FAA ARTCC - NETWORK NARRATIVE

The FAA ARTCC currently operates a CSI building automation system (BAS) (owned by Schneider Electric) to sequence and operate the chilled water (CHW), cooling tower water (CTW) and heating hot water (HHW) systems. These existing systems utilize nine CSI controllers located in the central plant identified as PCU-13, 14, 15, 16 and PCU-24, 25, 26, 27 & 28. These building level controllers are connected together with an RS485 (twisted pair) based communications network operating CSI's proprietary building level communication protocol called I/NET. Programming logic which provides for sequencing of pumps, towers and chillers exists in these nine main panels.

Of the four existing York chillers, two are constant speed (CH-100 and CH-400) and two are variable speed (CH-200 and CH-300). Currently these machines are networked together using a MODBUS protocol and a YORK Talk integration panel. Key performance monitoring points for these four machines are made available to the CSI system using PCU-26 which communicates directly to the YORK Talk integrator. As part of this UESC project, chillers CH-100 and CH-400 will be removed and replaced with new variable speed units. These new units will be removed from the YORK Talk system and communicate via BACnet over a newly installed BACnet MS/TP network.

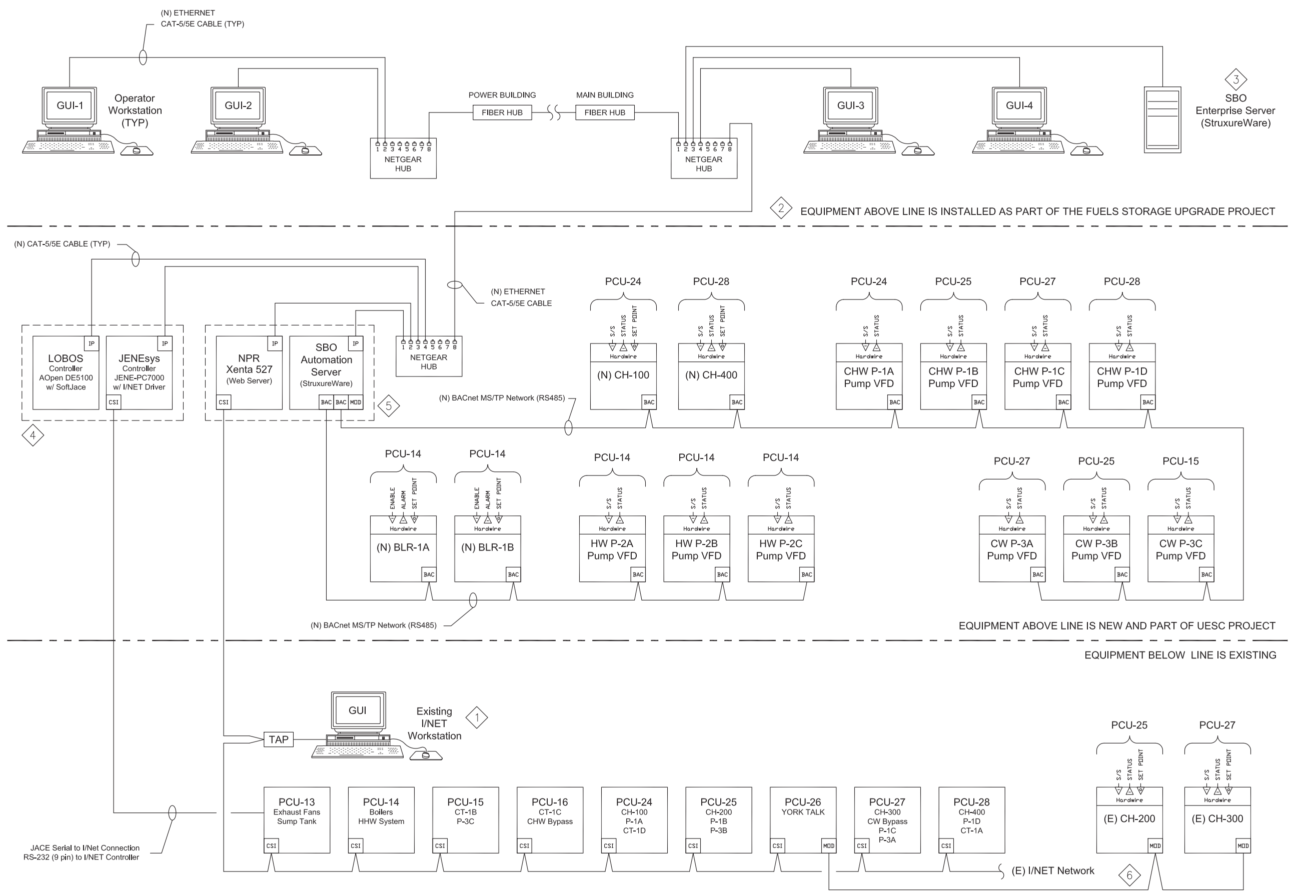
The goal of the integration work is to provide for a new StruxureWare BAS environment which will allow the passing of select monitoring points and set points among the existing CSI control system, a newly extended BACnet architecture and a new Tridium SoftJACE controller which functions on the Niagara AX framework. The new "Load Based Optimization System" (LOBOS) software solution resides in the SoftJACE controller and is comprised of several intelligent algorithms that provide HVAC optimization strategies including variable flow for the CHW, HHW and CTW systems. LOBOS will monitor in real time AHU data, room temperatures and central plant data and serve up optimized CHW and HHW system set points in response to the varying load conditions. Programs within the existing CSI controllers will be augmented to receive these optimized system set points and utilized for implementation of the LOBOS control schemes.

Integration between existing and new equipment will be accomplished with the addition of new hardware components and software. A new StruxureWare Building Operation (SBO) Automation Server (AS) will be added to the existing infrastructure. This StruxureWare controller is part of the Schneider Electric hardware family and supports multiple communication protocols including BACnet MS/TP, BACnet IP and MODBUS. This AS will also provide forward and backward compatibility for future FAA upgrade projects when converting the existing CSI control system to the new StruxureWare framework. In addition, a new JENEsys controller with an integral I/NET driver will be installed to provide the integration of I/NET data to be used by LOBOS. A new Xenta 527-NPR web server will be added to support I/NET Ethernet communications. Lastly, I/NET Seven software will be loaded onto the SBO Enterprise Server to allow access to the existing I/NET system from any of the new StruxureWare work stations.

The new IP based controllers (i.e. Tridium SoftJACE, JENEsys PC7000, SBO Automation Server & Xenta 527-NPR) will communicate by connecting to the new dedicated Ethernet network infrastructure which is currently being installed as part of the "Fuel Storage Upgrade Project". The new Ethernet infrastructure project will include network routers and client workstations in a number of locations within the center. This dedicated Ethernet network will not be connected to the FAA intranet or the internet. To accomplish the necessary communications for this UESC project, AECOM will need to add the new controllers identified above to the new Ethernet network, each of which will require IP addresses.

Currently, ARTCC ESU staff operates the plant and accesses the BAS system via operator work stations, OWS(s), located in the plant operations room or the power building. These clients communicate on CSI's I/NET network via dedicated LAN taps. Once the StruxureWare framework is established and the new dedicated Ethernet backbone installed, the new OWS(s) provided under the "Fuels Storage Upgrade Project" will be used to access the existing I/NET network and LOBOS system. However, at least one of the existing I/NET OWS will remain until the I/NET to StruxureWare integration is complete.

New chillers, boilers and variable frequency drives (VFDs) to be installed in the UESC energy project will be supplied with support for the BACnet MS/TP protocol. A new BACnet MS/TP network will be installed with the chilled water plant upgrade. This network will originate with the new StruxureWare Automation Server and extend to the two new chillers (CH-100 and CH-400), two boilers (B-1A and B-1B) and all new chilled water, condenser water and heating hot water pump VFDs. Monitoring and control of new chillers, boilers and VFDs will be accomplished both by hard wired inputs and monitoring through the BACnet integration, similar to the configuration of the existing YORK Talk chiller integration.



NOTES:

1. I/NET WORKSTATION TO REMAIN DURING CONSTRUCTION FOR ACCESS TO EXISTING BAS FOR PROGRAMMING AND MAINTENANCE. NO LONGER NECESSARY WHEN I/NET INTEGRATION WORK INCLUDING THE INSTALLATION OF THE XENTA 527-NPR(S) AND I/NET SERVER SOFTWARE INSTALLATION IS COMPLETE. UPON COMPLETION, NEW STRUXUREWARE WORKSTATIONS PROVIDED UNDER FUELS UPGRADE PROJECT WILL ALLOW USER ACCESS TO EXISTING CSI CONTROLLERS AND GRAPHICS.
2. SYSTEM COMPONENTS AND NETWORK SHOWN ARE FOR REFERENCE ONLY. REFER TO THE FUELS STORAGE UPGRADE PROJECT FOR NETWORK AND EQUIPMENT DETAILS.
3. ENTERPRISE SERVER MUST BE CONFIGURED WITH I/NET SEVEN SOFTWARE PRIOR TO INSTALLING SBO ENTERPRISE SOFTWARE FOR FUELS UPGRADE PROJECT. COORDINATE WITH FUELS STORAGE UPGRADE CONTRACTOR.
4. REFER TO ENERLIANCE SUBMITTAL AND SHOP DRAWING FOR CONTROL PANEL LAYOUT DETAILS.
5. REFER TO ACS CONTROLS SUBMITTAL AND SHOP DRAWING FOR CONTROL PANEL LAYOUT DETAILS.
6. PRIOR TO PERFORMING CHILLER WORK, CONTROLS CONTRACTOR IS TO VERIFY OPERATION AND FUNCTIONALITY OF EXISTING YORK TALK INTEGRATION. WORK TO BE COORDINATED WITH OWNER. CAREFULLY REMOVE YORKTALK NETWORK SEGMENTS FROM CHILLERS CH-100 AND CH-400. ENSURE NETWORK INTEGRITY IS MAINTAINED (I.E. NO SPLICES) AND COMMUNICATION IS RE-ESTABLISHED WITH CHILLERS CH-200 & CH-300.

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

REGISTERED PROFESSIONAL ENGINEER JAMES P. WALTZ No. 17795 Mechanical STATE OF CALIFORNIA

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

CONTROLS – NEW SYSTEM ARCHITECTURE

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–1

PROJECT OVERVIEW

I. Purpose of Project: The purpose of this project is to reduce the Owner's energy consumption and life-cycle costs related to the chilled water (CHW) and heating hot water (HHW) systems, as well as improve system performance. The scope outlined herein shall utilize the existing Building Automation System (BAS) and CSI direct digital control panels (DDCPs). In addition, new equipment shall be BACnet compatible for compliance with the Owner's standards to help ensure or maintain a reliable network for future control upgrades.

A. Chilled Water (CHW) System: This retrofit involves the removal of two [2] existing 300-ton centrifugal chillers (CH-100 & CH-400) and the installation of two [2] new 295-ton high-performance chillers with centrifugal compressors. These chillers will be selected for very high-efficiency at supply temperatures between 42°F - 52°F and will utilize the existing CHW and cooling tower water (CTW) system piping and cooling towers. In addition, existing flow meters shall be replaced with new owner furnished electromagnetic meters as part of this UESC project. When applicable, existing valves, sensors and gauges will be reused. Variable Frequency Drives (VFDs) will be installed on four [4] chilled water pumps and three [3] condenser water pumps and four [4] cooling tower fans. All new VFDs and new chillers will be provided with BACnet communication modules.

B. Heating Water System: This retrofit involves the removal of two [2] existing hot water boilers and the installation of two [2] new high-efficiency modulating boilers. These boilers will be sized at 800,000 Btu/hr and will utilize the existing heating-water system piping and pumps. Variable Frequency Drives will be installed on three [3] heating water pumps. All new VFDs and new boilers will be provided with BACnet communication modules.

II. Existing Conditions:

A. Chilled water for the FAA Fremont Facility is generated by four [4] York water-cooled centrifugal chillers. Two of the chillers (CH-100 & CH-400) are constant speed 300-ton units and the other two (CH-200 & CH-300) are variable speed 250-ton units. The chillers are located in the basement mechanical room. The CHW system uses four [4] Paco split case centrifugal pumps (P-1A thru P-1D) with 50 horsepower motors. Each pump is sized for a single chiller. The CHW system is a constant volume system that uses a bypass to control flow rate to the building. The CTW system uses three Johnston vertical turbine pumps with 50 horsepower motors. Flow in the CTW system is also regulated with a chiller bypass. There are four [4] cooling towers equipped with two speed fans that cool the condenser water. Typical system operation requires one chiller, one chilled water pump, one condenser water pump and two cooling tower cells. In times of high load, two chillers, two chilled water pumps, two condenser water pumps and three cooling tower cells are used.

B. Heating hot water for the site is provided by two [2] Cleaver Brooks boilers at 1,674,000 BTU/hr each which are piped in a parallel configuration. The heating water is distributed by three [3] centrifugal pumps also piped in parallel. The system originally used a boiler bypass and mixing valve for temperature control. Currently, the bypass line is valved off and no longer utilized and the mixing valve is disabled. In addition, there is an automatic flow control valve located at each boiler that adapts to system pressure fluctuations to maintain constant flow through the boiler.

III. Controls Contractor(s)

A. Automation Contractor:
ACS Controls
4704 Roseville Road, Suite #101
No. Highlands, CA 95660
Phone: (916) 640-8800

B. Optimization Contractor:
Enerliance
16480 Bake Parkway
Irvine, CA 92618
Phone: (949) 383-4850

C. Schneider Electric ARTCC Program Office:
Schneider Electric Buildings Critical Systems, Inc.
8989 Herrmann Drive, Columbia MD 21045
Phone: (410) 381-7655

IV. Optimization Overview:

The Optimization Contractor shall provide the "LOad Based Optimization System" (LOBOS) software solution that operates within a new Tridium JACE controller and provides enhanced HVAC control strategies including variable flows and CHW, CTW & HHW temperature resets. These control strategies shall be based on real time operating data of HVAC equipment received from the existing CSI BAS and information received directly from the new equipment via a newly installed network utilizing the BACnet communication protocol. LOBOS will analyze the data and provide appropriate HVAC utility system set points that will satisfy the current load conditions in the most efficient manner. The Optimization Contractor shall coordinate with the Automation Contractor to ensure all relevant data is passing to/from the existing CSI control system for reliable plant operations.

The optimization set points defined by LOBOS are supplemental to the BAS and dependent upon the existing CSI control algorithms for implementation. In addition, new programs utilizing PID control algorithms will be provided within the new SBO Automation Server for VFD control of the pumps. Under the failsafe or default mode of operation as described below in the "Fundamental Sequences" section, the pump VFD(s) will operate at fixed speeds. When LOBOS is enabled, the VFD(s) will modulate and flows will vary to meet the optimized set point(s).

Interface to the LOBOS system will be via new graphics that will be accessible from any of the new operator workstations residing on a new Ethernet network dedicated for building operations. These LOBOS graphics will be separate from the existing I/NET control graphics and shall clearly summarize relevant elements of each optimization control scheme including system limits, target set points, system feedback and control output values that will be served up to the BAS for use in the existing control algorithms. In addition to the summary pages, the graphics are created in a manner to allow the facility operator access to LOBOS to enable/disable optimization programs, set parameters, adjust limits, select equipment and assign weighted importance factors to equipment that will be used in the control schemes. These optimization routines include CHW supply temperature reset, CTW supply temperature reset, HHW supply temperature reset, CTW pump speed control, CHW differential pressure reset control and HHW differential pressure reset control.

V. Communications:

A. In conjunction with the Fuels Upgrade Project, a new dedicated Ethernet backbone will be installed at the center for building controls with a new StruxureWare operating environment. New hardware will be provided (e.g. SBO Automation Server) to fully integrate the existing CSI I/NET system data and new BACnet data into the StruxureWare environment for use in the LOBOS optimization strategies.

B. Access to the new and existing field controllers as well as the new equipment will be available via new computer workstations residing on the new Ethernet network and operating the StruxureWare Enterprise Software.

C. The existing CSI I/NET BAS system will remain and shall receive chiller point data from the existing YORK Talk module. The YORK Talk will continue to communicate with chillers CH-200 and CH-300. Operating conditions such as temperatures, voltage, amperage, and operating and alarm codes are all received by the YORK Talk module and communicated thru the CSI I/NET system. In addition, physical control points including Start/Stop commands and Run Status points are hardwired to the existing chiller room DDCPs. A new Supply Temperature Reset point will be added as part of this UESC project.

D. The new Daikin chillers (CH-100 & CH-400) will communicate via BACnet and will be connected using a new BACnet MS/TP network. Similarly, operating conditions such as temperatures, voltage, amperage, power and operating and alarm codes will be communicated to the controllers and workstations. In addition, physical control points including Start/Stop commands, Run Status and Supply Temperature Reset points will be hardwired to the existing chiller room DDCPs.

E. All new pump VFDs will reside on the new BACnet MS/TP network. Relevant operating conditions such as drive speed, voltage, amperage, power and alarm codes will be communicated via the BACnet network. In addition, physical control points including Start/Stop commands and Run Status points will be hardwired to the existing chiller room DDCPs.

F. The new GasMaster boilers (B-1A & B-1B) will communicate via BACnet and will be connected using the new BACnet MS/TP network. Operating conditions such as supply temperature, fire rate, and alarm codes will be communicated to the controllers and workstations. In addition, physical control points including Enable/Disable commands, Alarm Status, Burner Status and Supply Temperature Reset points will be hardwired to the associated boiler DDCP.

SEQUENCE OF OPERATIONS

Fundamental Sequences (Existing):

The following Sequences of Operations are based on a compilation of written sequences from earlier projects at the ZOA ARTCC facility and feedback from facility personnel and are currently implemented within the existing CSI BAS. The Controls Contractor shall thoroughly review the sequences identified below and compare to the existing programs for verification prior to performing related work. Deviations in the actual plant operation from the existing written sequences described herein shall be documented and provided to AECOM and captured in the as-built documents.

Clarifications between the existing BAS sequences and modifications due to this UESC project shall be distinguishable using ***bold italicized type*** to identify new work.

I. **Chillers -** Two existing 250 ton chillers (CH-200 & CH-300) and two new 295 ton chillers (CH-100 & CH-400) are utilized. The system shall be started by the BAS and associated DDCPs located in the existing chilled water plant. The facilities operator shall have the ability to start the chiller system from the Operator Workstation (OWS). Once the chiller system is started, the pumps, flow control valves, chillers, and cooling towers shall be controlled automatically by the BAS. Systems shall start in a programmed sequence through the BAS to prevent any power overload upon restart after power transfer.

New programming will be implemented to automatically notify the building operator to trigger the implementation of the existing chiller lead/lag/standby rotation routine. This notification flag shall turn ON based on a weekly (adjustable) schedule or as programmed by the building operator. The notification shall be broadcast through the BAS and clearly visible on the OWS's "Staging" graphic. When triggered ON, the building operator will set the new chiller rotation order per the existing sequence. The notification flag will turn OFF once the chiller rotation order has been changed.

If either of the existing York chillers (CH-200 or CH-300) is set as the new lead, then a new timer will begin and count up for a period of several hours (e.g. 6 hours) based on the manufacturer's recommended run time for the chiller to maintain its operational readiness. At the end of the recommended chiller run time, the chiller rotation notification flag will again be triggered ON. Similarly, the notification flag will turn OFF once the chiller rotation order has been changed.

A. Chiller Loading - Any combination of chillers, chilled water pumps, cooling towers and cooling tower pumps may be selected and utilized. The operator shall have the ability to select which chiller, CHW pump, CTW pump and cooling tower shall start first, second, third etc. At least one CHW pump, CTW pump, cooling tower cell and chiller shall be in operation at all times. The units shall be staged as follows:

1. Unit Staging Control
   a) 1st stage unit is assigned sequence number 1
   b) 2nd stage unit is assigned sequence number 2
   c) 3rd stage/standby unit is assigned sequence number 3
   d) Failed/maintenance unit is assigned sequence number 0.
2. ***The suggested sequence of operation for highest energy efficiency is to assign one of the new Daikin chillers as the first stage unit and the other Daikin chiller as the second stage unit.***
3. ***To maintain operational readiness of the existing York chillers (CH-200 and CH-300), the user shall alternate selection of either chiller as the lead on a regular basis (e.g. weekly) or as recommended by the chiller manufacturer. In addition, it will operate continuously for a specified period of time (e.g. 6 hours) or per the manufacturer's recommendation. At the end of its programmed time period, a notification signal to rotate the chillers as described above will be sent to the Building Operator.***
4. The manual isolation valves for each chiller, pump, and tower shall be manually opened whenever the respective unit is available for automatic operation.
5. The first stage CHW pump P-1x shall start and the designated flow control valve FCV-xA in the CHW return of the first stage chiller CH-x00 shall open. The first stage CTW pump P-3x shall start, the CTW chiller bypass valve FCV-5B shall open and the designated flow control valve FCV-xB in the CTW supply of the first stage chiller CH-x00 shall open. When both CHW and CTW flow has been established the first stage chiller CH-x00 shall be started by its associated DDCP and operated by its own self-contained control package.
   Note: If the LOBOS CTW Pump optimization program allowing variable CTW flow is enabled, then the CTW chiller bypass valve FCV-5B shall remain closed.
6. If the amperage of the operating chiller CH-x00 exceeds 95% (adjustable) of the rated amperage of the chiller for more than 20 minutes (adjustable), or the flow in the CHW bypass drops below 50 GPM for more than 10 hours, the second stage CHW pump P-1x shall start and the CHW flow control valve FCV-xA of the 2nd stage chiller CH-x00 shall open. The CTW chiller bypass valve FCV-5B shall close and the CTW flow control valve FCV-xB of the second stage chiller CH-x00 shall open. When both CHW and CTW flow has been established, the second stage chiller CH-x00 shall be started by its associated DDCP and operated by its own self-contained control package.
   Note: If the LOBOS CHW Differential Pressure Control program allowing variable CHW flow is enabled, then the stage-up criterion based on CHW bypass flow < 50 GPM will be disabled. During this mode of operation, the CHW bypass flow control valve (FCV-6A) will be closed except when used to maintain minimum flow through the chiller.
   In addition, if the LOBOS CTW Pump optimization program allowing variable CTW flow is enabled, then the CTW chiller bypass valve FCV-5B shall remain closed.
7. If the total amperage of both operating chillers exceeds 95% (adjustable) of the total rated amperage of the chillers for more than 20 minutes (adjustable), or the flow in the chilled water bypass drops below 75 GPM for more than 10 hours, the third stage CHW pump P-1x shall start and the CHW flow control valve FCV-xA of the 3rd stage chiller CH-x00 shall open. The 2nd CTW pump P-3x shall start, chiller bypass valve FCV-5B shall open and the cooling tower water flow control valve FCV-xB of the third stage chiller CH-x00 shall open. When both CHW and CTW flow has been established, the third stage chiller CH-x00 shall be started by its associated DDCP and operated by its own self-contained control package.
   Note: If the LOBOS CHW Differential Pressure Control program allowing variable CHW flow is enabled, then the stage-up criterion based on CHW bypass flow < 75 GPM will be disabled.
   In addition, if the LOBOS CTW Pump optimization program allowing variable CTW flow is enabled, then the CTW chiller bypass valve FCV-5B shall remain closed.
8. Chiller Failure - If an enabled chiller should fail, an alarm shall be generated in the BAS and the standby unit shall automatically start. A chiller shall be considered "Failed" if the BAS receives a fault alarm or senses a loss of its run status. After the newly started chiller is in operation, the failed chiller shall be shut down. When disabled, the BAS will command the chiller OFF and fully close its associated CHW and CTW flow control valves.
9. Any chiller that fails shall automatically be assigned a sequence number of 0. Similarly, any unit 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 unit with an assigned sequence number of 0.
10. Adjustable inter-stage time delays which are initially set at 240 minutes shall be provided to prevent rapid cycling of the units. The BAS contractor shall be responsible for adjusting the timing to provide a stable yet responsive fully operational system.
11. The BAS shall calculate the tonnage of each unit and the total tonnage of the chilled water plant. This information shall be available at the OWS for operator use.
12. ***See "LOBOS Chiller Staging" description below in the LOBOS routine section for additional details.***

B. Chiller Unloading

1. If the CHW bypass exceeds 110 percent of the third stage chiller's CHW flow capacity for more than 5 minutes, and the total amperage of the three chillers is less than 54 percent (adjustable) of the total rated amperage of the three chillers for more than 5 minutes, the third stage chiller shall be shut down. After the chiller is off, the chiller's cooling tower flow control valve FCV-xB shall close, the chiller bypass valve FCV-5B shall close, and the last CTW pump to start shall be stopped. After an adjustable time delay, initially set at 2 minutes, the respective CHW flow control valve FCV-xA shall close and the last CHW pump to start shall be shutdown.
   Note: If the LOBOS CHW Differential Pressure Control program allowing variable CHW flow is enabled, then the stage-down criterion based on CHW bypass flow will be disabled.
   In addition, if the LOBOS CTW Pump optimization program allowing variable CTW flow is enabled, then the CTW chiller bypass valve FCV-5B shall remain closed.
2. If the flow in the CHW bypass exceeds 110 percent of the second stage chiller's CHW flow capacity for more than 5 minutes, and the total amperage of the two chillers is less than 39 percent (adjustable) of the total rated amperage of the two chillers for more than 5 minutes, the second stage chiller shall be shut down. After the chiller is off, the chiller's cooling tower flow water control valve FCV-xB shall close and the CTW chiller bypass valve FCV-5B shall open. After an adjustable time delay, initially set at 2 minutes, the respective CHW flow control valve FCV-xA shall close and the last CHW pump to start shall be shutdown.
   Note: If the LOBOS CHW Differential Pressure Control program allowing variable CHW flow is enabled, then the stage-down criterion based on CHW bypass flow will be disabled.
   In addition, if the LOBOS CTW Pump optimization program allowing variable CTW flow is enabled, then the CTW chiller bypass valve FCV-5B shall remain closed.
3. ***See "LOBOS Chiller Staging" description below in the LOBOS routine section for additional details.***

SEE SHEET C-3 FOR CONTINUATION

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No. 17795
Mechanical
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CONTROLS SCOPE – SEQUENCE OF OPERATION
SHEET 1 OF 3

MECHANICAL CHILLED WATER AND
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