1.1 Chilled Water Systems Chiller C-1, Chilled Water Pumps CWP-1,2

The chiller will have a BMS interface card to allow all the chiller parameters to be mapped back to the existing work station. The chilled water pumps shall be equipped with VFD drives. These drives shall also be equipped with communication cards to allow the points to be mapped back to the existing OWS. The lead chilled water pump will start whenever the outside air temperature is above 55 degrees and either one of the two AHU is energized. The speed of the pump shall vary from a water differential pressure transmitter to maintain a set differential. A pump lead-lag DDC system shall be provided for the new chilled water pumps.

Chilled Water Temperature & BTU monitoring:
The controller shall measure the building loop chilled water supply and return temperatures. In combination with the loop flow meter, a BTU value shall be calculated and historically trended for peak and minimum usage on a daily, weekly and monthly basis.

Alarms shall be provided as follows:

- High Chilled Water Supply Temperature: If the chilled water supply temperature is 5°F (adj.) greater than the designed value.
- Low Chilled Water Supply Temperature: If the chilled water supply temperature is 5°F (adj.) less than the designed value.
- Lead Pump Failure

1.2 Hot Water System

This new heat exchanger will provide hot water to the new reheat coils. These systems shall run continuously. (Reheat available year round). Steam shall be extended from the existing plant.

A new PRV system will be provided by the mechanical contractor to reduce the steam from medium pressure to low pressure. all miscellaneous control wiring for the condensate receiver tanks and pumps shall be provided.

The hot water will be maintained by modulating the steam 1/3 and 2/3 control valves in sequence to maintain 180 degree supply. Provide a hot water pump lead lag rotation to rotate the lead hot water pump once a month and automatically start the lag pump whenever the lead pump fails.

Provide water differential pressure sensors located on the 2th floor. These sensors shall, via the ASC, modulate the lead hot water pump speed to maintain its setting.

Hot Water Temperature & BTU monitoring:
Provide a steam measuring station to measure and document the amount of steam usage for this building

Alarms shall be provided as follows:

- High Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Hot Water Supply Temp: If less than 100°F (adj.) when heating is enabled.
- Lead Pump Failure

1.3 Variable Air Volume AHU's 1&2

AHU's 1&2 operate in unison to provide heating, cooling and ventilation to the Research Building supply riser which serves VAV boxes. Each AHU contains isolation dampers on the outside, supply, return and exhaust ducts. These dampers serve to isolate one AHU from the other if in cases of maintenance or a loss of flow across a fan. Under normal operating conditions, these two AHU's will operate as a single AHU responding to the needs of the building.

When one of the four AHU's is off, its associated isolation dampers shall be closed. When the AHU is enabled for operation, the unit fan will ramp up to 50% of the current fan speed control signals and then the isolation dampers shall open (this is to prevent reverse rotation of the fan that is off). Once the isolation dampers are open, the fan speeds will track the other unit fan speeds in unison to maintain the necessary system static pressures and flows.

The AHU's outside air ducts run to the common outside air intake plenum. Each duct will have a motorized two position damper that shall open when the AHU's are operating.

Run Conditions - Requested:
The unit(s) shall run whenever:

- Any zone is occupied.
- OR a definable number of unoccupied zones need heating or cooling.

Freeze Protection:
The unit(s) shall shut down via a hard wired safety circuit and generate an alarm upon receiving a low limit alarm from switch. Provide one low temperature switch for each 10 foot of square feet.

High/Low Static Shutdown:
The unit(s) shall shut down via a hard wired safety circuit and generate an alarm upon receiving a high or low static shutdown signal from either the supply fan discharge cutout switch or the return fan inlet cutout switch.

Duct Smoke Detection:
The unit(s) shall shut down and close the supply, return and outside air dampers via a hard wired safety circuit and generate an alarm upon receiving a supply or return duct smoke detection alarm. There shall be supply duct smoke detectors(provided by the EC) and on the first and second floor for each of the main return shaft to the return shaft. Each AHU shall have an individual return duct smoke detector located near the unit.

AHU Optimal Start:
The unit(s) shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.

Supply Fan(s):
The supply fan(s) shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan(s) shall have a user definable (adj.) minimum runtime.

Alarms shall be provided as follows for each fan:

- Supply Fan Failure: Commanded on, but the status is off.
- Supply Fan in Hand: Commanded off, but the status is on.
- Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Low Temperature cutout tripped
- Smoke Detector tripped
- High or Low static tripped

Supply Air Duct Static Pressure Control:
The controller shall measure the second floor duct static pressure and modulate the supply fan variable frequency drives in unison to maintain a minimum duct static pressure setpoint for all static pressure sensing locations. The static pressure setpoint shall be reset based on zone cooling requirements.

- The initial duct static pressure setpoint shall be 1.5in H2O (adj.).
- As cooling demand increases, the setpoint shall incrementally reset up to a maximum of 1.8in H2O (adj.).
- As cooling demand decreases, the setpoint shall incrementally reset down to a minimum of 1.3 in H2O (adj.) .

Alarms shall be provided as follows:

- High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
- Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.

A local supply fan discharge duct static pressure sensor will limit the discharge static pressure from the supply fan(s) from exceeding 3" w.c. (adj.)

Return Fan:
The return fan(s) shall run whenever the associated supply fan(s) runs.

Alarms shall be provided as follows for each fan:

- Return Fan Failure: Commanded on, but the status is off.
- Return Fan in Hand: Commanded off, but the status is on.
- Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Return Airflow:
The return fan variable frequency drive(s) shall modulate in unison to maintain a total system return air volume of the total supply air volume less the total outside air volume plus or 5% (adj.) to maintain a positive building static pressure (the volume offset to be confirmed during building commissioning).

RAtv = (SAtv - (OAtv+ (5% x OAtv)))
RAtv = Return Air Total Volume
SAtv = Supply Air Total Volume
OAtv = Outside Air Total Volume

Alarms shall be provided as follows:

- High Return Airflow: If the total return airflow is [an adjustable percentage] greater than setpoint.
- Low Return Airflow: If the total return airflow is [an adjustable percentage] less than setpoint.

Supply Air Temperature Setpoint - Optimized:
The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements

The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:

- The initial supply air temperature setpoint shall be 55°F (adj.).
- As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
- As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 65°F (adj.).

Heating Coil Valve(s):
The controller shall measure the supply air temperature and modulate the heating coil valve(s) in conjunction with the face and bypass dampers to maintain the supply air temperature setpoint of 50 degrees.

Heating shall be enabled whenever:

- Outside air temperature is less than 60°F (adj.).
- AND the associated supply fan status is on.

The heating coil valve shall fully open for freeze protection whenever any of the following occurs:

- Mixed air temperature drops from 50°F to 45°F (adj.). The face and bypass dampers shall modulate to maintain the supply air temperature of 55 degrees with the heating coil valve full open.
- The low limit is on. Under this condition, the unit fans shall de-energize and an alarm shall be generated.
- Whenever the unit fans are shut down per normal time schedule, the face and bypass dampers shall modulate to maintain an interior plenum temperature of 55 degrees. If this temperature is exceeded even when the dampers are in the full bypass position (shielding the heating surfaces), the heating coil valve may then modulate to maintain the required interior plenum temperature.

Cooling Coil Valve(s):
The controller shall measure the supply air temperature and modulate the cooling coil valve(s) to maintain its cooling setpoint of 55 degrees.

Cooling shall be enabled whenever:

- Outside air temperature is greater than 50°F (adj.).
- AND the economizer is disabled or fully open.
- AND the associated supply fan status is on.
- AND the heating is not active.

The cooling coil valve shall open to 50% (adj.) whenever the low limit is on.

The cooling coil discharge air temperature sensor shall be monitored for high and low temperature conditions

Alarms shall be provided as follows:

- High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.
- High Cooling Coil Discharge Air Temp: If the discharge air temperature is 5°F (adj.) greater than the supply air temperature setpoint.
- Low Cooling Coil Discharge Air Temp: If the discharge air temperature is 45°F (adj.) or less.

Low Supply Air Temperature Alarm:
The controller shall alarm if the supply air temperature is less than 45°F (adj.).

Humidifier Control:
When the controller is not calling for humidity, sensed by the return air and/or zone humidity sensors, the electronic steam humidifiers shall not provide steam to the units. When the controller is calling for humidity, the electronic steam humidifiers shall be enabled.

The controller shall measure the common return air humidity and monitor three (3) space humidity sensors connected to terminal unit controllers (one sensor associated to each of the floor in the building). These sensors shall be used to maintain the building humidity setpoint of 50% RH (adj.) by resetting the supply air humidity setpoint through a cascaded loop between 25% RH (adj.) and 75% RH (adj.).

A duct high humidity limit sensor in each AHU will close the steam control valve through a hard wired safety circuit if the duct humidity exceeds 85% RH.

The humidifier shall be enabled whenever:

- Return air humidity or other humidity sensor is below setpoint.
- AND the cooling is off.
- AND the associated supply fan status is on.

The supply air humidity sensor(s) shall be monitored for high humidity conditions when cooling is off as follows:

- High Supply Air Humidity: If the supply air humidity is greater than 80% RH (adj.).

If a High Supply Air Humidity alarm is generated, the controller shall disenable the electronic steam humidifiers.

Exhaust Duct Static Pressure Control:
The controller shall measure the exhaust duct static pressure and modulate the exhaust air damper(s) in unison to maintain the exhaust duct static pressure setpoint of 0.25in H2O (adj.). The exhaust air damper control shall be enabled when the supply fan status is proven. The exhaust air damper will close when the unit is off.

Alarms shall be provided as follows:

- High Exhaust Static Pressure: If the static pressure is 25% (adj.) greater than setpoint.
- Low Exhaust Static Pressure: If the building static pressure is 25% (adj.) less than setpoint.

Building Static Pressure:
The controller shall measure the building static pressure in each of the four common areas of the building on the second floor and monitor that the building is operating at a positive static pressure.

Alarms shall be provided as follows:

- High Building Static Pressure: If the building static pressure is 0.1" wc (adj.) or greater.
- Low Building Static Pressure: If the building static pressure is 0.0" wc (adj.) or less.

Economizer:
The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum outside air flow as scheduled on the mechanical drawings whenever occupied. All AHU economizers shall operate in unison.

The economizer shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the outside air enthalpy is less than 22Btu/lb (adj.)
- AND the outside air temperature is less than the return air temperature.
- AND the outside air enthalpy is less than the return air enthalpy.
- AND the supply fan status is on.

The economizer shall close whenever:

- Mixed air temperature drops from 40°F to 35°F (adj.)
- OR the low limit is on.
- OR on loss of supply fan status.

The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off.

Prefilter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the prefilter.

Alarms shall be provided as follows:

- Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).

Final Filter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the final filter.

Alarms shall be provided as follows:

- Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

Mixed Air Temperature:
The controller shall monitor the mixed air temperature and use as required for economizer control or heating control .

Alarms shall be provided as follows:

- High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
- Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

Return Air Humidity:
The controller shall monitor the common return air humidity and use as required for economizer control or to reset the discharge air humidity setpoint control .

Alarms shall be provided as follows:

- High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
- Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

Return Air Temperature:
The controller shall monitor the return air temperature in each of the four main return air trunks as well as the common return air plenum and use as required for setpoint control or economizer control .

Alarms shall be provided as follows:

- High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
- Low Return Air Temp: If the return air temperature is less than 45°F (adj.).

Supply Air Temperature:
The controller shall monitor the supply air temperature from each AHU as well as the common supply air plenum.

Alarms shall be provided as follows:

- High Supply Air Temp: If the supply air temperature is greater than 90°F (adj.).
- Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

Water Flow Monitoring:
Both the heating coil and the cooling coil will have water flow sensors for monitoring purposes.

1.4 Make Up Air Unit-MAU-1 (MER)

This shall consist of outside air and return dampers, filters, hot water coil with integral face and bypass damper, constant volume supply fan. The unit is design to run fulltime to ventilate and heat the basement MER.

A unit will be provided with a combination starter disconnect provided by the mechanical contractor. Provide all miscellaneous control wiring for the starter and low temperature cutouts and duct smoke detectors shutdown circuit.

The unit fan shall run continuously, whenever the unit fan is energized the outside air damper will open to the minimum position to provide the scheduled flow of outside air. This setting shall be adjustable from the BAS work station.

Provide a discharge air transmitter to modulate the hot water valve in sequence with the outside air and return dampers to maintain a 70 degree discharge at all times. Upon a raising discharge temperature, the hot water valve shall modulate close while the outside air damper remains at a minimum position. On a continued raise in discharge temperature the outside air damper shall begin to modulate open while the return damper closes, at no time shall the discharge air fall below 70 degrees.

Provide a low temperature protection thermostat in the heating coil discharge to de-energize the unit fan and alarm at the OWS. Also the electrical contractor will furnish duct detectors it will be this contractor's responsibility to wire the fan shutdown circuit into the detectors and alarm at the OWS.

Freeze Protection:
The unit shall shut down via a hard wired safety circuit and generate an alarm upon receiving a low limit alarm from switch.

Duct Smoke Detection and Smoke Dampers:
The unit shall shut down and close the outside and return duct dampers via a hard wired safety circuit and generate an alarm upon receiving a supply or return duct smoke detection alarm. Detectors are by the EC.

Supply Fan:
The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
Alarms shall be provided as follows:

- Supply Fan Failure: Commanded on, but the status is off.
- Supply Fan in Hand: Commanded off, but the status is on.
- Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Prefilter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the prefilter.

Alarms shall be provided as follows:

- Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).

Supply Air Temperature:
The controller shall monitor the supply air temperature.

Alarms shall be provided as follows:

- High Supply Air Temp: If the supply air temperature is greater than 100°F (adj.).
- Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

1.5 Toilet Exhaust Fan EF-1

This fan shall serve the general restrooms. Provide a occupied unoccupied time schedule and an interlock to issue that if either AHU supply fan is on this fan is energized.

1.6 VAV - Terminal Unit - With Reheat/Radiation

Run Conditions - Scheduled:
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
- A 74°F (adj.) cooling setpoint
- A 70°F (adj.) heating setpoint.
- Unoccupied Mode (night setback); The unit shall maintain
- A 85°F (adj.) cooling setpoint.
- A 55°F (adj.) heating setpoint.

Alarms shall be provided as follows:

- High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

Zone Temperature Sensing and Control:
The zone temperature will be sensed by an area sensor or space thermostat (depending on the type of space), located in the the space served. Local adjustment and/or overrides shall be provided where thermostats are indicated. For areas controlled by sensors, all adjustments and overrides will be performed though the campus wide building automation system.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

Zone Unoccupied Override:
A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

Variable Volume Terminal Unit - Flow Control:
The unit shall maintain zone setpoints by controlling the airflow through one of the following:

Occupied:

- When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
- When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
- When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint and the zone damper shall maintain the minimum required zone ventilation (adj.).

Unoccupied:

- When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).
- When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
- When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint and the zone damper shall maintain the minimum required zone ventilation (adj.).

Reheating Coil Valve:
The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.

Radiant Panel Heating Coil Valve: (Only on units with perimeter radiation)
In zones with radiant heat panels, these will operate when the outside air temperature is below 50°F (adj.). When a radiant panel is enabled, it will operate as the first stage of heat within a zone.

Discharge Air Temperature:
The controller shall monitor the discharge air temperature.

Alarms shall be provided as follows:

- High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
- Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

Space Humidity Monitoring:
Selected controllers shall have space humidity sensors connected to them for control of the humidification system. Refer to the AHU sequences for the arrangement and operation of the space humidity sensors.

Space CO2 Monitoring:
Provide a space IAQ sensor for selected conference rooms and rooms of high density occupancy. On a rising PPM reading in carbon dioxide, the respective box VAV minimum position shall be reset upwards to allow more supply air into the zone. The reheat coil shall remain in control of zone temperature. Upon a farther rise in carbon dioxide PPM, an alarm shall be sent to the BAS workstation.

1.7 VAV's with Split A/C units

Certain rooms are served with a VAV box and a Split A/C system. The VAV box is to operate as described previously when the associated AHU is on. The Split A/C system will operate via its self contained thermostat when the VAV box cannot maintain the space cooling setpoint or the associated AHU is off. It is this contractor's responsibility to provide all control wiring between the indoor and outdoor units.

1.8 Hot Water Unit Heater and Cabinet Heater Controls

A wall or unit mounted DDC thermostat (see plans) shall modulate the unit control valve and cycle the unit fan to maintain space temperature upon a decrease in space temperature. The valve shall modulate close and de-energize the fan upon the space temperature being satisfied. The operation shall be able to de-energize either the heating, fan or both if the Owner needs to.

1.9 Heat Trace Monitoring

Provide an enable-relay current switch to alarm the BAS workstation when any heat trace tape fails when enabled. Failure of heat trace tape shall be identifiable by location including plumbing piping in Basement areaway plenum, chilled water piping outside of building at chiller, and chiller components. . Heat trace tape shall be enabled by outside air temperature.

2.0 Sump Pump Alarm

Provide into the DDC BAS all alarm reporting capabilities of each elevator sump pump, such as pump failure or high water level.

2.1 Booster Pump

The booster pump controller panel will be provided with a communication interface via Lon or BACnet to the BAS system. The BAS shall be able to read run time, pump rpm, power/LEW/LEWH, KW, inlet and outlet pressures from this interface. All operating parameter settings and alarms shall be extended to the BAS system.

2.2 Electric Water Heaters

Provide a DDC strap-on sensor at the HW discharge leaving the tank. Provide all alarms, monitoring, and reporting capabilities to the DDC system. This sensor will alarm if the water temperature rises above 130 degrees F or falls below set point. The campus DDC system shall monitor HW temperature and provide means to control or disable the system from the main BAS work station.

2.3 Co-ordination

1. Provide and assist the air balance contractor with the balancing software to maintain the required airflows.
2. Provide factory or field mounting of the DDC controllers as required by the box manufacturer.
3. All 120 volt power and control wiring to atc panels, vav box actuators, combination f/s dampers and local ASC shall be by the EC.
4. All above points shall be mapped back to the existing OWS. Provide graphics for all new AHUs, pumps, split systems and exhaust fans.
5. All DDC wiring above accessible ceilings shall be run with open cable.

FOR CONSTRUCTION
FULLY SPRINKLERED

Revisions:	Date

CONSULTANTS:

HDR Architecture, Inc.
1101 King Street | Suite 400 | Alexandria, Virginia 22314-2944 | 703.518.8500

ARCHITECT/ENGINEERS:

ARCHITECTURE
ENGINEERING
INTERIOR DESIGN
DESIGN/BUILD
ASTORINO
227 Fort Pitt Boulevard Pittsburgh Pennsylvania 15222
TEL 412 765 3700 FAX 412 765 3711 www.astorino.com

Drawing Title	HVAC Sequence of Operations
Approved: Project Director	
Project Title	VA CARES CONSOLIDATION VAMC, PITTSBURGH, PA RESEARCH OFFICE BLDG.
Location	VAPHS UNIVERSITY DRIVE
Date	08-18-10
Checked	JS
Drawn	RAN
Project Number	646CA2500R
Building Number	30
Drawing Number	MH7-106
Dwg. . of	

Office of Facilities Management
Department of Veterans Affairs

VA FORM 08-6231, OCT 1978