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6.0 Electrical Breadth

Purpose

The purpose of the Electrical Breadth is to provide electrical service to the equipment selected in the most cost-effective design alternative discovered in the Mechanical Depth. Since the on site centrifugal cooling design alternative was the best, equipment includes two chillers, the cooling tower cells, two primary water pumps, and two condenser water pumps. Providing electrical service includes sizing wire, conduit, and breakers, laying out a new panelboard, and resizing the existing Switchgear F so that it may handle the newly added loads. Since no mechanical equipment is being removed from the base case scenario in the on site centrifugal cooling design alternative, no electrical equipment needs to be taken out either.

Justification

Justification of the work to be carried out in the electrical breadth is fairly straightforward. Without providing electrical service to the equipment selected in the most cost-effective design alternative found in the Mechanical Depth, the equipment can not run. Failing to resize Switchgear F would also put other systems throughout the HBCCH at risk, too.

Method of Analysis

The first required task was to determine which pieces of equipment would be placed onto new electrical panelboards and which equipment would be directly tied into Switchgear F. Due to their extremely large start up load requirements, it was decided that both of the chillers would be directly tied into Switchgear F, while the remaining equipment would be placed on a panelboard.

Creating a Panelboard

First, the full load current for each piece of equipment was determined using Table 430.250 of the 2005 National Electric Code. Once the full load current was known, Table 310.16 and Table C.1 of the National Electric Code were used in order to size the wire and associated conduit. Breakers were sized based on 250% of the full load current in order to allow for higher start up load requirements. The resulting sizes can be seen in Table-8 below.

Table-8: Sizing of Wires, Conduit, and Breakers for Panelboard

Wire, Conduit, and Breaker Sizes for Panelboard Equipment				
Equipment	Full Load Current (A)	Wire Size	Conduit Size (Inches)	Breaker Size (A)
Cooling Tower Cell A	77	#4 AWG	1	200
Cooling Tower Cell B	77	#4 AWG	1	200
Primary Pump A	27	#8 AWG	3/4	80
Primary Pump B	27	#8 AWG	3/4	80
Condenser Pump A	77	#4 AWG	1	200
Condenser Pump B	77	#4 AWG	1	200

Note: All wires sized as Copper THW at 75 degrees centigrade

Next the panelboard was laid out. Effort was taken to ensure that the loads on all three phases were similar. In this case, the loads on each phases are identical since all equipment was three phase and there was an even number of each piece of equipment. Once the panelboard was designed, the main circuit breaker could be sized. This was achieved using the following equation:

$$\text{Breaker Requirement} = (1.25)(\text{Highest Load}) + (1.0)(\text{Remaining Loads})$$

The resulting breaker size is 400A. Table 310.16 of the National Electric Code was then employed yet again to determine the feeder size. For the new panelboard, 500 kcmil wire in 2 ½" conduit is required. The new panelboard for the HBCCH can be seen in Figure-14 below.

Figure-14: New Electrical Panelboard

Voltage: 480 V 3 Φ **Main Breaker:** 400 A **Feeder:** 500 kcmil (2 1/2" C) **(#, size wire & conduit)**

Description	LOAD (kVA) A	LOAD (kVA) B	LOAD (kVA) C	Brk. Trip (A)	Cond. Size	Ckt. #	Ckt. #	Cond. Size	LOAD (kVA) A	LOAD (kVA) B	LOAD (kVA) C	Brk. Trip (A)	Description
Cooling Tower Cell A	21.33			200/3	1"	1	2	1"	21.33			200/3	Cooling Tower Cell B
		21.33				3	4			21.33			
			21.33			5	6				21.33		
Primary Pump A	7.48			80/3	3/4"	7	8	3/4"	7.48			80/3	Primary Pump B
		7.48				9	10			7.48			
			7.48			11	12				7.48		
Condenser Pump A	21.33			200/3	1"	13	14	1"	21.33			200/3	Condenser Pump B
		21.33				15	16			21.33			
			21.33			17	18				21.33		
						19	20						
						21	22						
						23	24						
						25	26						
						27	28						
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						

Total Load on Phase A: 100.28 kVA
Total Load on Phase B: 100.28 kVA
Total Load on Phase C: 100.28 kVA

Total Load on Panel: 300.84 kVA Demand
361.85 A

Providing Service for Chillers

Both of the new 950 ton centrifugal chillers will be wired directly to Switchgear F. Cutsheets for the chillers indicate that a 1600 A breaker is required in order for the chiller to operate as designed. Using the National Electric Code, it was determined that each chiller requires two sets of 800 kcmil wiring in 3 inch conduit.

Another option for wiring up the chillers and other equipment would have been the installation of a motor control center. Motor control centers help reduce cost and save space by only needing one main feeder to run from the distribution panel to the loads. The motor control center then has a motor starter inside for each individual load. For the HBCCH, a motor control center was not selected for two main reasons. First, Switchgear F, the main distribution panel being utilized, is in the room next to the mechanical room. Feeders will not have to travel large distances to get to the loads. Also, there just wasn't enough equipment to justify buying an entire motor control center.

Resizing Switchgear F

Since numerous pieces of equipment were added to the HBCCH and none were removed, it was a concern that the current electrical service would not be sufficient. The current distribution panel for the loads, Switchgear F, is only sized at 2000A. A one line diagram of the original Switchgear F can be seen in Figure-15 below. Fortunately, there were three spare spaces available. These three spaces were used for the new panelboard, Chiller 1, and Chiller 2. In order to resize the switchgear, the following equation was used:

$$\text{Switchgear Size} = (0.8)(\text{Original Breaker Sizes}) + (1.0)(\text{FLC of New Equipment})$$

This equation was used because panelboard schedules for the panels connected to Switchgear F could not be obtained. The National Electric Code assumes that all panels under 600 A (which all of the original loads are) can be considered lighting and appliance panels. These are fairly consistent loads. The 0.8 multiplier was recommended by industry professionals. The newly resized Switchgear F can be seen in Figure-16 below.

Figure-15: Original Switchgear F Layout

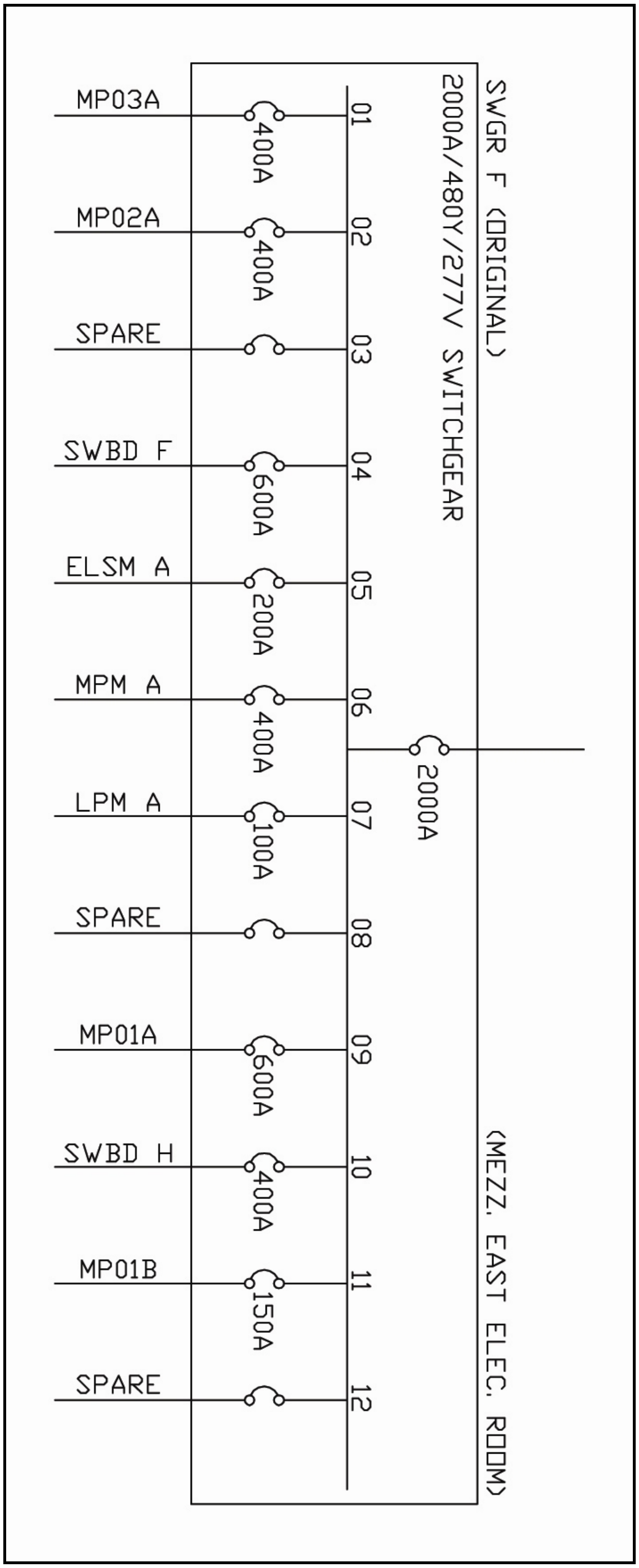

Figure-16: Resized Switchgear F Layout