



STANFORD UNIVERSITY



HVAC Sequences of Operation

Stanford SEQ2

Environment and Energy Building



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HVAC Sequence of Operations

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CHILLED WATER SYSTEM

(serving AHU's and Laboratories requiring additional cooling)

The campus central plant provides chilled water to the Stanford SEQ2 E&E building. A booster pump (CHWP-B1) is located in the mechanical room of the building. Control valves and the booster pump will be used to provide the required chilled water to the building.

Differential Pressure Control – Normal Operation

The main chilled water control valve is modulated to maintain the required pressure differential between the building supply and return lines. This pressure differential shall be determined during the test and balance of the building. When the required differential is not met for five minutes (Adj.) with the main control valve at 100% open, the EM&CS shall enable CHWP-B1. The VFD controlling the speed of CHWP-B1 shall be modulated to maintain the required differential pressure until the VFD speed is reduced to 15% of full speed, at which time the pump shuts off and pressure differential control reverts back to the main control valve.

Maximize Chilled Water Return Temperature By Reducing Flow

While maintaining the differential pressure, if the chilled water return temperature drops below 58°F for 5 minutes (adj), the EM&CS shall reset down the differential pressure setpoint. The EM&CS shall maintain a minimum differential pressure setpoint to ensure that balanced flow is maintained in the building. This minimum setpoint shall be determined during the test and balance of the building.

Maximize Chilled Water Return Temperature by Re-circulating the Return Chilled Water

If the return temperature continues to drop and falls below 55°F for 5 minutes (adj), the EM&CS shall start CHWP-B1 and ramp up the speed to maintain the differential pressure setpoint. The EM&CS shall then modulate closed the main control valve to maintain the chilled water return temperature above 58°F. The EM&CS shall monitor the temperature of the chilled water supplying the building during this time. If this mixed water temperature drops below 48°F then control of the system shall revert to Normal Operation.

Alarms and Monitoring

Description	Monitor	Alarm When	Duration of alarm condition before alarming	EM&CS	BMS	From BMS to EM&CS	
						24/7	Next Work Day
CHW Pump Differential Pressure when running		3 psig below setpoint	5 min	X			
CHW Supply Temperature to building	X			X			
CHW Return Temperature		2°F below setpoint	10 min	X			
CHW Flow Meter (GPM)	X			X			
Cooling Capacity (Calculated) Capacity (Btu/hr) = GPM * 500 * (CHWR Temp – CHWS Temp)	X			X			
CHW Pump VFD Fault / Status	X	General Fault		X			

TEMPERED CHILLED WATER (CHWP-B2 / CHWP-B3) (for Active Beams)

The tempered chilled water loop consists of two base-mounted end-suction pumps located in the mechanical room. These pumps circulate water through a closed loop that feeds the active chilled beams throughout the building.

Pump On/Off and Speed Control

CHWP-B2 and CHWP-B3 shall be controlled through the building management system (BMS). System on/off and lead/lag position will be through a weekly schedule programmed into the BMS.

When tempered chilled water is required, the lead pump shall be staged on. If the lead pump cannot maintain the differential pressure setpoint for 5 min (adj), the lag pump shall be started. Both pumps shall ramp up to their maximum speed and then ramp down together to maintain the differential pressure setpoint.

The BMS shall maintain the differential setpoint by controlling the speed of the VFD's. The differential setpoint shall be adjustable through the BMS and set during the test and balance of the tempered chilled water system.

When both pumps are running, if they are running below 25 Hz for a period of 5 min (adj) then the lag pump shall be staged off. Both pumps shall be staged off during unoccupied hours. If a thermostat override is activated within the building and there is a call for cooling in that zone, the lead pump shall be enabled.

Temperature Control - Normal Operation

The tempered chilled water supply shall be maintained at a temperature of 60°F (adj). A control valve in the line returning water to the building chilled water system will be used to maintain the setpoint. When the tempered chilled water supply temperature rises above 60°F the control valve shall modulate open. When the tempered chilled water supply drops below 60°F the control valve shall modulate closed. On loss of power the control valve shall fail closed.

Supply Temperature Reset

In order to ensure that water does not condense on the active chilled beam, the tempered chilled water may need to be reset. The BMS shall monitor the outside air dewpoint. If the dewpoint of the outside air rises above 58°F (adj.) for a period of 5 minutes (adj.) the tempered chilled water supply setpoint shall be reset to stay 2°F above the dewpoint. If the outside air dewpoint drops below 58°F (adj.) for a period of 5 minutes (adj.) the tempered chilled water supply setpoint shall revert back to normal control.

Alarms and Monitoring

See section on Alarms and BMS Point List.

STEAM SUPPLY and STEAM CONDENSATE RETURN

High Pressure steam at 125 psig is supplied to the Stanford SEQ2 E & E building from the campus central utilities.

The steam enters a two-stage pressure reducing station and is reduced to 60 psig and then to 15 psig. The low-pressure steam, 15 psig, is supplied to the building steam-to-hot water heat exchanger and the domestic hot water heater.

Alarms and Monitoring

Description	Monitor	Alarm When	Duration of alarm condition before alarming	EM&CS	BMS	From BMS to EM&CS	
						24/7	Next Work Day
Low pressure steam temperature	X			X			
Low pressure steam pressure		Above 16 psig / below 13 psig.	5 min	X			
Steam Flow Rate	X			X			

HEATING HOT WATER SYSTEM (HX-1, HWP-B1, HWP-B2) (for Air Handlers, Reheat coils for Laboratories, and Baseboard Heating)

The heating hot water system consists of a steam-to-hot water shell-and-tube heat exchanger (HX-1) with 1/3 and 2/3 capacity control valves, hot water circulation pumps (HWP-B1 / HWP-B2) with variable frequency drives, air separator, expansion tank, make-up water station, and pot feeder.

System On/Off and Pump Speed Control

The heating system shall be operated by the Building Management System (BMS) and shall operate 24/7. Hot water pump lead/lag position shall be alternated on a weekly basis.

When hot water is required, the lead heating hot water pump shall be started. If the lead pump cannot maintain the differential pressure setpoint for 5 min (adj), the lag pump shall be started. Both pumps shall ramp up to their maximum speed and then ramp down together to maintain the differential pressure setpoint. The BMS shall maintain the differential setpoint by controlling the speed of the VFD's. The differential setpoint shall be adjustable through the BMS and set during the test and balance of the hot water system.

When both pumps are running, if they are running below 25 Hz for a period of 5 min (adj) then the lag pump shall be staged off. Both pumps shall be staged off during unoccupied hours. If a thermostat override is activated within the building and there is a call for heating in that zone, the lead pump shall be enabled.

When hot water is not required, the steam control valves for HX-1 shall be closed. The pumps shall remain running for 2 minutes (adj) to dissipate residual heat in the heat exchanger and then the pumps shall be shut off.

Temperature Control - Normal Operation

The hot water system shall maintain a HHW supply temperature of 180°F (adj). Prior to opening the steam control valves for HX-1 hot water flow shall be verified by checking the differential pressure switches off of each pump. If there is no flow then the steam control valve shall remain closed.

Upon proof of flow, the 1/3 capacity steam control valve (CV-1) shall be modulated open to maintain the setpoint temperature. If the HHW supply temperature rises above the setpoint, the steam control valve shall modulate closed to maintain the setpoint temperature. If CV-1 is full open and cannot maintain the temperature setpoint then the 2/3 capacity control valve (CV-2) shall be opened. If the HHW supply temperature rises above the setpoint, the steam control valve, CV-2, shall modulate closed to maintain the setpoint temperature. (Open and close valves slowly)

Alarms and Monitoring

See section on Alarms and BMS Point List.

TEMPERED HOT WATER (HWP-B3 / HWP-B4) (for Active Beams and Radiant Slab)

The tempered hot water loop consists of two base-mounted end-suction pumps located in the mechanical room. These pumps circulate water through a closed loop that feeds the active beams throughout the building and the radiant slab on the first floor.

Pump On/Off and Speed Control

HWP-B3 and HWP-B4 shall be controlled through the building management system (BMS). System on/off and lead/lag position will be through a weekly schedule programmed into the BMS.

When tempered hot water is required, the lead pump shall be staged on. If the lead pump cannot maintain the differential pressure setpoint for 5 min (adj), the lag pump shall be started. Both pumps shall ramp up to their maximum speed and then ramp down together to maintain the differential pressure setpoint.

The BMS shall maintain the differential setpoint by controlling the speed of the VFD's. The differential setpoint shall be adjustable through the BMS and set during the test and balance of the tempered chilled water system.

When both pumps are running, if they are running below 25 Hz for a period of 5 min (adj) then the lag pump shall be staged off. Both pumps shall be staged off during unoccupied hours. If a thermostat override is activated within the building and there is a call for heating in that zone, the lead pump shall be enabled.

Temperature Control - Normal Operation

The tempered hot water supply shall be maintained at a temperature of 110°F (adj). A control valve in the line returning water to the house hot water system will be used to maintain the setpoint. When the tempered hot water supply temperature drops below 110°F the control valve shall modulate open. When the tempered hot water supply rises above 110°F the control valve shall modulate closed.

Alarms and Monitoring

See section on Alarms and BMS Point List.

AIR HANDLING UNITS (AHU-R1, AHU-R2, AHU-R3):

The AHU's will operate continuously to supply air to the laboratory spaces. The EM&CS will control the supply fan VFD to maintain the static pressure setpoint at a sensor in the supply air main just upstream of the basement FSD's. Leaving air will be maintained at 65°F with a maximum dewpoint of 60°F. A heat recovery "heat pipe" with bypass, hot water heating coil, and chilled water cooling coil with bypass will be used to accomplish the temperature and dewpoint control.

Cooling:

Heat Pipe – Heat Recovery

When the outside air temperature is above the exhaust air temperature, the heat pipe bypass damper will modulate closed, forcing air to pass over the heat pipe for pre-cooling. The heat pipe bypass damper shall be modulated to maintain a leaving air temperature of 1°F less than the supply air temperature setpoint (SAT-1). When the outside air temperature is below the exhaust air temperature but above the leaving air set point, the heat pipe bypass damper will be fully opened allowing air to bypass the heat pipe.

Chilled Water

If the supply air temperature is above SAT-1 for a period of 5 min (adj) and the hot water control valve is closed, the chilled water coil bypass damper shall be fully closed and the CHW control valve modulated open to maintain SAT-1. If the supply air temperature drops below SAT-1 the CHW control valve shall be modulated closed. If the supply air temperature continues to be below SAT-1 for a period of 5 min. (adj), the chilled water bypass damper shall be fully opened.

Heating:

Heat Pipe – Heat Recovery

When the outside air temperature falls below the heat pipe leaving air temperature and the exhaust air temperature is above the heat pipe leaving air temperature, then the heat pipe bypass damper will modulate closed, forcing air across the heat pipe for preheating. The heat pipe bypass damper shall be modulated to maintain a leaving air temperature 1°F more than SAT-1. When the outside air temperature rises above SAT-1 or the exhaust air temperature is below the outside air temperature, the heat pipe bypass damper will be fully opened allowing air to bypass the heat pipe.

Hot Water

If the supply air temperature is below SAT-1 for a period of 5 min (adj) and the chilled water control valve is closed, the hot water control valve will modulate open to maintain SAT-1. The bypass damper on the chilled water coil shall be fully open during this time.

Dehumidification:

Heat Pipe

If the leaving air dewpoint exceeds 60°F, the heat pipe shall operate in heating mode only, if applicable.

Chilled Water

If the leaving air dewpoint exceeds 60°F for a period of 5 min (adj), the chilled water coil bypass damper shall be closed, the chilled water control valve shall open to maintain a leaving chilled water coil air dew point setpoint (DPS-1).

Hot Water

While DPS-1 is maintained, if the discharge temperature drops below SAT-1, the hot water control valve shall be modulated open to maintain SAT-1.

When the OSA dewpoint falls below 60°F for 10 min (adj), the control sequence will return to maintaining SAT-1 only.

Morning Warmup:

When the daytime outdoor temperature did not exceed 68°F (adj) the air-handler system will go through a morning warmup cycle to ensure adequate warmth in the interior spaces and to preheat perimeter zones. From 2am – 6am (adjustable time range) the discharge supply air temperature shall be reset up to 69°F and the terminal boxes on floors 1, 2, and 3 will open to their design setpoint. After 6am, the supply air temperature shall be returned to the normal setpoint.

Alarms and Monitoring

Description	Monitor	Alarm When	Duration of alarm condition before alarming	EM&CS	BMS	From BMS to EM&CS	
						24/7	Next Work Day
Supply Air Temperature		+/- 2°F from setpoint	5 min	X			
Leaving CHW coil air temperature	X			X			
Fan VFD Fault / Status	X	General Fault		X			
Individual Fan Failure		From VFD		X			
Heat Pipe Effectiveness	X			X			
Supply Air Flowrate	X			X			

EXHAUST FANS (EF-R1, EF-R2, EF-R3, EF-R4, EF-R5, EF-R6)

Exhaust fans operate 24 hours a day in conjunction with the AHU's. Fans 1&2, 3&4, and 5&6 operate as pairs. A VFD will be present on each fan for balancing only. The fans will exhaust a constant volume of 17,500 CFM each, for a total of 35,000 CFM per system.

Exhaust Volume Control

The exhaust from the building shall be variable volume. Two relief dampers in the duct between the AHU and the fans will modulate as required to maintain the required negative static pressure in the exhaust air riser and provide makeup air to keep a constant volume of 35,000 CFM to each pair of fans. The first damper, which is sized for 25% of makeup flow, will modulate between 0 and 100%. If the static pressure rises above the set point with damper 1 at 100% open, damper 2 will modulate open while damper 1 remains open. Damper 2 will modulate to maintain the static pressure setpoint in the exhaust plenum. When the exhaust duct static pressure falls below the setpoint for 30 seconds (adj.), damper 2 will be controlled closed and damper 1 will operate alone to maintain static pressure.

Fan Failure / Power Failure

If a fan should fail, the remaining fan shall ramp up to maximum speed while duct static pressure control remains in effect.

If power fails, the fan on emergency power shall ramp up to the “emergency power setpoint” while duct static pressure control remains in effect. The “emergency power setpoint” shall be determined through test and balance to ensure adequate exhaust through the fume hoods but not creating too negative a pressure differential in the laboratory. The terminal boxes on floors 1, 2, and 3 shall be closed and the general exhaust terminal boxes not serving fume hoods shall also be closed.

Failure of associated AHU

If an air handler's supply fan bank loses power (due to smoke detection or other power failure) then the associated exhaust system will go into a reduced exhaust mode:

- In the laboratory areas, general exhaust terminal boxes not serving fume hoods shall be closed (Note: 6 ac/hr in the laboratories will not be met during this time)

Alarms and Monitoring

Description	Monitor	Alarm When	Duration of alarm condition before alarming	EM&CS	BMS	From BMS to EM&CS	
						24/7	Next Work Day
Exhaust fan differential pressure (each fan)		Below 50% of design	5 min		X	X	
Duct (negative) static pressure setpoint		+/- 0.25" from setpoint	5 min		X	X	
Fan VFD Fault / Status	X	General Fault			X	X	
Exhaust Air Flowrate	X				X		

ACTIVE BEAMS

Throughout the building Active temperature control Beams will be utilized for heating and cooling. Temperature control shall vary for occupied and unoccupied building status. The schedule for occupied and unoccupied times shall be set by the owner and programmed at the BMS.

Air Flow Control

During building occupancy time or when the zone override is activated, the active beams are supplied with a constant volume of air from a constant volume terminal box served by one of the rooftop air handlers. The constant volume box will be setup to modulate the internal damper to maintain a constant flow through the terminal box independent of inlet pressure. When unoccupied the constant volume terminal boxes shall modulate closed.

Preliminary Terminal Box Operation Schedule serving Active Beams:

- Basement: 24 hours
- Floors 1-3: Weekday M-F: Open @ 7am, Close @ 6pm, Closed on Weekends

This schedule will be overridden if the space temperature on floors 1-3 requires night set-up or setback or during the morning warm up sequence.

Zone Temperature Control (Occupied)

Each zone is provided with a thermostat. The thermostat shall have a display with temperature and setpoint. The occupant shall be able to adjust the setpoint +/- 3°F. The thermostat shall also have a button for unoccupied override. The room setpoint shall be adjustable through the BMS. Each thermostat will be used by the BMS to control a tempered chilled water and, in some cases, a tempered hot water control valve as well. A control valve may serve one or multiple active beams.

A temperature control deadband of +/- 2°F (adj) shall be set to eliminate excessive cycling of heating and cooling.

When the zone temperature rises above the temperature setpoint and the heating hot water control valve is closed, the tempered chilled water valve shall modulate open to maintain the temperature setpoint. When the temperature drops below the setpoint, the valve shall modulate closed.

Heating: (Only used with Active Beam zones that require heating.)

A temperature control deadband of +/- 2°F (adj) shall be set to eliminate excessive cycling of heating and cooling.

When the zone temperature drops below the temperature setpoint and the chilled water control valve is closed, the tempered hot water valve shall modulate open to maintain the room temperature setpoint. When the temperature rises above the setpoint, the tempered hot water valve shall modulate closed.

Room Temperature Control (Un-Occupied)

During unoccupied times the building will be maintained at a night setback temperature range. The cooling setpoint shall be 78°F (adj). The heating setpoint shall be 65°F (adj).

Alarms and Monitoring

See section on Alarms and BMS Point List.

BASEBOARD RADIATORS

Perimeter spaces with no forced mechanical air conditioning (North and East exposures) will have hot water baseboard radiators for space heating. Each zone will have a modulating two-way hot water control valve.

Temperature Control – Normal Operation

A wall mounted thermostat shall be provided for each zone. Each thermostat shall have a display with temperature and setpoint. The occupant shall be able to adjust the setpoint +/- 3°F. The thermostat shall also have a button for unoccupied override. The zone setpoint shall be adjustable through the BMS. The BMS shall control the hot water valve to the baseboard heaters.

When the zone temperature falls below the setpoint, the control valve shall modulate open. When zone temperature is above set point, the control valve will modulate closed. When the outside air temperature is greater than 78°F (adj.) the hot water control valves shall be commanded closed.

Night Setback

During unoccupied hours the temperature setpoint shall be 65°F (adj).

Alarms and Monitoring

See section on Alarms and BMS Point List.

RADIANT FLOOR

A radiant floor heating system will be utilized at the social entry on the first floor. It is fed off of the tempered hot water piping loop. Slab temperature and space temperature sensors will be used to control the heating of the floor. A circulation pump will recirculate water through the radiant floor. A control valve on the return loop to the tempered hot water piping loop will modulate to bleed 110°F tempered hot water into the radiant floor piping system.

Temperature Control (Normal Operation)

If the outside air temperature is above 78°F, the radiant floor heating system shall be disabled. If the outside air temperature is below 78°F and there is a call for heating the circulation pump shall be started. The temperature control valve shall be opened at 10% increments (adj) at 10 minute minimum duration (adj) per stage. The hot water valve will continue to open in this fashion until the temperature setpoint (T(rad)) is achieved. At this point the hot water control valve will be maintained in the last position. If T(rad) continues to rise the hot water valve shall be closed in 5% increments (adj) at 10 minute minimum duration (adj) per stage. The control system shall reduce the hot water valve increment adjustment in order to reach a steady-state valve position. Once steady-state is achieved any valve adjustments shall occur in 1% increments (adj) each over a 10 minute period (adj). This shall continue until the call for heating has ended.

T(rad) = Average temperature between the slab temperature and the space temperature.

The initial setpoint shall be 71°F (adj).

On loss of power the temperature control valve shall fail closed to allow water to recirculate.

Night Setback

During unoccupied hours the setpoint shall be reduced to 66°F (adj).

Alarms and Monitoring

See section on Alarms and BMS Point List.

FAN COIL UNITS

Various spaces within the building are cooled using small fan coil units. These rooms are typically electrical rooms, mechanical rooms, tele/data rooms, and equipment closets. The majority of these units will be on emergency power. See the equipment schedule on the mechanical drawings to identify which systems require emergency power.

Unit On/Off

The fan coils shall run 24 hr/day, as required, to maintain space temperature and shall be controlled by the building management system (BMS).

Temperature Control – Normal Operation

A temperature sensor shall report zone temperature back to the BMS. The BMS shall control the chilled water control valve. When the zone temperature rises above the setpoint, the control valve shall modulate open. When the zone temperature is below the set point, the control valve will close.

In some cases a fan coil unit will serve two spaces. In this situation two zone sensors will be provided and the sensor furthest above setpoint will be used to control the chilled water valve.

Alarms and Monitoring

See section on Alarms and BMS Point List.

CONFERENCE ROOMS

Active chilled beams serve the conference rooms within the building. Temperature control of the conference rooms remains the same as the active beam sequence of operation. A carbon dioxide sensor shall be located within specific conference rooms, see drawings for locations. When the level of carbon dioxide exceeds the setpoint an inline supply fan shall be enabled to draw more air into the conference room to dilute the air, lowering the carbon-dioxide level. The supply fan shall remain on for ½ hour (adj). If at that point the carbon-dioxide level has dropped below the setpoint, the fan shall be shut off.

The setpoint for the carbon-dioxide shall be determined during the startup of the building. Determine the average level of carbon-dioxide in the outside air (ppm of carbon dioxide) by taking multiple readings over a period of a 4-5 days. When this base level has been determined the setpoint for carbon-dioxide within each conference room shall be set at 500 ppm above the outside air carbon-dioxide concentration.

Alarms and Monitoring

See section on Alarms and BMS Point List.

LABORATORIES

AIR FLOW, PRESSURIZATION AND TEMPERATURE CONTROL

The laboratories in the Stanford SEQ2 E&E building fall under one of the following control schemes:

1. Variable Air Volume Supply and General Exhaust
 - a. With Cooling Coil
 - b. With Heating Coil
 - c. With Fume Hood Exhaust

2. Constant Volume Supply and Exhaust
 - a. With Cooling Coil
 - b. With Heating Coil

Air Flow Control

The rate of supply air to the laboratories is controlled through variable volume or constant volume terminal boxes. The boxes shall be setup to maintain either (1) the required air changes, 6 ac/hr min, or (2) provide the proper amount of air for cooling, or (3) provides sufficient makeup air to any fume hoods within the space; whichever is greatest.

Variable Air Volume Supply and General Exhaust

A space temperature sensor will control the VAV terminal supply and exhaust boxes. The VAV supply and exhaust air terminal boxes will start at their minimum flow positions which will be balanced at building startup to meet the required air change rate for that space.

A temperature control deadband of +/- 2°F (adj) shall be set to eliminate excessive cycling of heating and cooling.

Cooling: When the space temperature rises above the setpoint, the supply air and exhaust air terminal boxes shall modulate open to maintain the space temperature setpoint. The supply and exhaust terminal boxes will maintain a set CFM differential between them as they modulate.

Heating: As the temperature drops below the setpoint, the supply air and exhaust air terminal boxes shall modulate closed to maintain the space temperature setpoint. The supply and exhaust terminal boxes will maintain a set CFM differential between them as they modulate. The supply and exhaust shall not close beyond their minimum setpoints.

With Cooling Coil

If the space temperature continues to rise and the supply air terminal box is full open then the BMS shall modulate the chilled water control valve open to

maintain the space temperature setpoint. As the temperature drops below the setpoint the BMS will modulate the chilled water control valve closed.

With Heating Coil

If the supply air terminal box is at its minimum position and the space temperature continues to fall below the setpoint, then the BMS shall modulate the hot water control valve open to maintain the space temperature setpoint. As the temperature rises above the setpoint, the BMS will modulate the hot water control valve closed.

With Fume Hood Exhaust

Fume hoods within laboratories will utilize constant volume exhaust. The VAV supply and exhaust air terminal boxes will start at their minimum flow positions which will be balanced at building startup to meet either (1) the required air change rate for that space, or (2) the makeup air required for the fume hood(s).

Constant Volume Supply and General Exhaust

The supply and exhaust air terminal units will be setup to maintain a constant volume flow through the space. The design CFM will meet either (1) the required air change rate for that space, or (2) the makeup air required for the fume hood(s); whichever is greater. The laboratory airflows will be balanced to maintain the pressurization required by offsetting the exhaust from the supply. Any fumehoods within laboratories will utilize constant volume exhaust.

With Cooling Coil

If the space temperature rises above the temperature setpoint and, if applicable, the hot water valve is closed, then the BMS shall modulate the chilled water control valve open to maintain the space temperature setpoint. As the temperature drops below the setpoint the BMS will modulate the chilled water control valve closed.

With Heating Coil

If the space temperature continues to fall below the setpoint and, if applicable, the chilled water valve is closed, then the BMS shall modulate the hot water control valve open to maintain the space temperature setpoint. As the temperature rises above the setpoint, the BMS will modulate the hot water control valve closed.

Alarms and Monitoring

See section on Alarms and BMS Point List.

BUILDING PRESSURIZATION CONTROL

Building pressure control is accomplished through supply/exhaust relationships in the basement and through atrium louver positions linked to space pressure sensors for the first through third floors.

Basement:

Although no specific pressure classes are being maintained, there are general pressure relationships that separate the different basement areas. Labs are held at a negative pressure relative to surrounding rooms by exhausting 5-10% more air than is supplied. Offices are held at a positive pressure relative to surrounding rooms by exhausting 5-10% less air than is supplied. Air supplied to the corridors will be exhausted by means of transfer into core toilet areas. Any residual corridor air will rise through the atriums.

Above Grade Levels: (First through Third)

Each floor has a two-hour rating that runs north to south around column line 6. A static pressure sensor will be located on each half of the second floor, totaling two sensors. Atriums 1&2 are located on the west side of the fire rating. Atriums 3&4 are located on the east side of the rating.

Static pressure sensor 1-West will be continuously monitored. The reading will control one louver position in Atrium 1 and one in Atrium 2. If the space pressure rises above 0.03”w.c., the louver dampers in Atrium 1 and Atrium 2 will modulate open to keep the space pressure below 0.03” w.c.

Static pressure sensor 1-East will be continuously monitored. The reading will control one louver position in Atrium 3 and one in Atrium 4. If the space pressure rises above 0.03”w.c., the louver dampers in Atrium 3 and Atrium 4 will modulate open to keep the space pressure below 0.03” w.c.

Alarms and Monitoring

See section on Alarms and BMS Point List.

NATURAL VENTILATION

Areas of Stanford's E & E building will use natural ventilation as a means of temperature control. A portion of the windows along the north and east exposures of the floors 1 through 3 will be supplied with electric actuators and controlled by the BMS. Air will be introduced at each floor through these windows. There are four atriums spaced throughout the building. Louvers with dampers located at the top of each atrium will be opened. Air will be drawn through the building by stack effect, into the atriums, and then exit out of the building.

Temperature Control – Normal Operation

Natural ventilation will be employed when bringing in the outdoor air will provide cooling or a cooling effect

The stack effect created through the floors into the atrium will be fairly consistent throughout the year. The window actuators shall be 2-position actuators and the open position shall be balanced and set for each window during the test and balance of the building. The setpoint shall maximize the flow of air through the space without creating a draft that would be uncomfortable for the occupants. The louver dampers at the top of the atrium will be modulating dampers with a setpoint position during natural ventilation that can be over-ridden and fully opened during the smoke exhaust mode within the building. The air-balance on the louvers will utilize only 3 out of the 4 louver banks per atrium. This may require two setpoints per atrium depending on louver configuration. Based on wind direction, the fourth louver bank will be closed. As the average direction of the wind changes for a period of 5 min (adj), the louver bank facing the wind shall be closed and the previously closed damper opened. (ex. if the wind is blowing from south to north, the louver on the south facing atrium wall shall be closed.)

There will be four (4) temperature zones per floor; one per floor per atrium. The operable windows shall be grouped within a temperature zone. Temperature control within each zone shall operate the associated operable windows. Each atrium will have three (3) associated temperature zones (one per floor).

The initial range for natural ventilation shall be when the outdoor air temperature is between 68°F and 85°F. The final temperature range through which natural ventilation is used will be determined when the building is occupied and in operation. When the outdoor temperature rises above 68°F (adj) and the average zone temperature is above 70°F, the louver dampers shall be opened to their set positions. For each zone where the temperature exceeds 70°F (adj) the operable windows shall also be opened. If the zone temperature drops below 70°F (adj) for a period of 5 minutes (adj), the windows within that zone shall be closed. If all operable windows associated with one atrium are closed, the louver dampers for that atrium shall be closed and revert to building pressurization control.

The windows will remain open as the outdoor temperature rises. When the outdoor temperature exceeds 85°F and a zone temperature rises above 80°F, the windows for that zone shall be closed. When the outdoor air temperature is above 70°F, if any zone

temperature is above the outdoor air temperature, the windows for that zone shall be opened.

Night Purge (Use when daytime outside air temperature exceeded 75°F)

Daily, during unoccupied hours, the windows shall be opened to pre-cool the space in preparation for the next day. This will allow cool thermal mass storage in the space to offset some of the heat load developed during the day. The night purge space temperature setpoint shall be 65°F (adj). After hours, if the outdoor air temperature drops below 65°F (adj) and the space temperature is above 65°F (adj), the windows shall be opened. The windows shall remain open until the space temperature reaches 63°F (adj). At this point the windows shall close. If the space temperature rises above 65°F (adj), the windows shall be opened again. When the space temperature reaches 63°F (adj) the windows shall be closed. This sequence is to be repeated until the space no longer climbs above 65°F (adj) or until the building is occupied.

Alarms and Monitoring

See section on Alarms and BMS Point List.

ALARMS AND BMS POINT LIST

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to Modbus	1=24X7 alarm	1=24X7 alarm	Notes
					Field Server	2=work day	2=work day	
Tempered Chilled Water (CHWP-B2 / CHWP-B3)								CHWP-B2 and CHWP-3 have LonMark VFD's
Loop differential pressure	X							
Chilled water supply temperature	X							Setpoint=60°F
Chilled water return temperature	X							
Chilled water Control valve				X				
Outside air humidity	X							
Outside air temperature	X							
CHWP-B2 Status		X						DP Swtich
CHWP-B3 Status		X						DP Swtich
Loop differential pressure alarm to EMCS					X	{+/-5PSI} 1		
CHW Supply Temperature Alarm to EMCS					X	{+/-3Deg} 1		
CHWP-B2 Fault to EMCS					X	2		
CHWP-B3 Fault to EMCS					X	2		
Main HHW System								
Heating water supply temperature	X							
Heating water return temperature	X							
Heating water system required to EMCS					X			
Tempered Hot Water (HWP-B3 / HWP-B4)								HWP-B3 and HWP-B4 have LonMark VFD's
Heating water supply temperature	X							

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to Modbus	1=24X7 alarm	1=24X7 alarm	Notes
					Field Server	2=work day	2=work day	
Heating water return temperature	X							
Heating water valve				X				
HWP-B3 status		X						DP Swtich
HWP-B4 status		X						DP Swtich
Loop diffrential pressure	X							
Loop diffrential pressure alarm to EMCS					X	{+/-5PSI} 1		
HHW Supply Temperature Alarm to EMCS					X	{+/-3Deg} 1		
HWP-B3 Fault to EMCS					X	2		
HWP-B4 Fault to EMCS					X	2		
Active Beams								
Space Temperature	X							
Space Temperature setpoint	X							
Cooling Valve				X				
Heating Valve				X				If Exists
Zone Temperature alarm to EMCS					X		{+/-5Deg} 2	
Baseboard Radiators								
Space Temperature	X							
Space Temperature setpoint	X							
Heating Valve				X				
Zone Temperature alarm to EMCS					X		{+/-5Deg} 2	
Radiant Floor								
Slab Sensor #1	X							
Slab Sensor #2	X							

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to	1=24X7 alarm	1=24X7 alarm	Notes
					Modbus	2=work day	2=work day	
					Field Server			
Slab Sensor #3	X							
Slab Sensor #4	X							
Space Temperature #1	X							
Space Temperature #2	X							
Circ Pump Start/Stop			X					
Circ Pump Status			X					
Zone Temperature alarm to EMCS					X		{+/-5Deg} 2	
Fan Coil Units								
Space Temp #1	X							
Space Temp #2 (If required)	X							
Supply fan start/stop			X					
Supply fan status		X						Current Switch
Discharge air temperature	X							
Chilled water valve				X				
Space Temperature alarm to EMCS					X		{+/-5Deg} 2	
Confernece Rooms								
Space CO2 level	X					X		16 Rooms
CO2 level high alarm to EMCS					X		2	
Variable Air Volume Supply and General Exhaust								
Space Temperature	X							
Discharge Air Temperature	X							
CFM	X							

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to Modbus	1=24X7 alarm	1=24X7 alarm	Notes
					Field Server	2=work day	2=work day	
VAV Damper				X				
Chilled coil valve				X				If exists
Heating coil valve				X				
Zone Temperature alarm to EMCS					X		{+/-5Deg} 2	
Air flow alarm to EMCS					X		{+/-20% 10 min.} 2	
Building Pressurization								
Space static Pressure 1st floor Atrium A & B	X							
Space static Pressure 2nd floor Atrium A & B	X							
Space static Pressure 3rd floor Atrium A & B	X							
Space static Pressure 1st floor Atrium C & D	X							
Space static Pressure 2nd floor Atrium C & D	X							
Space static Pressure 3rd floor Atrium C & D	X							
Pressure Reading					X			
Natural Ventilation/ Smoke Removal								
Zone A 1st floor space temperature	X							
Zone A 2nd floor space temperature	X							
Zone A 3rd floor space temperature	X							
Zone A 1st floor windows open/close			X					
Zone A 2nd floor windows open/close			X					
Zone A 3rd floor windows open/close			X					
Zone B 1st floor space temperature	X							
Zone B 2nd floor space temperature	X							
Zone B 3rd floor space temperature	X							

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to	1=24X7 alarm	1=24X7 alarm	Notes
					Modbus	2=work day	2=work day	
					Field Server			
Zone B 1st floor windows open/close			X					
Zone B 2nd floor windows open/close			X					
Zone B 3rd floor windows open/close			X					
Zone C 1st floor space temperature	X							
Zone C 2nd floor space temperature	X							
Zone C 3rd floor space temperature	X							
Zone C 1st floor windows open/close			X					
Zone C 2nd floor windows open/close			X					
Zone C 3rd floor windows open/close			X					
Zone D 1st floor space temperature	X							
Zone D 2nd floor space temperature	X							
Zone D 3rd floor space temperature	X							
Zone D 1st floor windows open/close			X					
Zone D 2nd floor windows open/close			X					
Zone D 3rd floor windows open/close			X					
Section A & B 1st Floor Window Fire Alarm open signal		X						
Section A & B 1st Floor Window Fire Alarm close signal		X						
Section C & D 1st Floor Window Fire Alarm open signal		X						
Section C & D 1st Floor Window Fire Alarm close signal		X						
Section A & B 2nd Floor Window Fire Alarm open signal		X						
Section A & B 2nd Floor Window Fire Alarm close signal		X						
Section C & D 2nd Floor Window Fire Alarm open signal		X						

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to Modbus	1=24X7 alarm	1=24X7 alarm	Notes
					Field Server	2=work day	2=work day	
Section C & D 2nd Floor Window Fire Alarm close signal		X						
Section A & B 3rd Floor Window Fire Alarm open signal		X						
Section A & B 3rd Floor Window Fire Alarm Close signal		X						
Atria A & B Windows and Dampers Fire Alarm open signal (Fireman's switches in Auto, only downwind dampers and windows open)		X						
Atrium A Windows and dampers Fire Alarm open signal (Fireman's Atrium A switch in open position, all Atrium A dampers and windows open)		X						
Atrium A Windows and dampers Fire Alarm close signal (Fireman's Atrium A switch in close position, all Atrium A dampers and windows open)		X						
Atrium B Windows and dampers Fire Alarm open signal (Fireman's Atrium B switch in open position, all Atrium A dampers and windows open)		X						
Atrium B Windows and dampers Fire Alarm close signal (Fireman's Atrium B switch in close position, all Atrium A dampers and windows open)		X						
East Atrium A windows open/close			X					
West Atrium A windows open/close			X					
North Atrium A windows open/Close			X					
South Atrium A windows open/Close			X					
East Atrium B windows open/close			X					
West Atrium B windows open/close			X					

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to Modbus	1=24X7 alarm	1=24X7 alarm	Notes
					Field Server	2=work day	2=work day	
North Atrium B windows open/Close			X					
South Atrium B windows open/Close			X					
East Atrium A dampers				X				
West Atrium A dampers				X				
North Atrium A dampers				X				
South Atrium A dampers				X				
East Atrium B dampers				X				
West Atrium B dampers				X				
North Atrium B dampers				X				
South Atrium B dampers				X				
Wind Direction Sensor #1	X				X			
Wind Speed sensor #1	X				X			
Section C & D 1st Floor Window Fire Alarm open signal		X						
Section C & D 1st Floor Window Fire Alarm close signal		X						
Section A & B 2nd Floor Window Fire Alarm open signal		X						
Section A & B 2nd Floor Window Fire Alarm close signal		X						
Section C & D 2nd Floor Window Fire Alarm open signal		X						
Section C & D 2nd Floor Window Fire Alarm close signal		X						
Section A & B 3rd Floor Window Fire Alarm open signal		X						
Section A & B 3rd Flr Window Fire Alarm Close signal		X						

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to Modbus	1=24X7 alarm	1=24X7 alarm	Notes
					Field Server	2=work day	2=work day	
Atria A & B Windows and Dampers Fire Alarm open signal (Fireman's switches in Auto, only downwind dampers and windows open)		X						
Atrium A Windows and dampers Fire Alarm open signal (Fireman's Atrium A switch in open position, all Atrium A dampers and windows open)		X						
Atrium A Windows and dampers Fire Alarm close signal (Fireman's Atrium A switch in close position, all Atrium A dampers and windows open)		X						
Atrium B Windows and dampers Fire Alarm open signal (Fireman's Atrium B switch in open position, all Atrium A dampers and windows open)		X						
Atrium B Windows and dampers Fire Alarm close signal (Fireman's Atrium B switch in close position, all Atrium A dampers and windows open)		X						
East Atrium A windows open/close			X					
West Atrium A windows open/close			X					
North Atrium A windows open/Close			X					
South Atrium A windows open/Close			X					
East Atrium B windows open/close			X					
West Atrium B windows open/close			X					
North Atrium B windows open/Close			X					
South Atrium B windows open/Close			X					
Atria C & D Windows and Dampers Fire Alarm open signal (Fireman's switches in Auto, only downwind dampers and windows open)		X						

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to	1=24X7 alarm	1=24X7 alarm	Notes
					Modbus	2=work day	2=work day	
					Field Server			
Atrium C Windows and dampers Fire Alarm open signal (Fireman's Atrium C switch in open position, all Atrium C dampers and windows open)		X						
Atrium C Windows and dampers Fire Alarm close signal (Fireman's Atrium C switch in close position, all Atrium C dampers and windows open)		X						
Atrium D Windows and dampers Fire Alarm open signal (Fireman's Atrium D switch in open position, all Atrium C dampers and windows open)		X						
Atrium D Windows and dampers Fire Alarm close signal (Fireman's Atrium D switch in close position, all Atrium C dampers and windows open)		X						
East Atrium C windows open/close			X					
West Atrium C windows open/close			X					
North Atrium C windows open/Close			X					
South Atrium C windows open/Close			X					
East Atrium D windows open/close			X					
West Atrium D windows open/close			X					
North Atrium D windows open/Close			X					
South Atrium D windows open/Close			X					
East Atrium C dampers				X				
West Atrium C dampers				X				
North Atrium C dampers				X				
South Atrium C dampers				X				
East Atrium D dampers				X				
West Atrium D dampers				X				
North Atrium D dampers				X				

Alarm status to DDC alarm page
EM&CS via Field with common alarm
Server to EM&CS

Point Description	AI	DI	DO	AO	LON to	1=24X7 alarm	1=24X7 alarm	Notes
					Modbus	2=work day	2=work day	
					Field Server			
South Atrium D dampers				X				
Atrium C 3rd floor space temperature								
Atrium D 3rd floor space temperature								
Wind Direction Sensor #2								
Wind Speed sensor #2								
Alarm output to EM&CS Smoke control weekly test failure					X		2	
General Building Points								
Outside air temperature	X				X			
Outside air Temperature	X				X			
Outside air Relative Humidity	X				X			
Outside air Barometric Pressure	X				X			