CONTINUED FROM SHEET C-2

C. CHW Supply Temperature Set point - Currently the chiller plant delivers a fixed CHW supply temperature of 45°F. This set point is adjusted manually at the chiller. ***As part of this UESC project, additional hardwired control signals will be installed in each chiller to allow the BAS to reset the CHW supply temperature from it associated DDCP and for use in the LOBOS optimization routine. See "LOBOS CHW Supply Temperature Set Point Control" below for more details.***

D. Chiller CHW Flow Control - The two fundamental modes of control described below for the CHW flow control valves shall be provided through the BAS. The mode shall be manually selected by the operator through the BAS and the OWS.

1. Pressure Control Mode: The CHW flow control valve shall be modulated by the BAS to maintain a constant differential pressure between the CHW supply and return lines serving the chiller. The set point shall be initially set at X psid which corresponds to the chiller's design flow.
2. Flow Control Mode: The CHW flow control valve shall be modulated by the BAS to maintain a constant chiller CHW flow as sensed by the chiller's own flow meter located in its CHW supply line.
3. ***If the LOBOS optimization program is enabled for the CHW Differential Pressure Control, then CHW flow through the chiller will be allowed to vary. The flow control valve will remain fully open during this mode of operation.***

E. Chiller CTW Flow Control - The two fundamental modes of control described below for the CTW flow control valves shall be provided through the BAS. The mode shall be manually selected by the operator through the BAS and the OWS.

1. Pressure Control Mode: The CTW flow control valve shall be modulated by the BAS to maintain a constant differential pressure between the CTW supply and return lines serving the chiller. The set point shall be initially set at X psid which corresponds to the chiller's design flow.
2. Flow Control Mode: The CTW flow control valve shall be modulated by the BAS to maintain a constant chiller CTW flow as sensed by the chiller's own flow meter located in its CTW supply line.
3. ***If the LOBOS optimization program is enabled for the CTW pumps, then CTW flow through the chiller will be allowed to vary. The CTW flow control valve will remain fully open during this mode of operation.***

II. **CHW Pump Control** - There are two modes of control for the CHW pumps provided through the BAS.

A. Constant Volume Mode: Under the fundamental sequence of operation, each CHW pump will be staged on/off by the BAS as described under the chiller staging sections above. ***Each CHW pump will operate at a fixed speed (adjustable) to provide full design flows. This fixed speed set point shall be determined during the commissioning phase of the project.***

B. Variable Volume Mode: See "LOBOS CHW Differential Pressure Control" description below in the LOBOS routines section for additional details.

C. Upon loss of BACnet network communication, the pump VFD shall sense the communication failure and revert to a constant speed programmed in the VFD controller. This VFD speed shall match the constant volume speed set point used when the pumps are operating in their "Constant Volume Mode" described above.

D. If any CHW pump VFD(s) are placed in bypass mode, a network signal will notify the BAS and in turn, the LOBOS "Variable Volume Mode" of operation will be automatically disabled.

E. If an operating CHW pump fails, an alarm shall be generated in the BAS and the standby CHW pump shall automatically start. A pump shall be considered "Failed" if its run status deviates from the BAS command. After the newly started pump is in operation, the failed pump shall be disabled.

F. Any CHW pump that fails shall automatically be assigned a sequence number of 0. Similarly, any CHW pump that is taken out of operation for maintenance shall be manually assigned a sequence number of 0 by the operator. The BAS shall not attempt to start any pump with an assigned sequence number of 0.

III. **CHW Bypass Valve Control** - Two modes of operation are described below for the building CHW flow control bypass valve (FCV-6A). The operating mode shall be manually selected by the operator through the BAS and the OWS. Note: use of the flow meter installed in the bypass line shall be used by the BAS to stage the chillers as described under chiller staging.

A. Pressure Control Mode: The CHW bypass flow control valve shall be modulated by the BAS to maintain a constant differential pressure (DP) set point between the CHW supply and return mains as sensed in the central plant downstream of the CHW bypass line. This set point is based on the number of CHW pumps operating and indicated below.

B. Flow Control Mode: The CHW bypass flow control valve shall be modulated by the BAS to maintain a constant chiller plant CHW flow in the bypass corresponding to the number of CHW pumps operating as indicated below.

C. Current default set points for Pressure Control and Flow Control Modes:

# Pumps	DP (psid)	Flow (gpm)
Stage-1:	12	180
Stage-2:	18	360
Stage-3:	20	500

D. See "CHW Bypass Valve Control" description below in the LOBOS routines section for additional details.

IV. **Cooling Tower Temperature Controls** - The existing cooling tower control program maintains the desired CTW supply set point by utilizing an algorithm that aptly stages the cooling tower fans (Off, Low Speed and High Speed) based on its calculated "Demand" value. Existing "Demand" set points for staging the towers will remain and are identified as follows:

Demand	Tower Fan Stage
<15	Off
15	1st Tower - Slow
30	1st Tower - High
40	2nd Tower - Slow
50	2nd Tower - High
60	3rd Tower - Slow
70	3rd Tower - High
80	4th Tower - Slow
90	4th Tower - High

The existing tower control algorithm provides for the desired CTW supply set point based on the following modes of operation:

A. Manual Set point Mode: In this mode, the CTW supply set point shall be manually adjustable by the facility operator between 65°F and 85°F and initially set at 80°F.

B. Automated Mode: In this mode, the BAS shall reset the CTW supply set point according to the following schedule which is based on a set differential between outdoor air wet-bulb temperature and the desired CTW supply temperature:

O.A. Wet-Bulb Temperature	CTW Set point
67°F	70°F
57°F	65°F

C. See "LOBOS CTW Supply Temperature Control" description below in the LOBOS routines section for additional details.

D. If any emergency generator requiring cooling tower water is ON (DG-1 thru DG-4), the BAS shall see an ON status and override the current CTW supply set point to a fixed value of 65°F.

E. If an operating cooling tower fails, an alarm shall be generated in the BAS and the standby tower shall automatically start. A tower shall be considered "Failed" if the run status deviates from its BAS command or its associated vibration switch has been activated. After the newly started tower is in operation, the failed tower shall be disabled and isolated. If no cooling towers are available to operate in place of the "Failed" cooling tower, the BAS shall continue to flow water through the failed cooling tower.

F. Any cooling tower that fails shall automatically be assigned a sequence number of 0. Similarly, any tower that is taken out of operation for maintenance shall be manually assigned a sequence number of 0 by the operator. The BAS shall not attempt to start any tower with an assigned sequence number of 0.

V. **Staging Towers** - CT-1A, CT-1B, CT-1C and CT-1D are arranged in line and mounted on continuous concrete footings. Due to the size and design flow of the CTW pumps, the number of cooling tower cells in use at any time shall be based on an "n+1" strategy where "n" represents the number of operating CTW pumps.

A. ***Note if one CTW pump is operating and its VFD is in bypass or there is a loss of network communication with the VFD, then to prevent overflowing of the towers, two cells must be used***. For instance, if cooling tower water pump P-3A starts in bypass, flow control valves FCV-1C and FCV-2C shall open and allow water to flow through cooling towers CT-1A and CT-1B.

B. ***Note if two CTW pumps are operating and their VFDs are in bypass or there is a loss of network communication with the VFDs, then to prevent overflowing of the towers, three cells must be used***. For instance, when cooling tower water pump P-3B starts, flow control valve FCV-4C shall open allowing water to flow through cooling tower CT-1D (the 3rd cell). The fourth cooling tower CT-1C shall be operated in programmed sequence with its respective pumps and flow control valves if required as standby or in a lead-lag position.

C. All cooling towers shall have the capability of being operated remotely from the OWS.

D. A low water level switch (LS-1, LS-2 and LS-3) provided in each cooling tower pump pit is interlocked with the pump starter and shall prevent pump operation with low water level. The level switch shall also signal an alarm to the BAS of the low level condition and pump shutdown. When this signal is received, the BAS shall automatically start a standby pump. To prevent excessive sump draw down, the BAS shall not allow the start of more than one pump at a time. A minimum 30-second time delay (adjustable) shall be incorporated between starts for multiple pumps.

E. A low water level switch (LS-4) shall be provided in the cooling tower sump. LS-4 is interlocked and controls the cooling tower water makeup valve (LCV-1). When the low level condition exists, the level switch (LS-4) opens LCV-1 and supplies water for the cooling tower sump. When a high level condition is sensed, LS-4 closes LCV-1 and shuts off water to the sump. LS-4 also provides signals for both low and high level conditions to the BAS. Similarly, level switch LS-5 is interlocked to control the second makeup valve LCV-2 and provides both low and high level signals to the BAS. LS-6 controls the water tank makeup valve LCV-3.

VI. **CTW Pump Control** - There are two modes of control described below for the CTW pumps provided through the BAS.

A. Constant Volume Mode: Under the fundamental sequence of operation, each CTW pump will be staged on/off by the BAS as described under the chiller staging sections above. ***Each CTW pump will operate at a fixed speed (adjustable) to provide full design flows. This fixed speed set point shall be determined during the commissioning phase of the project.***

B. Variable Volume Mode: See "LOBOS CTW Pump Control" description below in the LOBOS routines section for additional details.

C. Upon loss of BACnet network communication, the pump VFD shall sense the communication failure and revert to a constant speed programmed in the VFD controller. This VFD speed shall match the constant volume speed set point used when the pumps are operating in their "Constant Volume Mode" described above.

D. If any CTW pump VFD(s) are placed in bypass mode, a network signal will notify the BAS and in turn, the LOBOS "Variable Volume Mode" will be automatically disabled.

E. If an operating CTW pump fails, an alarm shall be generated in the BAS and the standby CTW pump shall automatically start. A pump shall be considered "Failed" if its run status deviates from the BAS command. After the newly started pump is in operation, the failed pump shall be disabled.

F. Any CTW pump that fails shall automatically be assigned a sequence number of 0. Similarly, any CTW pump that is taken out of operation for maintenance shall be manually assigned a sequence number of 0 by the operator. The BAS shall not attempt to start any pump with an assigned sequence number of 0.

VII. ***Refrigerant Leak Monitor System*** - ***The existing SenTech refrigerant (R-123) leak detection monitor shall be replaced with a new dual refrigerant (R-123 & R134A) sensing unit. The new 4-port leak detection monitor shall draw air samples from strategic locations close to the ground (e.g. < 18") near the chillers where refrigerant would concentrate if a leak occurred. The existing 3/8" sampling tubes shall be inspected and re-used if free from damage and obstruction. Damaged sampling tubes will be replaced. The existing alarm level contacts, BAS points, programs and hardwire interlocks shall remain in place and are highlighted as follows:***

A. The BAS shall monitor the statuses of both the low and high level refrigerant alarm contacts from the refrigerant leak detection monitor. When an alarm is activated, the refrigerant monitor shall generate an alarm to the BAS and OWS. The new refrigerant monitor shall be programmed to energize both the low and hi alarm conditions for either R-123 or R-134A refrigerants.

B. In addition, existing interlock wiring amongst the refrigerant monitor, strobe lights, audible horns and horn silence switches will remain. Upon detection of a low level alarm for either refrigerant, the strobe lights will be energized. If the high level alarm is triggered for either refrigerant, the audible horns will sound. The audible alarm can be silenced by activating one of the silence switches located inside the chiller room (B115) or outside the main entrance (B112). Either of these switches will energize a relay that de-energizes the audible alarm circuit. However, these audible alarms shall remain engaged until the alarm condition has cleared, the refrigerant leak monitor system is manually reset and the alarm silence switches and silence relay are returned to their normal operating positions.

C. The existing BAS control points associated with the emergency refrigerant purge fan, EF-310B shall be re-commissioned. Ensure existing programming is in place to run the fan when the high refrigerant leak alarm is activated.

VIII. **Chiller Room Ventilation** - The BAS shall continuously monitor the temperature within the chiller room. Upon a temperature rise above 75°F (adjustable), the BAS shall energize EF-310's low speed motor to exhaust warm air from the space. If room temperature continues to increase above 80°F (adjustable), the BAS shall switch off EF-310's low speed and switch to its high speed motor.

IX. **Boiler Sequence of Operation** - Currently, the boilers are manually enabled or disabled by facility personnel and are programmed to operate at a fixed set point of 180°F. The CSI BAS monitors boiler status, boiler supply temperatures and alarm conditions. This information is used by facility personnel to manually alternate boilers to equalize run times or to intervene and enable the stand-by boiler if an alarm condition exists.

As part of this UESC project, new fundamental programming described below will be implemented to fully automate the HHW system. When enabled, LOBOS will provide input to the new HHW system program to optimize boiler plant operations by resetting the boiler supply temperature and resetting the HHW distribution DP control set points.

The HHW system shall be enabled/disabled through the BAS based on heating demand or as programmed by the facility operator. The boilers shall operate in a lead/lag manner. Similarly, the pumps operate in a lead/lag configuration with the third in standby. One HHW pump shall operate per boiler and any combination of boiler and HHW pump may be selected. The operator shall have the ability to select which boiler or HHW pump is the lead, lag or standby device.

A. Boiler Stage-Up: When the HHW system is enabled from the BAS, the lead boiler will start per the "Boiler ON" sequence identified below and the lead HHW pump will start. If the lead boiler fire rate is above 95% (adjustable) for more than 15 continuous minutes (adjustable) and the HHW supply temperature is more than 5°F (adjustable) below set point, then enable the lag boiler.

B. Boiler Stage-Down: If the lead boiler fire rate drops below 40% (adjustable) for more than 15 continuous minutes (adjustable), then disable the lag boiler per the "Boiler OFF" sequence. After the lag boiler's isolation valve has been commanded closed, turn OFF the lag pump.

C. Boiler ON sequence:

1. ***Open boiler isolation valve.***
2. ***Once valve position is proven open, enable boiler.***
3. ***The boiler will start once flow is proven and modulate on its own internal controls to maintain the HHW supply temperature set point.***

D. Boiler OFF sequence:

1. ***Disable boiler.***
2. ***After a time delay of 90 seconds (adjustable) to allow heat to dissipate from the boiler, close its isolation valve.***

SEE SHEET C-4 FOR CONTINUATION

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1999 AVENUE OF THE STARS
SUITE 2600
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REV.	DATE	DESCRIPTION	CHECKED	APPROVED
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REGISTERED PROFESSIONAL ENGINEER JAMES P. MALTZ No. 17795 Mechanical STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WESTERN–PACIFIC REGION LOS ANGELES, CALIFORNIA

CONTROLS SCOPE – SEQUENCE OF OPERATION
SHEET 2 OF 3
MECHANICAL CHILLED WATER AND HEATING WATER SYSTEM RETROFIT
FAA AIR ROUTE TRAFFIC CONTROL CENTER
FREMONT, CALIFORNIA

REVIEWED BY	SUBMITTED BY:	APPROVED BY:

OAKLAND ARTCC
FREMONT
CALIFORNIA

DESIGNED BY: BB
DRAWN BY: BB
CHECKED BY: JW
ISSUED BY
DATE: 4/3/15
DRAWING NO.: C–3

CONTINUED FROM SHEET C-3

E. *Boiler Alarm - If the lead boiler is in alarm, then the BAS will disable it, close its isolation valve and automatically start the lag boiler. In addition, an alarm condition will be sent to the OWS to notify facility personnel.*

F. *Two different modes of control for HHW supply temperature (HHW-ST) reset shall be provided through the BAS:*

1. *Outside Air Reset: The HHW-ST set point shall reset between a range of 130°F and 180°F (adjustable) by an analog output signal from the BAS to the boiler. Per the boiler manufacturer's recommendation, the HHW-ST set point shall be limited to a low value of 130°F. This HHW-ST set point shall be reset based on a linear relationship to outside air temperature (OAT) as follows:*

OAT	Set Point
40°F	180°F
70°F	130°F

2. *Demand Reset: See "LOBOS HHW Supply Temperature Set Point Control" description below in the LOBOS routine section for additional details.*

Note: the operator shall be able to override the HHW reset strategy and set the HHW-ST to a fixed value between the range of 130°F and 180°F.

G. *Outside Air Boiler Lockout - There shall be an outside air temperature (OAT) lockout program that the user can enable or disable. When enabled and if OAT is above 75°F (adjustable) the HHW system shall be automatically disabled.*

Additional programming shall be implemented in the BAS to provide a status that will trigger "on" when dehumidification is occurring at any of the AHU(s) serving critical spaces (e.g. AHU-205A or AHU-205B). When this status point is triggered on, the OAT lockout will be automatically overridden and the boiler system will continue to operate. During periods of dehumidification, HHW is required for reheating associated airstreams to meet each unit's discharge air temperature or zone temperature set point.

H. *To equalize equipment run times, lead/lag status of the boilers shall automatically be evaluated on a weekly basis (adjustable). The boiler with the least run time shall become the lead boiler and the one with the most run time will become the lag unit.*

I. *HHW Pump Speed Control - The BAS monitors the heating load utilizing four (4) DP sensors located in different locations throughout the facility. The BAS will utilize these DP sensors to control the HHW pump VFD(s) utilizing one of the following two modes of operation:*

1. *Constant DP Set Point Mode: Under the fundament control sequence for control of the HHW pumps, the BAS will modulate the new VFD(s) to meet fixed HHW DP set points. The BAS will determine which of the sensors represents the worst case scenario (highest heating demand) and assign priority control to the sensor that is furthest from (below) its set point. Actual set points will be determined and verified during the commissioning phase of the project and will be user adjustable. Initial set points identified below are estimated based on current operations with constant flow:*
   a) *Automation Wing (Attic) - 25 psid*
   b) *Automation Wing (Basement) - 10 psid*
   c) *Control Wing (ATOP Attic) - 25 psid*
   d) *Control Wing (DSR Attic) - 25 psid*

   If a sensor fails, the BAS shall exclude it from the set point calculation. All operating pumps will be controlled in parallel and receive the same control signal. In addition, the speed change rate shall be slow enough to ensure stability in the boiler system (e.g. change rate > 1% speed / 15 seconds) or per the boiler manufacturer's recommendation.
2. *Variable DP Set Point Mode: See "LOBOS HHW Differential Pressure Control" description below in the LOBOS routine section for additional details.*

J. *The minimum pump speed shall be limited to provide a minimum flow of at least 70 GPM to the operating boiler per the manufacturer's recommendation. Flow in the HHW system shall be continuously monitored via a new flow meter located in the main 6" supply line.*

K. *To equalize equipment run times, lead/lag/standby status of the pumps shall automatically be evaluated on a weekly basis (adjustable). The pump with the least run time shall become the lead pump. The one with the most run time shall become the standby pump and remaining pump will become the lag.*

L. *Operation of pump status shall be via a new current switch located in the VFD. If pump status deviates from the BAS command, then the pump will be shut down and the standby pump shall start. In addition, an alarm will be indicated at the OWS.*

LOBOS Routines (New):

As previously described, the LOBOS software solution is a series of user selectable optimization control routines that are fully customized to provide variable utility system (CHW, CTW & HHW) set points to the existing BAS that will operate the facility in an efficient manner to serve dynamic cooling and heating loads. The LOBOS optimization algorithms are dependent on the existing BAS programs for their implementation. Modifications shall be made in the existing BAS to accept the LOBOS control set points when associated optimization programs are enabled by the user.

To ensure stability and safeguard operation of the facility's utility systems, the operator can disable individual LOBOS optimization programs or LOBOS altogether at any time. In addition, new programming shall be implemented in the existing BAS to automatically disable LOBOS if a network failure is detected, the chiller plant is disabled thru the BAS or when the facility is utilizing stand-by power. The BAS monitors the run status of each emergency generator and if proven on, the LOBOS system shall be disabled. When LOBOS is disabled, the central plant shall switch from the optimized variable operation to its fallback or safe mode of operation based on constant flows and fixed temperature set points. Whenever LOBOS is automatically disabled, it will remain locked out until the operator manually re-enables LOBOS to restore the optimization routines.

The following LOBOS sequence descriptions are provided to summarize elements of each optimization routine or control strategy as it pertains to the facility. Greater detail on the control strategies, user interface and system integration can be found in the following reference manuals and are supplemental documents to this design package:

A. *LOBOS Energy Efficiency (EE) User Manual 3.0*
B. *LOBOS Energy Efficiency (EE) Integration Manual 3.0*

LOBOS Chiller Staging *- If the LOBOS optimization program is enabled for the chillers, then LOBOS will serve up a recommended number of chillers to run that will serve the cooling load. This recommendation will be based on overall plant efficiency and whether the load is trending up or down. LOBOS will calculate the estimated power consumption of operating additional or less equipment (i.e. chiller, CHW pump, CTW pump, cooling tower fan) and compare it to the current cooling plant operating conditions and determine the most efficient stage count to serve the given load. Actual staging on/off of relevant equipment and opening/closing isolation valves shall be performed by the existing BAS program.*

LOBOS CHW Supply Temperature Set Point Control *- If this LOBOS optimization routine is enabled for the chillers, then the CHW supply temperature set point may reset in a range between 44°F and 50°F (adjustable). This reset will be based on real time load data from zone conditions, air handler operating parameters including CHW valve positions and equipment size and distances from the central plant. The user will have means to select/deselect relevant devices as well as assign weighted importance factors to each (i.e. 0 - 100 scale) for use in the optimization algorithms. For instance, AHU(S) that serve critical areas such as those in the Control Wing would be weighted higher to others in the facility. LOBOS will evaluate operating conditions of all devices selected, their weighted importance, unit size and operating characteristic to determine an optimized CHW supply temperature set point to serve the worst case AHU's cooling requirements. Changes to the CHW supply temperature set point will be at a rate not to exceed the chiller manufacturer's recommendations to promote stability in the chiller systems (e.g. 1°F / 30 minutes).*

To ensure existing secondary CHW control programs serving the DSR area are maintained, additional programming will be implemented to limit the upper value of the LOBOS CHW supply set point range. This upper limit will be based on the secondary CHW supply set point which is currently programmed to maintain a fixed set point of 50°F under normal operation or could be as low as 46°F during emergency situations for cooling and dehumidification. This secondary CHW supply set point is maintained by the BAS utilizing a mixing valve that blends warmer CHW return water with cold CHW supply temperature coming from the plant.

LOBOS CHW Differential Pressure Control *- If this LOBOS optimization program is enabled for CHW differential pressure (DP) control, then the CHW pump VFD(s) will modulate speed and flows will be allowed to vary. This optimization program generally operates in conjunction and is complimentary to the CHW supply temperature reset but can work independently. Currently, the BAS monitors the cooling load utilizing four (4) DP sensors located in different locations throughout the facility and one DP sensor located inside the chiller plant as indicated per the following:*

1. *Administration Wing (Central Plant)*
2. *Automation Wing (Attic and Basement)*
3. *Control Wing (ATOP Attic and DSR Attic)*

LOBOS will utilize the four sensors located out at the load (Automation and Control Wings) as feedback when determining the optimized DP set point for control of the pump VFD(s). In general, LOBOS will adjust the DP set point as an immediate response to increasing and decreasing loads to provide sufficient cooling flow to the worst case AHU - the unit determined by LOBOS that requires the most cooling. Note: the CHW supply temperature reset as described above is adjusted at a much slower rate than the CHW DP reset and is used more to accommodate overall load trends and for operating the chiller plant more efficiently.

Similar to the CHW supply set point reset algorithm, the LOBOS program will evaluate the load conditions and the rate at which the load is increasing or decreasing, operating parameters of selected AHU equipment and their relative size and distance from the plant when determining the worst case AHU as defined as the unit requiring the most cooling. Depending where the unit is located, the associated DP set point may reset up or down. For instance, if AH-205A is determined to be the worst case unit and requires more cooling, then the DP set point will be increased and the DP sensor located in the Control Wing's DSR attic will govern. In addition, the speed change rate shall be slow enough to ensure stability in the chiller system (e.g. change rate > 1% speed / 15 seconds) or per the chiller manufacturer's recommendation. All operating pumps will be controlled in parallel and receive the same control signal.

CHW Bypass Valve Control *- Under the fundamental or default program, the building CHW bypass valve (FCV-6A) is controlled to maintain a constant DP as sensed in the central plant or to maintain a fixed flow rate through the bypass line - see Section III above.*

When LOBOS is enabled for CHW Differential Pressure Control, the CHW pump VFD(s) will modulate and flows in the system will be allowed to vary. In this case, the CHW Bypass Valve Control algorithm will be modified and operate in a "Minimum Flow Control Mode". In this mode, the CHW bypass valve is normally fully closed. The BAS will monitor the CHW flow through each operating chiller. If the flow rate drops to the chiller's minimum flow rate plus a 20% buffer (adjustable) the BAS will modulate the CHW bypass valve open and control to this fixed minimum flow set point value. As flows increase through the operating chiller(s) above the minimum flow set point, the bypass valve will modulate closed. The operating chiller with the lowest flow will be used for control of the building CHW bypass valve.

LOBOS CTW Supply Temperature Control *- When enabled, the CTW supply set point criteria for the towers shall be determined by the LOBOS program to provide the most efficient overall operation of the cooling plant. One aspect of the optimization program will consider the available cooling tower surface area, flow limitations and required flows necessary for proper operation in staging the towers. In addition, the program will evaluate overall fan and chiller power requirements as well as ambient conditions in determining the CTW supply set point that will provide the most efficient operation. The BAS will then stage the cooling tower fan(s) (off, low speed, high speed) as necessary to meet the CTW supply temperature set point.*

LOBOS CTW Pump Control *- If the LOBOS optimization program is enabled for the CTW pumps, then the pump VFD(s) will modulate speeds and associated flows will be allowed to vary. Under normal operation, the LOBOS program will provide CTW pump speed set points to vary condenser flows within the chiller manufacture's minimum and maximum limits. In addition, the program shall limit the low end of the pump speed to ensure sufficient flow is provided to the open cooling tower cells per the cooling tower manufacturer's recommendations. The low end speed parameters shall be determined during the commissioning process for various configurations (e.g. 1 cell/1 pump, 2 cells/1 pump, 3 cells/2 pumps). In general, LOBOS control of the pump VFD(s) will modulate CTW flow to maintain a fixed 10°F temperature differential across the operating chiller's condenser barrel. The program will utilize the worst case temperature differential (highest TD) across the operating chiller(s) condenser as the guiding temperature differential. All operating pumps will be controlled in parallel and receive the same control signal. In addition, the speed change rate shall be slow enough to ensure stability in the chiller system (e.g. change rate > 1% speed / 15 seconds) or per the chiller manufacturer's recommendation.*

LOBOS HHW Supply Temperature Set Point Control *- The HHW-ST set point shall reset between 130°F and 180°F (adjustable) by an analog output signal from the BAS to the boiler and will be based on input from the LOBOS system. LOBOS will evaluate every 60 seconds (adjustable) whether heating demand is increasing or decreasing by monitoring the HHW-ST set point and the HHW pump speed over time. Essentially, LOBOS will reset the HHW-ST set point up or down to maintain a HHW distribution pump speed of 70% (adjustable). The adjustment will be based on the deviation and direction between actual pump speed and pump speed set point. For instance, if the distribution pump speed is above 70%, LOBOS will raise the HHW-ST set point which would cause control valves to modulate closed resulting in less pumping to meet the DP set point. The opposite would occur for speeds less than 70%. In addition, the change rate in the boiler set point shall be slow enough to ensure stability in the HHW system (e.g. change rate > 0.5°F / 30 seconds) or per the boiler manufacturer's recommendation. This should provide a good balance of pump energy savings to boiler gas savings.*

LOBOS HHW Differential Pressure Control *- The HHW differential pressure set point will reset up or down every 60 seconds (adjustable) based on input from the LOBOS optimization program. The LOBOS system will evaluate the heating load and determine its trend rate by monitoring HHW valve positions and HHW pump speed over time. The user will have the ability to select and weight the importance of each AHU utilized in the optimization routine. In general, the optimization program will reset the HHW DP set points to values that accommodate both the rate at which the heating load is increasing or decreasing and to meet the current load condition. This will be accomplished utilizing a user selectable control algorithm listed below. Essentially, the optimization program provides a HHW DP set point that will maintain an open valve threshold based on either a single valve or numerous valve position(s) as indicated in the following schema:*

1. *Most open critical valve position (single valve) is greater than 90%*
2. *Average position of the top 3 valves is greater than 90%*
3. *Average position of X% valves is greater than 80%, where X% represents the percentage of user selected valves (e.g. 10, 20, 30, etc.)*

Standard VFD Operation

Hand-Off-Auto Operation: Hand-Off-Auto settings shall be provided as part of the VFD through the drive's keypad. In the Off mode, the pump shall be stopped. In the Hand mode, the pump shall run continuously. In the Auto mode, the pump shall be started and stopped by the BAS.

Local-Auto Speed Control: Local-Auto settings shall be provided as part of each VFD through the drive's keypad. In the "Local" mode, the drive's speed shall be controlled manually through its control interface panel. In the "Auto" mode, the VFD's speed shall be controlled by the BAS.

VFD Bypass: Each VFD is provided with an across the line starter (bypass) to allow the equipment to be run when the VFD is not available for operation. If the equipment is operated in this mode, it shall start and run at full speed using line voltage.

Failsafe Pump w/VFD Operation

If any utility system (CHW, CTW, and HHW) pump VFD(s) is placed in manual bypass, a network signal will notify the BAS and the associated optimization program will be disabled. For example, if a CHW pump VFD is placed in bypass, the LOBOS CHW Differential Pressure Control program will be automatically disabled. Similarly, if a CTW pump is placed in manual bypass, the LOBOS CTW Pump Control program will be disabled.

If there is a network failure, the pump VFD will sense the communication failure and will ramp to a failsafe or default speed as programmed internal to the VFD. These failsafe speed set points will match values established for operation with the fundamental programs to deliver design flows. The BAS will also sense the network failure and automatically disable the LOBOS system. In this case, the fundamental sequences defined above would govern control of the central plant.

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1999 AVENUE OF THE STARS
SUITE 2600
LOS ANGELES, CA 90067

REV.	DATE	DESCRIPTION	CHECKED	APPROVED
0	4/3/15	ISSUED FOR CONSTRUCTION		

REGISTERED PROFESSIONAL ENGINEER JAMES P. WALZ No. 17785 STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WESTERN–PACIFIC REGION — LOS ANGELES, CALIFORNIA

CONTROLS SCOPE – SEQUENCE OF OPERATION
SHEET 3 OF 3
MECHANICAL CHILLED WATER AND
HEATING WATER SYSTEM RETROFIT
FAA AIR ROUTE TRAFFIC CONTROL CENTER
FREMONT, CALIFORNIA

REVIEWED BY	SUBMITTED BY:	APPROVED BY:

OAKLAND ARTCC
FREMONT
CALIFORNIA

DESIGNED BY:	BB	ISSUED BY	DATE:	4/3/15
DRAWN BY:	BB		DRAWING NO.:	C-4
CHECKED BY:	JW			