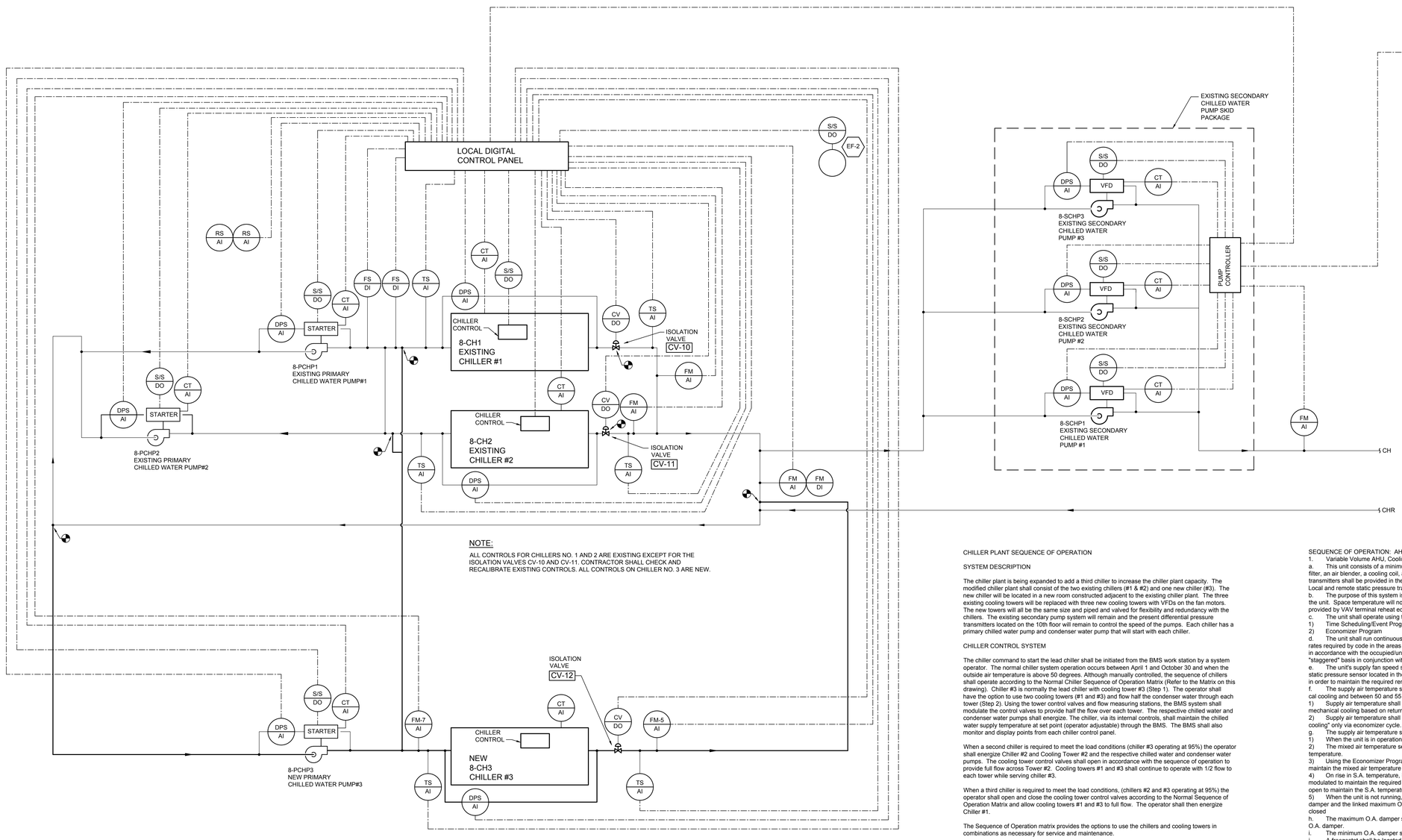

NOTE:

ALL CONTROLS FOR CHILLERS NO. 1 AND 2 ARE EXISTING EXCEPT FOR THE ISOLATION VALVES CV-10 AND CV-11. CONTRACTOR SHALL CHECK AND RECALIBRATE EXISTING CONTROLS. ALL CONTROLS ON CHILLER NO. 3 ARE NEW.

A 8-M8

CHILLED WATER SYSTEM CONTROLS

SCALE: NOT TO SCALE

ABBREVIATIONS

AI	ANALOG INPUT
AO	ANALOG OUTPUT
CT	CURRENT TRANSFORMER
CV	CONTROL VALVE
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DPS	DIFFERENTIAL PRESSURE SENSOR
FM	FLOW METER
FS	FLOW SWITCH
S/S	START/STOP
TS	TEMPERATURE SENSOR

CHILLER SEQUENCE OF OPERATION MATRIX WITH COOLING TOWER VALVE POSITIONS

NORMAL SEQUENCE	CHILLER	CT	CHILLER PUMPS (PCHP)			CONDENSOR WATER PUMPS (CWP)			COOLING TOWER VALVES											REMARKS
			1	2	3	1	2	3	1a	1b	2a	2b	3a	3b	4	5	6	7	8	9	
1	3	3	OFF	OFF	ON	OFF	OFF	ON	C	C	C	C	O	O	C	C	C	C	C	C	
2	3	1 & 3	OFF	OFF	ON	OFF	OFF	ON	C	C	C	C	O	O	C	C	C	C	O	O	Flow from CWP-3 split evenly with Towers 1 and 3
3	2 & 3	1, 2, &3	OFF	ON	ON	OFF	ON	ON	C	C	O	O	O	O	C	C	O	O	O	O	Flow from CWP-3 split evenly with Towers 1 and 3
4	1, 2, & 3	1, 2, &3	ON	ON	ON	ON	ON	ON	O	O	O	O	O	O	O	O	O	O	C	C	Open Valves 4 and 5 first, then close valves 8 and 9, 100% flow
OTHER COMBINATIONS																					
5	3	1	OFF	OFF	ON	OFF	OFF	ON	C	C	C	C	C	C	C	C	C	C	O	O	
6	3	2	OFF	OFF	ON	OFF	OFF	ON	C	C	O	O	C	C	O	O	O	C	C	C	
7	3	1 & 2	OFF	OFF	ON	OFF	OFF	ON	O	O	O	O	C	C	O	O	O	O	C	C	Flow from CWP-3 split evenly with Towers 1 and 2
8	3	2 & 3	OFF	OFF	ON	OFF	OFF	ON	C	C	O	O	O	O	O	O	O	O	C	C	Flow from CWP-3 split evenly with Towers 2 and 3
9	2	1	OFF	ON	OFF	OFF	ON	OFF	O	O	C	C	C	C	C	C	O	C	C	C	
10	2	2	OFF	ON	OFF	OFF	ON	OFF	C	C	O	O	C	C	C	C	O	C	C	C	
11	2	3	OFF	ON	OFF	OFF	ON	OFF	C	C	C	C	O	O	C	C	O	C	C	C	
12	1	1	ON		OFF	ON		OFF	O	O	C	C	C	C	C	C	C	C	C	C	
13	1	2	ON		OFF	ON		OFF	C	C	O	O	C	C	C	C	C	O	C	C	
14	1	3	ON		OFF	ON		OFF	C	C	C	C	O	O	O	O	O	O	C	C	Reverse flow occurs in this 18" pipe
15	1 & 2	1 & 2	ON	ON	OFF	ON	ON	OFF	O	O	O	O	C	C	O	O	O	O	C	C	
16	1 & 2	2 & 3	ON	ON	OFF	ON	ON	OFF	C	C	O	O	O	O	O	O	O	O	C	C	
17	1 & 2	1 & 3	ON	ON	OFF	ON	ON	OFF	O	O	C	C	O	O	O	O	O	O	C	C	
18	1 & 3	1 & 2	ON	OFF	ON	ON	OFF	ON	O	O	O	O	C	C	O	O	O	O	C	C	
19	1 & 3	2 & 3	ON	OFF	ON	ON	OFF	ON	C	C	O	O	O	O	C	C	C	C	C	C	
20	1 & 3	1 & 3	ON	OFF	ON	ON	OFF	ON	O	O	C	C	O	O	C	C	C	C	C	C	
21	1 & 3	1, 2, & 3	ON	OFF	ON	ON	OFF	ON	C	C	O	O	O	O	C	C	C	O	O	O	CH-3 uses towers 1 & 3, CH-1 uses CT-2
22	2 & 3	1 & 3	OFF	ON	ON	OFF	ON	ON	O	O	C	C	O	O	C	C	O	C	C	C	
23	2 & 3	1 & 2	OFF	ON	ON	OFF	ON	ON	O	O	O	O	C	C	O	O	O	C	C	C	
24	2 & 3	2 & 3	OFF	ON	ON	OFF	ON	ON	C	C	O	O	O	O	C	C	O	O	C	C	

CHILLER PLANT SEQUENCE OF OPERATION

SYSTEM DESCRIPTION

The chiller plant is being expanded to add a third chiller to increase the chiller plant capacity. The modified chiller plant shall consist of the two existing chillers (#1 & #2) and one new chiller (#3). The new chiller will be located in a new room constructed adjacent to the existing chiller plant. The three existing cooling towers will be replaced with three new cooling towers with VFDs on the fan motors. The new towers will all be the same size and piped and valved for flexibility and redundancy with the chillers. The existing secondary pump system will remain and the present differential pressure transmitters located on the 10th floor will remain to control the speed of the pumps. Each chiller has a primary chilled water pump and condenser water pump that will start with each chiller.

CHILLER CONTROL SYSTEM

The chiller command to start the lead chiller shall be initiated from the BMS work station by a system operator. The normal chiller system operation occurs between April 1 and October 30 and when the outside air temperature is above 50 degrees. Although manually controlled, the sequence of chillers shall operate according to the Normal Chiller Sequence of Operation Matrix (Refer to the Matrix on this drawing). Chiller #3 is normally the lead chiller with cooling tower #3 (Step 1). The operator shall have the option to use two cooling towers (#1 and #3) and flow half the condenser water through each tower (Step 2). Using the tower control valves and flow measuring stations, the BMS system shall modulate the control valves to provide half the flow over each tower. The respective chilled water and condenser water pumps shall energize. The chiller, via its internal controls, shall maintain the chilled water supply temperature at set point (operator adjustable) through the BMS. The BMS shall also monitor and display points from each chiller control panel.

When a second chiller is required to meet the load conditions (chiller #3 operating at 95%) the operator shall energize Chiller #2 and Cooling Tower #2 and the respective chilled water and condenser water pumps. The cooling tower control valves shall open in accordance with the sequence of operation to provide full flow across Tower #2. Cooling towers #1 and #3 shall continue to operate with 1/2 flow to each tower while serving chiller #3.

When a third chiller is required to meet the load conditions, (chillers #2 and #3 operating at 95%) the operator shall open and close the cooling tower control valves according to the Normal Sequence of Operation Matrix and allow cooling towers #1 and #3 to full flow. The operator shall then energize Chiller #1.

The Sequence of Operation matrix provides the options to use the chillers and cooling towers in combinations as necessary for service and maintenance.

PRIMARY CHILLED WATER AND CONDENSER WATER PUMP CONTROL

Chiller Isolation valves shall open and primary chilled water and condenser water pumps shall automatically start when its associated chiller has a status to start. When enabled, the pumps will start and run continuously. The internal controls for each chiller shall verify flow before allowing the chiller to energize. An alarm shall be generated if pump flow is not verified.

COOLING TOWER CONTROL SYSTEM

The cooling towers and cooling tower control valves shall be energized in accordance with the Normal Sequence of Operation Matrix.

Cooling tower fan shall automatically be placed under control of its sump temperature whenever its respective chiller is commanded to start. The cooling tower has a variable speed drive the speed will modulate to maintain the condenser water at set point (operator adjustable). If for any reason its fan status does not match its commanded value an alarm will be generated.

The BMS shall be capable to control the electric two position motorized valves to operate the tower sump fill and drains for each tower. The fill valves shall operate automatically with the sump control on each tower.

GRAPHICS

The new chiller, cooling towers, pumps, and equipment shall be added to the existing Johnson Controls BMS.

SEQUENCE OF OPERATION: AHU-1 and Ventilation

1. Variable Volume AHU, Cooling and Ventilation

a. This unit consists of a minimum O.A. damper, linked maximum O.A. and R.A. dampers, a pre-filter, an air blender, a cooling coil, a supply fan with VFD and a final filter section. Temperature transmitters shall be provided in the R.A. duct, in the mixed air plenum and in the S.A. duct. Local and remote static pressure transmitters shall be provided at the unit and in the S.A. ductwork.

b. The purpose of this system is to provide constant temperature cooling air to the area served by the unit. Space temperature will normally be maintained at 74 deg. F maximum. Heating will be provided by VAV terminal reheat equipment located in the space.

c. The unit shall operate using the following programs.

1) Time Scheduling/Event Program

2) Economizer Program

d. The unit shall run continuously (during normally occupied hours) to maintain critical airflow rates required by code in the areas served. The unit will normally be stopped for maintenance and in accordance with the occupied/unoccupied schedule. The unit shall be sequenced to start on a "staggered" basis in conjunction with other units after a power failure.

e. The unit's supply fan speed shall be modulated to maintain local supply fan static pressure via a static pressure sensor located in the duct. The local supply fan static pressure setpoint shall be reset in order to maintain the required remote duct static pressure.

f. The supply air temperature shall be maintained between 55 and 65 deg. F when using mechanical cooling and between 50 and 55 deg. F when using "free cooling" via economizer cycle.

1) Supply air temperature shall be reset to the highest temperature possible when using mechanical cooling based on return air (space) temperature.

2) Supply air temperature shall be reset to the lowest temperature possible when using "free cooling" only via economizer cycle.

g. The supply air temperature shall be maintained in the following manner:

1) When the unit is in operation the minimum O.A. damper shall open fully.

2) The mixed air temperature setpoint shall be reset in order maintain the required S.A. temperature.

3) Using the Economizer Program, the maximum O.A. and R.A. dampers shall be modulated to maintain the mixed air temperature setpoint.

4) On rise in S.A. temperature, based on the inability of the O.A. and R.A. dampers being modulated to maintain the required S.A. temperature, the chilled water valve shall be modulated open to maintain the S.A. temperature setpoint.

5) When the unit is not running, the chilled water valve shall close and the minimum O.A. damper and the linked maximum O.A./R.A. dampers shall reside with the O.A. dampers being fully closed

h. The maximum O.A. damper shall be N.C. The R.A. damper shall be linked to the maximum O.A. damper.

i. The minimum O.A. damper shall be N.C.

j. A freezestat shall be located upstream of the cooling coil. Upon detection of a freeze condition, the unit shall be stopped, the cooling valve shall open fully, the O.A. dampers shall be closed, and an alarm shall be initiated at the BMS System Operator's Console.

k. From the static pressure transmitter located in the supply fan discharge, if upon call for the fan to start, and if airflow is not detected in 20 seconds, the fan shall be stopped and an alarm shall be registered at the BMS System Operator's Console.

m. DP switches shall be provided across the prefilter section and the final filter section. These switches shall notify the BMS System Operator's Console of high filter differential pressure.

2. Variable Air Volume Boxes with Reheat

a. he VAV boxes shall modulate the dampers to maintain space temperature setpoint. If the damper is at minimum position and the space temperature falls below the setpoint, the heating valve shall modulate to achieve setpoint.

3. Chiller Room Ventilation

a. The BMS control system shall control the chiller room ventilation system. A temperature sensor located in the new chiller room shall upon sensing a temperature in the space greater than 70 degrees F modulate the intake air dampers open and energize the ventilation fan REF-1. Upon a drop in temperature in the space below 65 degrees F the control system shall de-energize the ventilation fan REF-1 and close the relief air dampers.

4. Chiller room emergency refrigerant relief

a. The BMS control system shall interface with the refrigerant monitor system. Upon receiving a signal indicating the presence of refrigerant in the chiller room the BMS control system shall open intake dampers and shall energize the refrigerant exhaust fans REF-2 and Ventilation Fan REF-1. The de-energizing of the roof exhaust fans shall be manually controlled through the operator control station. Upon the Fans being de-energized the intake air dampers shall be closed and the Ventilation fan REF-1 shall be placed under is normal control logic.

5. Graphics

a. The AHU and VAV boxes shall be added to the existing Johnson Controls BMS to display the equipment and monitoring/control points.

CONTRACT DOCUMENTS SUBMISSION

Revisions	Date
AMENDMENT No. 5 SHEET REISSUED	10/07/11

Professional Stamp/Seal: COMMONWEALTH OF VIRGINIA REGISTERED PROFESSIONAL ENGINEER DAVID R. PALMER 043216E 5-23-11

H.F. LENZ COMPANY
Engineers Planners Surveyors Energy Consultants
1407 Scalp Avenue Johnstown, PA 15904
Phone: 814-269-9300 FAX: 814-269-9301
cadd@hflenz.com www.hflenz.com

IKM
architecture planning interior design
IKM Incorporated
One PPG Place
Pittsburgh, PA 15222
412-281-1337
www.ikminc.com

Approved:	Approved: Director, VA Pittsburgh Healthcare System	Drawing Title: CHILLED WATER SYSTEM CONTROLS	Project Title: COOLING TOWER REPLACEMENT
Approved:	Approved: Associate Director, VAPHCS		
Approved:	Approved: Vice President, Facilities Management	Approved: Site Manager	Building No.: 8 / Scale: NONE / Drawn/Checked: JRO/DEP
Approved:	Approved: Manager, Projects Section	Approved: Project Manager	Location: VA PITTSBURGH HEALTHCARE SYSTEM UNIVERSITY DRIVE DIVISION PITTSBURGH, PA. 15240

Date: 23 JUNE 2011
Project No.: 646-09-126
DRAWING NO.: 8M-8
Dwg. X of X

Veterans Affairs

"U.S. GOVERNMENT PRINTING OFFICE: 1983-400-285

VA FORM 08-6231, FEB. 1983