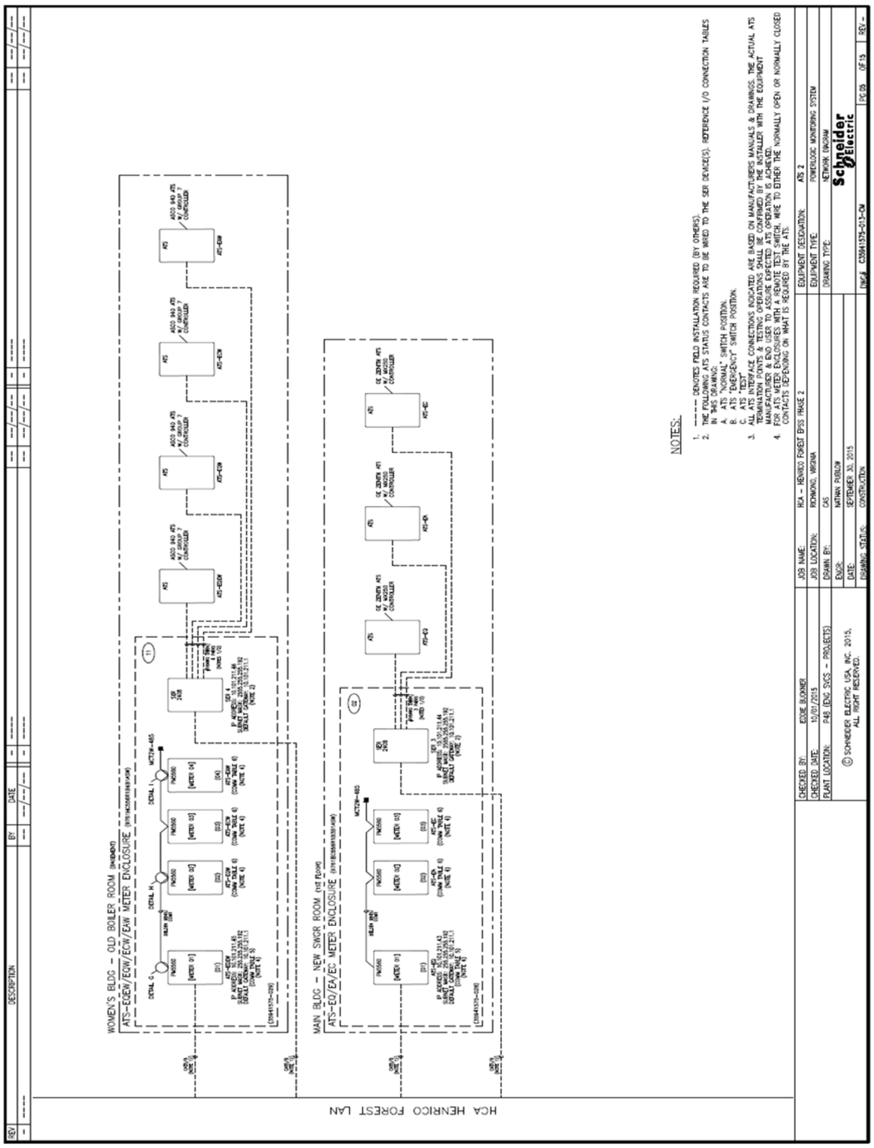
POWERHOUSE

Emergency Power Electrical Metering						Metering Inputs				Panel Requirements		Contractor Notes
Item #	Equipment Designation - Nameplate Data	Location	Meter/Enclosure Catalog Number	Description	METER ENCLOSURE INFORMATION	# Meters	CT Amperage / Wiring (Per Meter)	Voltage Wiring (Per Meter)	Status Wiring (Per Meter)	UPS Input from Emergency Power Circuit	Required CAT 6 Drops	Installation Description
002	**1500KW GEN & "GDP" - Emergency Power Switchboard**	POWERHOUSE / E1.0, ED1.0	**"1G" Single Gen Main Meter Panel / 9761HC7650R0B1B1A**	**Single Gen Main Meters Panel**: (1) 7650RD Meters, Ethernet comms, (1) Voltage Source, Three-Phase - 277/480V WYE with PT's Battery Monitoring, (1) 3-Pole Fusible disconnect provided for protection of all meters in enclosure. Universal power input configuration. Six pole CT shorting block to accommodate up to (3) CT's per Meter, UPS for control power. Includes standard engine control interface accessory.	36" H X 36" W X 12" D	1	Re-use existing CTs/ Per Meter Requires: (6) #12 AWG, 600V,THHN	Per Meter Requires: (5) #12 AWG, 600V, THHN	Gen Running / Gen Stopped (2) #18 AWG THHN	(3) #12 AWG, 600VAC, THHN	1	Mount meter panel, install CTs, wire CTs and voltage conductors to meters, UPS requires input from emergency power ckt, Gen status signal wired to meter digital input.

POWERHOUSE

ATS Electrical Metering						Metering Inputs (Wired by Electrical Contractor)					Panel Requirements		
Item #	Manufacturer / Model / Serial Number	Location	Meter Type / Part #	Description	METER ENCLOSURE INFORMATION	# Meters	CT Amperage / Wiring (Per Meter)	Voltage Wiring (Per Meter)	Status Wiring (Per Meter)	Required Signals (per ATS)	UPS Input from Emergency Power Circuit	Required CAT 6 Drops	Notes
003	**"ATS-ECHD"** - ASCO / G04ATSB31600N5XC / 412367-002 FP	POWERHOUSE EMERGENCY SWGR ROOM P-0004	**"2-ATS"Meter Only Panel / 9761HC556R0A2A1SW**	"2-ATS" Meter Only Panel with remote ATS selector switch: Industrial UL Listed Pad-Lockable Enclosure. Indoor Type 12. (2) METSEPM5560 Power Meter, (2) Voltage Source, Three-Phase - 277/480V,. (2) 3-Pole Fusible disconnect provided for protection of meters. Universal power input configuration (1) Multi-Tap CPT provided for control power source. Six pole CT shorting block to accommodate up to (3) CT's per Meter.	Separate ATS Meter Panel supplied and installed by the Electrical Contractor	2	**1200 Amp CTs /** Per Meter Requires: (6) #12 AWG, 600V,THHN	Per Meter Requires: (5) #12 AWG, 600V, THHN	Per Meter Requires: (6) #18 AWG, 600V, THHN	* ATS Switch on Normal Source, * ATS Switch on Emergency Source, * ATS Test Active OR Remote Test where needed	Includes UPS for meter panel control power	1	Each ATS to be field installed CTs and Voltage taps for ATS load-side terminal metering and ATS status signals wired by the E.C.
004	**"ATS-EQHD"** - ASCO / G04ATSB31600N5XC / 412367-001 FP						**1200 Amp CTs /** Per Meter Requires: (6) #12 AWG, 600V,THHN						

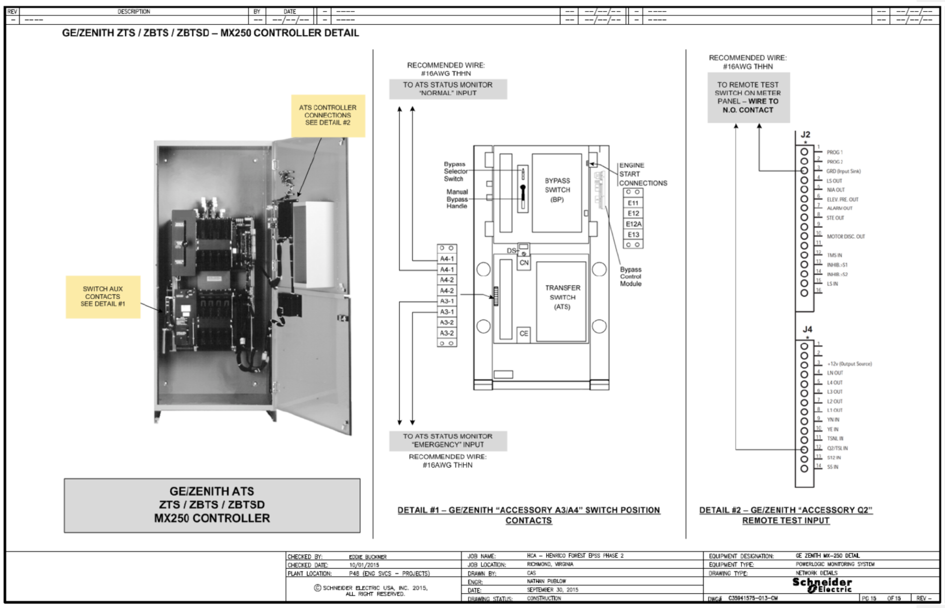
1.2 Sample System Drawings



1.3 Sample ATS Connection Details

SER 3 - I/O (SER-2408-P2X2)
MAIN BLDG - 1ST FLOOR - NEW SWGR ROOM
Digital Input

From		To			
Enclosure	Connection Point	Equipment	Connection Point	Description	Wire Size
ATS Meter Enclosure	T43B-2U	ATS-EQ	**J2-3** (MX-250 CONTACTS)	ATS-EQ - Test Q2 Std Control Option	16 AWG
ATS Meter Enclosure	T43B-2L	ATS-EQ	**J4-12** (MX-250 CONTACTS)		16 AWG
ATS Meter Enclosure	T43B-4U	ATS-EA	**J2-3** (MX-250 CONTACTS)	ATS-EA - Test Q2 Std Control Option	16 AWG
ATS Meter Enclosure	T43B-4L	ATS-EA	**J4-12** (MX-250 CONTACTS)		16 AWG
ATS Meter Enclosure	T43B-6U	ATS-EC	**J2-3** (MX-250 CONTACTS)	ATS-EC - Test Q2 Std Control Option	16 AWG
ATS Meter Enclosure	T43B-6L	ATS-EC	**J4-12** (MX-250 CONTACTS)		16 AWG
ATS Meter Enclosure	T43A-4U	ATS-EQ	**A3-1** (AUX CONTACT)	ATS-EQ - Emergency Position Accessory A3	16 AWG
ATS Meter Enclosure	T43A-4L	ATS-EQ	**A3-1** (AUX CONTACT)		16 AWG
ATS Meter Enclosure	T43A-5U	ATS-EQ	**A4-1** (AUX CONTACT)	ATS-EQ - Normal Position Accessory A4	16 AWG
ATS Meter Enclosure	T43A-5L	ATS-EQ	**A4-1** (AUX CONTACT)		16 AWG
ATS Meter Enclosure	T43A-6U	ATS-EA	**A3-1** (AUX CONTACT)	ATS-EA - Emergency Position Accessory A3	16 AWG
ATS Meter Enclosure	T43A-6L	ATS-EA	**A3-1** (AUX CONTACT)		16 AWG
ATS Meter Enclosure	T43A-7U	ATS-EA	**A4-1** (AUX CONTACT)	ATS-EA - Normal Position Accessory A4	16 AWG
ATS Meter Enclosure	T43A-7L	ATS-EA	**A4-1** (AUX CONTACT)		16 AWG
ATS Meter Enclosure	T43A-8U	ATS-EC	**A3-1** (AUX CONTACT)	ATS-EC - Emergency Position Accessory A3	16 AWG
ATS Meter Enclosure	T43A-8L	ATS-EC	**A3-1** (AUX CONTACT)		16 AWG
ATS Meter Enclosure	T43A-9U	ATS-EC	**A4-1** (AUX CONTACT)	ATS-EC - Normal Position Accessory A4	16 AWG
ATS Meter Enclosure	T43A-9L	ATS-EC	**A4-1** (AUX CONTACT)		16 AWG



REV
DESCRIPTION
BY
DATE
GE/ZENITH ZTS / ZBTS / ZBTSD – MX250 CONTROLLER DETAIL
ATS CONTROLLER CONNECTIONS SEE DETAIL #2
SWITCH AUX CONTACTS SEE DETAIL #1
GE/ZENITH ATS
ZTS / ZBTS / ZBTSD
MX250 CONTROLLER
RECOMMENDED WIRE: #16AWG THHN
TO ATS STATUS MONITOR "NORMAL" INPUT
Bypass Selector Switch
Manual Bypass Handle
BYPASS SWITCH (BP)
ENGINE START CONNECTIONS
E11
E12
E12A
E13
A4-1
A4-1
A4-2
A4-2
A3-1
A3-1
A3-2
A3-2
DS
CN
CE
TRANSFER SWITCH (ATS)
Bypass Control Module
TO ATS STATUS MONITOR "EMERGENCY" INPUT
RECOMMENDED WIRE: #16AWG THHN
DETAIL #1 – GE/ZENITH "ACCESSORY A3/A4" SWITCH POSITION CONTACTS
RECOMMENDED WIRE: #16AWG THHN
TO REMOTE TEST SWITCH ON METER PANEL – WIRE TO N.O. CONTACT
J2
PROG 1
PROG 2
GRD (Input Sink)
LS OUT
NIA OUT
ELEV. PRE. OUT
ALARM OUT
STE OUT
MOTOR DISC. OUT
TMS IN
INHIB.>S1
INHIB.>S2
LS IN
J4
+12v (Output Source)
LN OUT
L4 OUT
L3 OUT
L2 OUT
L1 OUT
YN IN
YE IN
TSNL IN
Q2/TSL IN
S12 IN
S5 IN
DETAIL #2 – GE/ZENITH "ACCESSORY Q2" REMOTE TEST INPUT
CHECKED BY: EDDIE BUCKNER
CHECKED DATE: 10/01/2015
PLANT LOCATION: P48 (ENG SVCS – PROJECTS)
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JOB NAME: HCA – HENRICO FOREST EPSS PHASE 2
JOB LOCATION: RICHMOND, VIRGINIA
DRAWN BY: CAS
ENGR: NATHAN PUBLOW
DATE: SEPTEMBER 30, 2015
DRAWING STATUS: CONSTRUCTION
EQUIPMENT DESIGNATION: GE ZENITH MX-250 DETAIL
EQUIPMENT TYPE: POWERLOGIC MONITORING SYSTEM
DRAWING TYPE: NETWORK DETAILS
Schneider Electric
DWG# C35941575-013-CM
PG 15 OF 15
REV –

1.4 Meter Readiness Forms

EPSS METER READINESS FORM

HCA SITE		LOCATION		DATE	

INFORMATION COLLECTED FROM EQUIPMENT NAMEPLATE							INFORMATION PROVIDED BY EQUIPMENT MANUFACTURER *Indicate the cable termination location Engine Controller Communications. Provide Gen Running / Stopped signal termination and whether a N.O. or N.C contact. Availability of each signal should be field verified if not known.*											MODS Required
GENERATORS							Gen Running/Stopped				Engine Controller Comms						
							Connection				Connection		Protocol (select one)				
item #	Manufacturer	Label	Gen Model#	S/N	Engine Model#	S/N	Terminal Block	Terminal	N.O.	N.C.	Terminal Block	Terminal	Modbus RTU	CAT Comms	Lon Works	Other	(Y/N)
001																	
002																	
003																	
004																	
005																	
006																	
007																	
008																	
009																	

ATS METER READINESS FORM

HCA SITE					LOCATION				DATE								
INFORMATION COLLECTED FROM EQUIPMENT NAMEPLATE					INFORMATION PROVIDED BY EQUIPMENT MANUFACTURER *Indicate the termination location for each signal and whether a N.O. or N.C contact. Availability of each signal must be field verified.*												MODS Required
Automatic Transfer Switches					ATS Connected to Normal				ATS Connected to Emergency "				ATS Remote Test				(Y/N)
item #	Manufacturer	Label	S/N	Model#	Terminal Block	Terminals	N.O.	N.C.	Terminal Block	Terminals	N.O.	N.C.	Terminal Block	Terminals	N.O.	N.C.	
001																	
002																	
003																	
004																	
005																	
006																	
007																	
008																	
009																	
010																	
011																	
012																	
013																	
014																	
015																	
016																	
017																	
018																	
019																	
020																	

APPENDIX F-5: WAGES and BAS Register

CHILLED WATER PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Analog	m.Chiller 1 Speed		0	101	32 bit real			2
Analog	m.Chiller 2 Speed		0	103	32 bit real			2
Analog	m.Chiller 3 Speed		0	105	32 bit real			2
Analog	m.Chiller 4 Speed		0	107	32 bit real			2
Analog	m.Chiller 5 Speed		0	109	32 bit real			2
Analog	m.Chiller 6 Speed		0	111	32 bit real			2
Analog	m.Chiller 7 Speed		0	113	32 bit real			2
Analog	m.Chiller 8 Speed		0	115	32 bit real			2
Analog	m.Primary CHP 1 Speed		0	117	32 bit real			2
Analog	m.Primary CHP 2 Speed		0	119	32 bit real			2
Analog	m.Primary CHP 3 Speed		0	121	32 bit real			2
Analog	m.Primary CHP 4 Speed		0	123	32 bit real			2
Analog	m.Primary CHP 5 Speed		0	125	32 bit real			2
Analog	m.Primary CHP 6 Speed		0	127	32 bit real			2
Analog	m.Primary CHP 7 Speed		0	129	32 bit real			2
Analog	m.Primary CHP 8 Speed		0	131	32 bit real			2
Analog	m.CWP 1 Speed		0	133	32 bit real			2
Analog	m.CWP 2 Speed		0	135	32 bit real			2
Analog	m.CWP 3 Speed		0	137	32 bit real			2

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

CHILLED WATER PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Analog	m.CWP 4 Speed		0	139	32 bit real			2
Analog	m.CWP 5 Speed		0	141	32 bit real			2
Analog	m.CWP 6 Speed		0	143	32 bit real			2
Analog	m.CWP 7 Speed		0	145	32 bit real			2
Analog	m.CWP 8 Speed		0	147	32 bit real			2
Analog	m.Secondary CHP 1 Speed		0	149	32 bit real			2
Analog	m.Secondary CHP 2 Speed		0	151	32 bit real			2
Analog	m.Secondary CHP 3 Speed		0	153	32 bit real			2
Analog	m.Secondary CHP 4 Speed		0	155	32 bit real			2
Analog	m.Cooling Tower 1 Speed		0	157	32 bit real			2
Analog	m.Cooling Tower 2 Speed		0	159	32 bit real			2
Analog	m.Cooling Tower 3 Speed		0	161	32 bit real			2
Analog	m.Cooling Tower 4 Speed		0	163	32 bit real			2
Analog	m.Cooling Tower 5 Speed		0	165	32 bit real			2
Analog	m.Cooling Tower 6 Speed		0	167	32 bit real			2
Analog	m.Cooling Tower 7 Speed		0	169	32 bit real			2
Analog	m.Cooling Tower 8 Speed		0	171	32 bit real			2
Analog			0	173	32 bit real			2
Analog			0	175	32 bit real			2
Analog			0	177	32 bit real			2
Analog			0	179	32 bit real			2
Analog			0	181	32 bit real			2
Analog			0	183	32 bit real			2
Analog			0	185	32 bit real			2

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

CHILLED WATER PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Analog			0	187	32 bit real			2
Analog			0	189	32 bit real			2
Analog			0	191	32 bit real			2
Analog			0	193	32 bit real			2
Analog			0	195	32 bit real			2
Digital	m.Chiller 1 Status			101	Digital Coil			1
Digital	m.Chiller 2 Status			102	Digital Coil			1
Digital	m.Chiller 3 Status			103	Digital Coil			1
Digital	m.Chiller 4 Status			104	Digital Coil			1
Digital	m.Chiller 5 Status			105	Digital Coil			1
Digital	m.Chiller 6 Status			106	Digital Coil			1
Digital	m.Chiller 7 Status			107	Digital Coil			1
Digital	m.Chiller 8 Status			108	Digital Coil			1
Digital	m.Primary CHP 1 Status			109	Digital Coil			1
Digital	m.Primary CHP 2 Status			110	Digital Coil			1
Digital	m.Primary CHP 3 Status			111	Digital Coil			1
Digital	m.Primary CHP 4 Status			112	Digital Coil			1
Digital	m.Primary CHP 5 Status			113	Digital Coil			1
Digital	m.Primary CHP 6 Status			114	Digital Coil			1
Digital	m.Primary CHP 7 Status			115	Digital Coil			1
Digital	m.Primary CHP 8 Status			116	Digital Coil			1
Digital	m.CWP 1 Status			117	Digital Coil			1
Digital	m.CWP 2 Status			118	Digital Coil			1

CHILLED WATER PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Digital	m.CWP 3 Status			119	Digital Coil			1
Digital	m.CWP 4 Status			120	Digital Coil			1
Digital	m.CWP 5 Status			121	Digital Coil			1
Digital	m.CWP 6 Status			122	Digital Coil			1
Digital	m.CWP 7 Status			123	Digital Coil			1
Digital	m.CWP 8 Status			124	Digital Coil			1
Digital	m.Secondary CHP 1 Status			125	Digital Coil			1
Digital	m.Secondary CHP 2 Status			126	Digital Coil			1
Digital	m.Secondary CHP 3 Status			127	Digital Coil			1
Digital	m.Secondary CHP 4 Status			128	Digital Coil			1
Digital	m.Cooling Tower 1 Status			129	Digital Coil			1
Digital	m.Cooling Tower 2 Status			130	Digital Coil			1
Digital	m.Cooling Tower 3 Status			131	Digital Coil			1
Digital	m.Cooling Tower 4 Status			132	Digital Coil			1
Digital	m.Cooling Tower 5 Status			133	Digital Coil			1
Digital	m.Cooling Tower 6 Status			134	Digital Coil			1
Digital	m.Cooling Tower 7 Status			135	Digital Coil			1
Digital	m.Cooling Tower 8 Status			136	Digital Coil			1
Digital	Tower Filter Pump Status			137	Digital Coil			1
Digital	Plate & Frame CHP Status			138	Digital Coil			1

CHILLED WATER PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Digital	Plate & Frame CWP Status			139	Digital Coil			1
Digital				140	Digital Coil			1
Digital				141	Digital Coil			1
Digital				142	Digital Coil			1
Digital				143	Digital Coil			1
Digital				144	Digital Coil			1
Digital				145	Digital Coil			1
Digital				146	Digital Coil			1
Digital				147	Digital Coil			1
Digital				148	Digital Coil			1
Digital				149	Digital Coil			1
Digital				150	Digital Coil			1
Digital				151	Digital Coil			1
Digital				152	Digital Coil			1
Digital				153	Digital Coil			1
Digital				154	Digital Coil			1
Digital				155	Digital Coil			1
Digital				156	Digital Coil			1
Digital				157	Digital Coil			1
Digital				158	Digital Coil			1
Digital				159	Digital Coil			1
Digital				160	Digital Coil			1
Digital				161	Digital Coil			1
Digital				162	Digital Coil			1
Digital				163	Digital Coil			1
Digital				164	Digital Coil			1

HEAT PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Analog	m.boiler 1 Speed		0	302	32 bit Real			2
Analog	m.boiler 2 Speed		0	303	32 bit Real			2
Analog	m.boiler 3 Speed		0	304	32 bit Real			2

HEAT PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Analog	m.boiler 4 Speed		0	305	32 bit Real			2
Analog	m.boiler 5 Speed		0	306	32 bit Real			2
Analog	m.boiler 6 Speed		0	307	32 bit Real			2
Analog	m.boiler 7 Speed		0	308	32 bit Real			2
Analog	m.boiler 8 Speed		0	309	32 bit Real			2
Analog	m.Primary HWP 1 Speed		0	310	32 bit Real			2
Analog	m.Primary HWP 2 Speed		0	311	32 bit Real			2
Analog	m.Primary HWP 3 Speed		0	312	32 bit Real			2
Analog	m.Primary HWP 4 Speed		0	313	32 bit Real			2
Analog	m.Primary HWP 5 Speed		0	314	32 bit Real			2
Analog	m.Primary HWP 6 Speed		0	315	32 bit Real			2
Analog	m.Primary HWP 7 Speed		0	316	32 bit Real			2
Analog	m.Primary HWP 8 Speed		0	317	32 bit Real			2
Analog	m.Secondary HWP 1 Speed		0	318	32 bit Real			2
Analog	m.Secondary HWP 2 Speed		0	319	32 bit Real			2
Analog	m.Secondary HWP 3 Speed		0	320	32 bit Real			2
Analog	m.Secondary HWP 4 Speed		0	321	32 bit Real			2
Analog	m.Domestic Booster Pump 1 Speed		0	322	32 bit Real			2
Analog	m.Domestic Booster Pump 2 Speed		0	323	32 bit Real			2

HEAT PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Analog	m.Domestic Booster Pump 3 Speed		0	324	32 bit Real			2
Analog			0	325	32 bit Real			2
Analog			0	326	32 bit Real			2
Analog			0	327	32 bit Real			2
Analog			0	328	32 bit Real			2
Analog			0	329	32 bit Real			2
Analog			0	330	32 bit Real			2
Analog			0	331	32 bit Real			2
Analog			0	332	32 bit Real			2
Analog			0	333	32 bit Real			2
Digital	m.boiler 1 Status		0	301	Digital Coil			1
Digital	m.boiler 2 Status		0	302	Digital Coil			1
Digital	m.boiler 3 Status		0	303	Digital Coil			1
Digital	m.boiler 4 Status		0	304	Digital Coil			1
Digital	m.boiler 5 Status		0	305	Digital Coil			1
Digital	m.boiler 6 Status		0	306	Digital Coil			1
Digital	m.boiler 7 Status		0	307	Digital Coil			1
Digital	m.boiler 8 Status		0	308	Digital Coil			1
Digital	m.Primary HWP 1 Status		0	309	Digital Coil			1
Digital	m.Primary HWP 2 Status		0	310	Digital Coil			1
Digital	m.Primary HWP 3 Status		0	311	Digital Coil			1
Digital	m.Primary HWP 4 Status		0	312	Digital Coil			1
Digital	m.Primary HWP 5 Status		0	313	Digital Coil			1
Digital	m.Primary HWP 6 Status		0	314	Digital Coil			1

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

HEAT PLANT TEMPLATE								
Type	**Name**	**BAS Point Description**	**Value**	**Modbus Register**	**Register Type**		**BACnet ID**	**#registers**
Digital	m.Primary HWP 7 Status		0	315	Digital Coil			1
Digital	m.Primary HWP 8 Status		0	316	Digital Coil			1
Digital	m.Secondary HWP 1 Status			317	Digital Coil			1
Digital	m.Secondary HWP 2 Status			318	Digital Coil			1
Digital	m.Secondary HWP 3 Status			319	Digital Coil			1
Digital	m.Secondary HWP 4 Status			320	Digital Coil			1
Digital	m.Feed Water Pump 1 Status			321	Digital Coil			1
Digital	m.Feed Water Pump 2 Status			322	Digital Coil			1
Digital	m.Feed Water Pump 3 Status			323	Digital Coil			1
Digital	m.Feed Water Pump 4 Status			324	Digital Coil			1
Digital	m.Condensate Pump 1 Status			325	Digital Coil			1
Digital	m.Condensate Pump 2 Status			326	Digital Coil			1
Digital	m.Condensate Pump 3 Status			327	Digital Coil			1
Digital	m.Condensate Pump 4 Status			328	Digital Coil			1
Digital	m.Domestic HW Pump 1 Status			329	Digital Coil			1
Digital	m.Domestic HW Pump 2 Status			330	Digital Coil			1
Digital	m.Domestic HW Pump 3 Status			331	Digital Coil			1
Digital	m.Domestic Booster Pump 1 Status			332	Digital Coil			1

HCA MEP DESIGN GUIDELINES FOR HOSPITALS

HEAT PLANT TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register Type		BACnet ID	#registers
Digital	m.Domestic Booster Pump 2 Status			333	Digital Coil			1
Digital	m.Domestic Booster Pump 3 Status			334	Digital Coil			1
Digital				335	Digital Coil			1
Digital				336	Digital Coil			1
Digital				337	Digital Coil			1
Digital				338	Digital Coil			1
Digital				339	Digital Coil			1
Digital				340	Digital Coil			1
Digital				341	Digital Coil			1
Digital				342	Digital Coil			1
Digital				343	Digital Coil			1
Digital				344	Digital Coil			1
Digital				345	Digital Coil			1
Digital				346	Digital Coil			1
Digital				347	Digital Coil			1
Digital				348	Digital Coil			1
Digital				349	Digital Coil			1
Digital				350	Digital Coil			1
Digital				351	Digital Coil			1
Digital				352	Digital Coil			1
Digital				353	Digital Coil			1
Digital				354	Digital Coil			1
Digital				355	Digital Coil			1
Digital				356	Digital Coil			1
Digital				357	Digital Coil			1
Digital				358	Digital Coil			1
Digital				359	Digital Coil			1
Digital				360	Digital Coil			1
Digital				361	Digital Coil			1
Digital				362	Digital Coil			1
Digital				363	Digital Coil			1
Digital				364	Digital Coil			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.Fan 1 Speed			501	32 bit Real			2
Analog	m.Fan 2 Speed			503	32 bit Real			2
Analog	m.Fan 3 Speed			505	32 bit Real			2
Analog	m.Fan 4 Speed			507	32 bit Real			2
Analog	m.Fan 5 Speed			509	32 bit Real			2
Analog	m.Fan 6 Speed			511	32 bit Real			2
Analog	m.Fan 7 Speed			513	32 bit Real			2
Analog	m.Fan 8 Speed			515	32 bit Real			2
Analog	m.Fan 9 Speed			517	32 bit Real			2
Analog	m.Fan 10 Speed			519	32 bit Real			2
Analog	m.Fan 11 Speed			521	32 bit Real			2
Analog	m.Fan 12 Speed			523	32 bit Real			2
Analog	m.Fan 13 Speed			525	32 bit Real			2
Analog	m.Fan 14 Speed			527	32 bit Real			2
Analog	m.Fan 15 Speed			529	32 bit Real			2
Analog	m.Fan 16 Speed			531	32 bit Real			2
Analog	m.Fan 17 Speed			533	32 bit Real			2
Analog	m.Fan 18 Speed			535	32 bit Real			2
Analog	m.Fan 19 Speed			537	32 bit Real			2
Analog	m.Fan 20 Speed			539	32 bit Real			2

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.Fan 21 Speed			541	32 bit Real			2
Analog	m.Fan 22 Speed			543	32 bit Real			2
Analog	m.Fan 23 Speed			545	32 bit Real			2
Analog	m.Fan 24 Speed			547	32 bit Real			2
Analog	m.Fan 25 Speed			549	32 bit Real			2
Analog	m.Fan 26 Speed			551	32 bit Real			2
Analog	m.Fan 27 Speed			553	32 bit Real			2
Analog	m.Fan 28 Speed			555	32 bit Real			2
Analog	m.Fan 29 Speed			557	32 bit Real			2
Analog	m.Fan 30 Speed			559	32 bit Real			2
Analog	m.Fan 31 Speed			561	32 bit Real			2
Analog	m.Fan 32 Speed			563	32 bit Real			2
Analog	m.Fan 33 Speed			565	32 bit Real			2
Analog	m.Fan 34 Speed			567	32 bit Real			2
Analog	m.Fan 35 Speed			569	32 bit Real			2
Analog	m.Fan 36 Speed			571	32 bit Real			2
Analog	m.Fan 37 Speed			573	32 bit Real			2
Analog	m.Fan 38 Speed			575	32 bit Real			2
Analog	m.Fan 39 Speed			577	32 bit Real			2
Analog	m.Fan 40 Speed			579	32 bit Real			2

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.Fan 41 Speed			581	32 bit Real			2
Analog	m.Fan 42 Speed			583	32 bit Real			2
Analog	m.Fan 43 Speed			585	32 bit Real			2
Analog	m.Fan 44 Speed			587	32 bit Real			2
Analog	m.Fan 45 Speed			589	32 bit Real			2
Analog	m.Fan 46 Speed			591	32 bit Real			2
Analog	m.Fan 47 Speed			593	32 bit Real			2
Analog	m.Fan 48 Speed			595	32 bit Real			2
Analog	m.Fan 49 Speed			597	32 bit Real			2
Analog	m.Fan 50 Speed			599	32 bit Real			2
Analog	m.Fan 51 Speed			601	32 bit Real			2
Analog	m.Fan 52 Speed			603	32 bit Real			2
Analog	m.Fan 53 Speed			605	32 bit Real			2
Analog	m.Fan 54 Speed			607	32 bit Real			2
Analog	m.Fan 55 Speed			609	32 bit Real			2
Analog	m.Fan 56 Speed			611	32 bit Real			2
Analog	m.Fan 57 Speed			613	32 bit Real			2
Analog	m.Fan 58 Speed			615	32 bit Real			2
Analog	m.Fan 59 Speed			617	32 bit Real			2
Analog	m.Fan 60 Speed			619	32 bit Real			2

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.Fan 61 Speed			621	32 bit Real			2
Analog	m.Fan 62 Speed			623	32 bit Real			2
Analog	m.Fan 63 Speed			625	32 bit Real			2
Analog	m.Fan 64 Speed			627	32 bit Real			2
Analog	m.Fan 65 Speed			629	32 bit Real			2
Analog	m.Fan 66 Speed			631	32 bit Real			2
Analog	m.Fan 67 Speed			633	32 bit Real			2
Analog	m.Fan 68 Speed			635	32 bit Real			2
Analog	m.Fan 69 Speed			637	32 bit Real			2
Analog	m.Fan 70 Speed			639	32 bit Real			2
Analog	m.Fan 71 Speed			641	32 bit Real			2
Analog	m.Fan 72 Speed			643	32 bit Real			2
Analog	m.Fan 72 Speed			645	32 bit Real			2
Analog	m.Fan 74 Speed			647	32 bit Real			2
Analog	m.Fan 75 Speed			649	32 bit Real			2
Analog	m.Fan 76 Speed			651	32 bit Real			2
Analog	m.Fan 77 Speed			653	32 bit Real			2
Analog	m.Fan 78 Speed			655	32 bit Real			2
Analog	m.Fan 79 Speed			657	32 bit Real			2
Analog	m.Fan 80 Speed			659	32 bit Real			2

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Digital	m.Fan 1 Status			401	Digital Coil			1
Digital	m.Fan 2 Status			402	Digital Coil			1
Digital	m.Fan 3 Status			403	Digital Coil			1
Digital	m.Fan 4 Status			404	Digital Coil			1
Digital	m.Fan 5 Status			405	Digital Coil			1
Digital	m.Fan 6 Status			406	Digital Coil			1
Digital	m.Fan 7 Status			407	Digital Coil			1
Digital	m.Fan 8 Status			408	Digital Coil			1
Digital	m.Fan 9 Status			409	Digital Coil			1
Digital	m.Fan 10 Status			410	Digital Coil			1
Digital	m.Fan 11 Status			411	Digital Coil			1
Digital	m.Fan 12 Status			412	Digital Coil			1
Digital	m.Fan 13 Status			413	Digital Coil			1
Digital	m.Fan 14 Status			414	Digital Coil			1
Digital	m.Fan 15 Status			415	Digital Coil			1
Digital	m.Fan 16 Status			416	Digital Coil			1
Digital	m.Fan 17 Status			417	Digital Coil			1
Digital	m.Fan 18 Status			418	Digital Coil			1
Digital	m.Fan 19 Status			419	Digital Coil			1
Digital	m.Fan 20 Status			420	Digital Coil			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Digital	m.Fan 21 Status			421	Digital Coil			1
Digital	m.Fan 22 Status			422	Digital Coil			1
Digital	m.Fan 23 Status			423	Digital Coil			1
Digital	m.Fan 24 Status			424	Digital Coil			1
Digital	m.Fan 25 Status			425	Digital Coil			1
Digital	m.Fan 26 Status			426	Digital Coil			1
Digital	m.Fan 27 Status			427	Digital Coil			1
Digital	m.Fan 28 Status			428	Digital Coil			1
Digital	m.Fan 29 Status			429	Digital Coil			1
Digital	m.Fan 30 Status			430	Digital Coil			1
Digital	m.Fan 31 Status			431	Digital Coil			1
Digital	m.Fan 32 Status			432	Digital Coil			1
Digital	m.Fan 33 Status			433	Digital Coil			1
Digital	m.Fan 34 Status			434	Digital Coil			1
Digital	m.Fan 35 Status			435	Digital Coil			1
Digital	m.Fan 36 Status			436	Digital Coil			1
Digital	m.Fan 37 Status			437	Digital Coil			1
Digital	m.Fan 38 Status			438	Digital Coil			1
Digital	m.Fan 39 Status			439	Digital Coil			1
Digital	m.Fan 40 Status			440	Digital Coil			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Digital	m.Fan 41 Status			441	Digital Coil			1
Digital	m.Fan 42 Status			442	Digital Coil			1
Digital	m.Fan 43 Status			443	Digital Coil			1
Digital	m.Fan 44 Status			444	Digital Coil			1
Digital	m.Fan 45 Status			445	Digital Coil			1
Digital	m.Fan 46 Status			446	Digital Coil			1
Digital	m.Fan 47 Status			447	Digital Coil			1
Digital	m.Fan 48 Status			448	Digital Coil			1
Digital	m.Fan 49 Status			449	Digital Coil			1
Digital	m.Fan 50 Status			450	Digital Coil			1
Digital	m.Fan 51 Status			451	Digital Coil			1
Digital	m.Fan 52 Status			452	Digital Coil			1
Digital	m.Fan 53 Status			453	Digital Coil			1
Digital	m.Fan 54 Status			454	Digital Coil			1
Digital	m.Fan 55 Status			455	Digital Coil			1
Digital	m.Fan 56 Status			456	Digital Coil			1
Digital	m.Fan 57 Status			457	Digital Coil			1
Digital	m.Fan 58 Status			458	Digital Coil			1
Digital	m.Fan 59 Status			459	Digital Coil			1
Digital	m.Fan 60 Status			460	Digital Coil			1

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VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Digital	m.Fan 61 Status			461	Digital Coil			1
Digital	m.Fan 62 Status			462	Digital Coil			1
Digital	m.Fan 63 Status			463	Digital Coil			1
Digital	m.Fan 64 Status			464	Digital Coil			1
Digital	m.Fan 65 Status			465	Digital Coil			1
Digital	m.Fan 66 Status			466	Digital Coil			1
Digital	m.Fan 67 Status			467	Digital Coil			1
Digital	m.Fan 68 Status			468	Digital Coil			1
Digital	m.Fan 69 Status			469	Digital Coil			1
Digital	m.Fan 70 Status			470	Digital Coil			1
Digital	m.Fan 71 Status			471	Digital Coil			1
Digital	m.Fan 72 Status			472	Digital Coil			1
Digital	m.Fan 73 Status			473	Digital Coil			1
Digital	m.Fan 74 Status			474	Digital Coil			1
Digital	m.Fan 75 Status			475	Digital Coil			1
Digital	m.Fan 76 Status			476	Digital Coil			1
Digital	m.Fan 77 Status			477	Digital Coil			1
Digital	m.Fan 78 Status			478	Digital Coil			1
Digital	m.Fan 79 Status			479	Digital Coil			1
Digital	m.Fan 80 Status			480	Digital Coil			1
Digital				481	Digital Coil			1

VENTILATION TEMPLATE								
Type	**Name**	**BAS Point Description**	**Value**	**Modbus Register**	**Register type**		**BACnet ID**	**# Registers**
Digital				482	Digital Coil			1
Digital				483	Digital Coil			1
Digital				484	Digital Coil			1
Digital				485	Digital Coil			1
Digital				486	Digital Coil			1
Digital				487	Digital Coil			1
Digital				488	Digital Coil			1
Digital				489	Digital Coil			1
Digital				490	Digital Coil			1
Digital				491	Digital Coil			1
Digital				492	Digital Coil			1
Digital				493	Digital Coil			1
Digital				494	Digital Coil			1
Digital				495	Digital Coil			1
Digital				496	Digital Coil			1
Analog	m.NORMAL MAIN 1 Phase A Amps		0	701	16 bit Real			1
Analog	m.NORMAL MAIN 1 Phase B Amps		0	702	16 bit Real			1
Analog	m.NORMAL MAIN 1 Phase C Amps		0	703	16 bit Real			1
Analog	m.NORMAL MAIN 1 Amps 3-Ph Ave		0	704	16 bit Real			1
Analog	m.NORMAL MAIN 1 Phase L-N Volts		0	705	16 bit Real			1
Analog	m.NORMAL MAIN 1 Phase L-L Volts		0	706	16 bit Real			1
Analog	m.NORMAL MAIN 1 PF Total		0	707	16 bit Real			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.NORMAL MAIN 1 kW Total		0	708	16 bit Real			1
Analog	m.NORMAL MAIN 1 kWD Total		0	709	16 bit Real			1
Analog	m.NORMAL MAIN 1 kWH - Total		0	710	32 bit Real			2
Analog	m.NORMAL MAIN 2 Phase A Amps		0	712	16 bit Real			1
Analog	m.NORMAL MAIN 2 Phase B Amps		0	713	16 bit Real			1
Analog	m.NORMAL MAIN 2 Phase C Amps		0	714	16 bit Real			1
Analog	m.NORMAL MAIN 2 Amps 3-Ph Ave		0	715	16 bit Real			1
Analog	m.NORMAL MAIN 2 Phase L-N Volts		0	716	16 bit Real			1
Analog	m.NORMAL MAIN 2 Phase L-L Volts		0	717	16 bit Real			1
Analog	m.NORMAL MAIN 2 PF Total		0	718	16 bit Real			1
Analog	m.NORMAL MAIN 2 kW Total		0	719	16 bit Real			1
Analog	m.NORMAL MAIN 2 kWD Total		0	720	16 bit Real			1
Analog	m.NORMAL MAIN 2 kWH - Total		0	721	32 bit Real			2

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.NORMAL MAIN 3 Phase A Amps		0	723	16 bit Real			1
Analog	m.NORMAL MAIN 3 Phase B Amps		0	724	16 bit Real			1
Analog	m.NORMAL MAIN 3 Phase C Amps		0	725	16 bit Real			1
Analog	m.NORMAL MAIN 3 Amps 3-Ph Ave		0	726	16 bit Real			1
Analog	m.NORMAL MAIN 3 Phase L-N Volts		0	727	16 bit Real			1
Analog	m.NORMAL MAIN 3 Phase L-L Volts		0	728	16 bit Real			1
Analog	m.NORMAL MAIN 3 PF Total		0	729	16 bit Real			1
Analog	m.NORMAL MAIN 3 kW Total		0	730	16 bit Real			1
Analog	m.NORMAL MAIN 3 kWD Total		0	731	16 bit Real			1
Analog	m.NORMAL MAIN 3 kWH - Total		0	732	32 bit Real			2
Analog	m.NORMAL MAIN 4 Phase A Amps		0	734	16 bit Real			1
Analog	m.NORMAL MAIN 4 Phase B Amps		0	735	16 bit Real			1
Analog	m.NORMAL MAIN 4 Phase C Amps		0	736	16 bit Real			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.NORMAL MAIN 4 Amps 3-Ph Ave		0	737	16 bit Real			1
Analog	m.NORMAL MAIN 4 Phase L-N Volts		0	738	16 bit Real			1
Analog	m.NORMAL MAIN 4 Phase L-L Volts		0	739	16 bit Real			1
Analog	m.NORMAL MAIN 4 PF Total		0	740	16 bit Real			1
Analog	m.NORMAL MAIN 4 kW Total		0	741	16 bit Real			1
Analog	m.NORMAL MAIN 4 kWD Total		0	742	16 bit Real			1
Analog	m.NORMAL MAIN 4 kWH - Total		0	743	32 bit Real			2
Analog+ 2:32	m.GEN MAIN 1 Phase A Amps		0	701	16 bit Real			1
Analog	m.GEN MAIN 1 Phase B Amps		0	702	16 bit Real			1
Analog	m.GEN MAIN 1 Phase C Amps		0	703	16 bit Real			1
Analog	m.GEN MAIN 1 Amps 3-Ph Ave		0	704	16 bit Real			1
Analog	m.GEN MAIN 1 Phase L-N Volts		0	705	16 bit Real			1
Analog	m.GEN MAIN 1 Phase L-L Volts		0	706	16 bit Real			1
Analog	m.GEN MAIN 1 PF Total		0	707	16 bit Real			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.GEN MAIN 1 kW Total		0	708	16 bit Real			1
Analog	m.GEN MAIN 1 kWD Total		0	709	16 bit Real			1
Analog	m.GEN MAIN 1 kWH -Total		0	710	32 bit Real			2
Analog	m.GEN MAIN 2 Phase A Amps		0	712	16 bit Real			1
Analog	m.GEN MAIN 2 Phase B Amps		0	713	16 bit Real			1
Analog	m.GEN MAIN 2 Phase C Amps		0	714	16 bit Real			1
Analog	m.GEN MAIN 2 Amps 3-Ph Ave		0	715	16 bit Real			1
Analog	m.GEN MAIN 2 Phase L-N Volts		0	716	16 bit Real			1
Analog	m.GEN MAIN 2 Phase L-L Volts		0	717	16 bit Real			1
Analog	m.GEN MAIN 2 PF Total		0	718	16 bit Real			1
Analog	m.GEN MAIN 2 kW Total		0	719	16 bit Real			1
Analog	m.GEN MAIN 2 kWD Total		0	720	16 bit Real			1
Analog	m.GEN MAIN 2 kWH -Total		0	721	32 bit Real			2
Analog	m.GEN MAIN 3 Phase A Amps		0	723	16 bit Real			1
Analog	m.GEN MAIN 3 Phase B Amps		0	724	16 bit Real			1
Analog	m.GEN MAIN 3 Phase C Amps		0	725	16 bit Real			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.GEN MAIN 3 Amps 3-Ph Ave		0	726	16 bit Real			1
Analog	m.GEN MAIN 3 Phase L-N Volts		0	727	16 bit Real			1
Analog	m.GEN MAIN 3 Phase L-L Volts		0	728	16 bit Real			1
Analog	m.GEN MAIN 3 PF Total		0	729	16 bit Real			1
Analog	m.GEN MAIN 3 kW Total		0	730	16 bit Real			1
Analog	m.GEN MAIN 3 kWD Total		0	731	16 bit Real			1
Analog	m.GEN MAIN 3 kWH -Total		0	732	32 bit Real			2
Analog	m.GEN MAIN 4 Phase A Amps		0	734	16 bit Real			1
Analog	m.GEN MAIN 4 Phase B Amps		0	735	16 bit Real			1
Analog	m.GEN MAIN 4 Phase C Amps		0	736	16 bit Real			1
Analog	m.GEN MAIN 4 Amps 3-Ph Ave		0	737	16 bit Real			1
Analog	m.GEN MAIN 4 Phase L-N Volts		0	738	16 bit Real			1
Analog	m.GEN MAIN 4 Phase L-L Volts		0	739	16 bit Real			1
Analog	m.GEN MAIN 4 PF Total		0	740	16 bit Real			1
Analog	m.GEN MAIN 4 kW Total		0	741	16 bit Real			1
Analog	m.GEN MAIN 4 kWD Total		0	742	16 bit Real			1

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VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.GEN MAIN 4 kWH -Total		0	743	32 bit Real			2
Digital	m.Gen 1 Run Status			745	Digital Coil			1
Digital	m.Gen 2 Run Status			746	Digital Coil			1
Digital	m.Gen 3 Run Status			747	Digital Coil			1
Digital	m.Gen 4 Run Status			748	Digital Coil			1
Digital				749	Digital Coil			1
Digital				750	Digital Coil			1
Digital				751	Digital Coil			1
Digital				752	Digital Coil			1
Analog+ 2:32	m.CHILLER 1 Phase A Amps		0	753	16 bit Real			1
Analog	m.CHILLER 1 Phase B Amps		0	754	16 bit Real			1
Analog	m.CHILLER 1 Phase C Amps		0	755	16 bit Real			1
Analog	m.CHILLER 1 Amps 3-Ph Ave		0	756	16 bit Real			1
Analog	m.CHILLER 1 Phase L-N Volts		0	757	16 bit Real			1
Analog	m.CHILLER 1 Phase L-L Volts		0	758	16 bit Real			1
Analog	m.CHILLER 1 PF Total		0	759	16 bit Real			1
Analog	m.CHILLER 1 kW Total		0	760	16 bit Real			1
Analog	m.CHILLER 1 kWD Total		0	761	16 bit Real			1
Analog	m.CHILLER 1 kWH -Total		0	762	32 bit Real			2
Analog	m.CHILLER 2 Phase A Amps		0	764	16 bit Real			1
Analog	m.CHILLER 2 Phase B Amps		0	765	16 bit Real			1

VENTILATION TEMPLATE								
Type	**Name**	**BAS Point Description**	**Value**	**Modbus Register**	**Register type**		**BACnet ID**	**# Registers**
Analog	m.CHILLER 2 Phase C Amps		0	766	16 bit Real			1
Analog	m.CHILLER 2 Amps 3-Ph Ave		0	767	16 bit Real			1
Analog	m.CHILLER 2 Phase L-N Volts		0	768	16 bit Real			1
Analog	m.CHILLER 2 Phase L-L Volts		0	769	16 bit Real			1
Analog	m.CHILLER 2 PF Total		0	770	16 bit Real			1
Analog	m.CHILLER 2 kW Total		0	771	16 bit Real			1
Analog	m.CHILLER 2 kWD Total		0	772	16 bit Real			1
Analog	m.CHILLER 2 kWH -Total		0	773	32 bit Real			2
Analog	m.CHILLER 3 Phase A Amps		0	775	16 bit Real			1
Analog	m.CHILLER 3 Phase B Amps		0	776	16 bit Real			1
Analog	m.CHILLER 3 Phase C Amps		0	777	16 bit Real			1
Analog	m.CHILLER 3 Amps 3-Ph Ave		0	778	16 bit Real			1
Analog	m.CHILLER 3 Phase L-N Volts		0	779	16 bit Real			1
Analog	m.CHILLER 3 Phase L-L Volts		0	780	16 bit Real			1
Analog	m.CHILLER 3 PF Total		0	781	16 bit Real			1
Analog	m.CHILLER 3 kW Total		0	782	16 bit Real			1
Analog	m.CHILLER 3 kWD Total		0	783	16 bit Real			1

VENTILATION TEMPLATE								
Type	Name	BAS Point Description	Value	Modbus Register	Register type		BACnet ID	# Registers
Analog	m.CHILLER 3 kWH -Total		0	784	32 bit Real			2
Analog	m.CHILLER 4 Phase A Amps		0	786	16 bit Real			1
Analog	m.CHILLER 4 Phase B Amps		0	787	16 bit Real			1
Analog	m.CHILLER 4 Phase C Amps		0	788	16 bit Real			1
Analog	m.CHILLER 4 Amps 3-Ph Ave		0	789	16 bit Real			1
Analog	m.CHILLER 4 Phase L-N Volts		0	790	16 bit Real			1
Analog	m.CHILLER 4 Phase L-L Volts		0	791	16 bit Real			1
Analog	m.CHILLER 4 PF Total		0	792	16 bit Real			1
Analog	m.CHILLER 4 kW Total		0	793	16 bit Real			1
Analog	m.CHILLER 4 kWD Total		0	794	16 bit Real			1
Analog	m.CHILLER 4 kWH -Total		0	795	32 bit Real			2
Analog				797	16 bit Real			1
Analog				798	16 bit Real			1
Analog				799	16 bit Real			1

APPENDIX G: EQUIPMENT EVALUATION SHEETS

APPENDIX G-1: Two Chiller Energy Analysis Spreadsheet

Refer to Appendix G-1_2 Chiller Energy Analysis Spreadsheet.xlsx.

APPENDIX G-2: Three Chiller Energy Analysis Spreadsheet

Refer to Appendix G-2_3 Chiller Energy Analysis Spreadsheet.xlsx.

APPENDIX G-3: Four Chiller Energy Analysis Spreadsheet

Refer to Appendix G-3_4 Chiller Energy Analysis Spreadsheet.xlsx.

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