MOTOR CONTROL CENTER DESIGN

A motor control center is typically used when it is necessary to control a number of motors from one location. The Independence Visitor Center does not currently have any motor control centers.

Advantages of a motor control center:

- Reduce cost for on-site installation by keeping time and labor to a minimum
- Compact assembly takes up less space than all motors separately
- Centralized location of controls allows for convenient operation and maintenance
- Modular arrangement leads to possibility of future expansion

Room B-16, the Mechanical/Maintenance Room, is an overly crowded room with a lot of equipment that can be simplified if a motor control center was used to control all of this equipment. Since the Independence Visitor Center does not have any Motor Control Centers, one was designed for room B-16. Figure 2.1 shows the existing Room B-16.

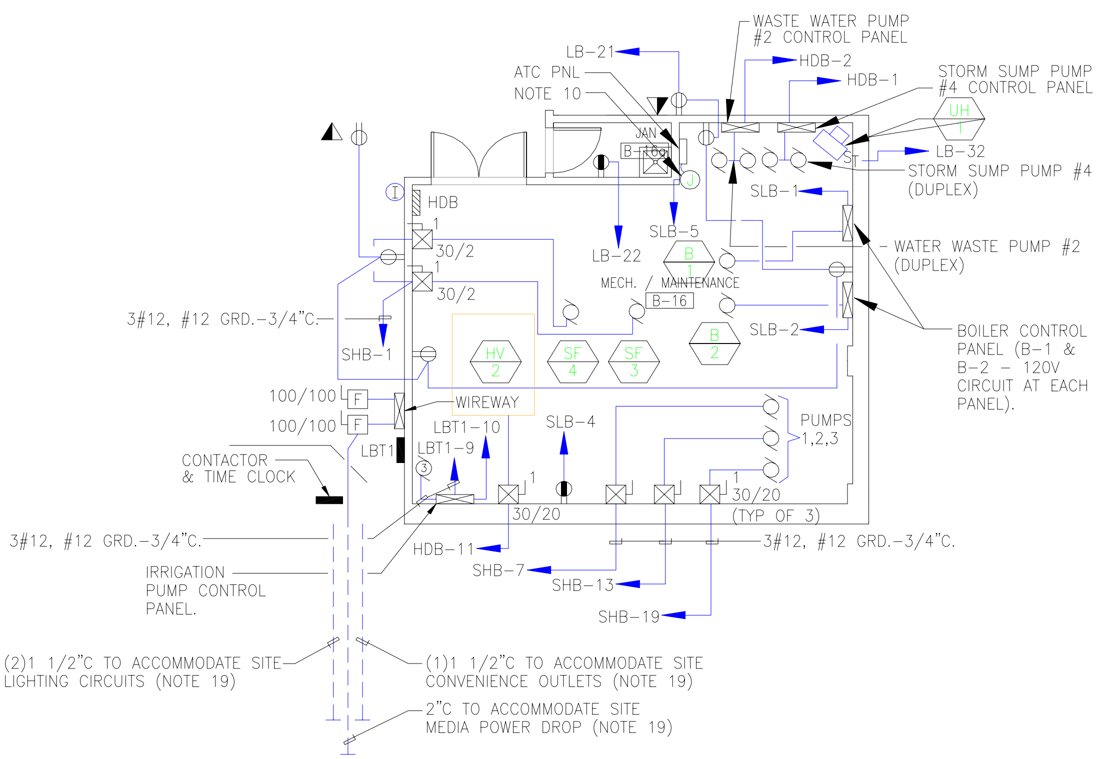

Figure 2.1: Existing Conditions for Room B-16

Figure 2.2 shows the redesigned Room B-16 with the Motor Control Center in place. It takes up much less space than all of the previous equipment.

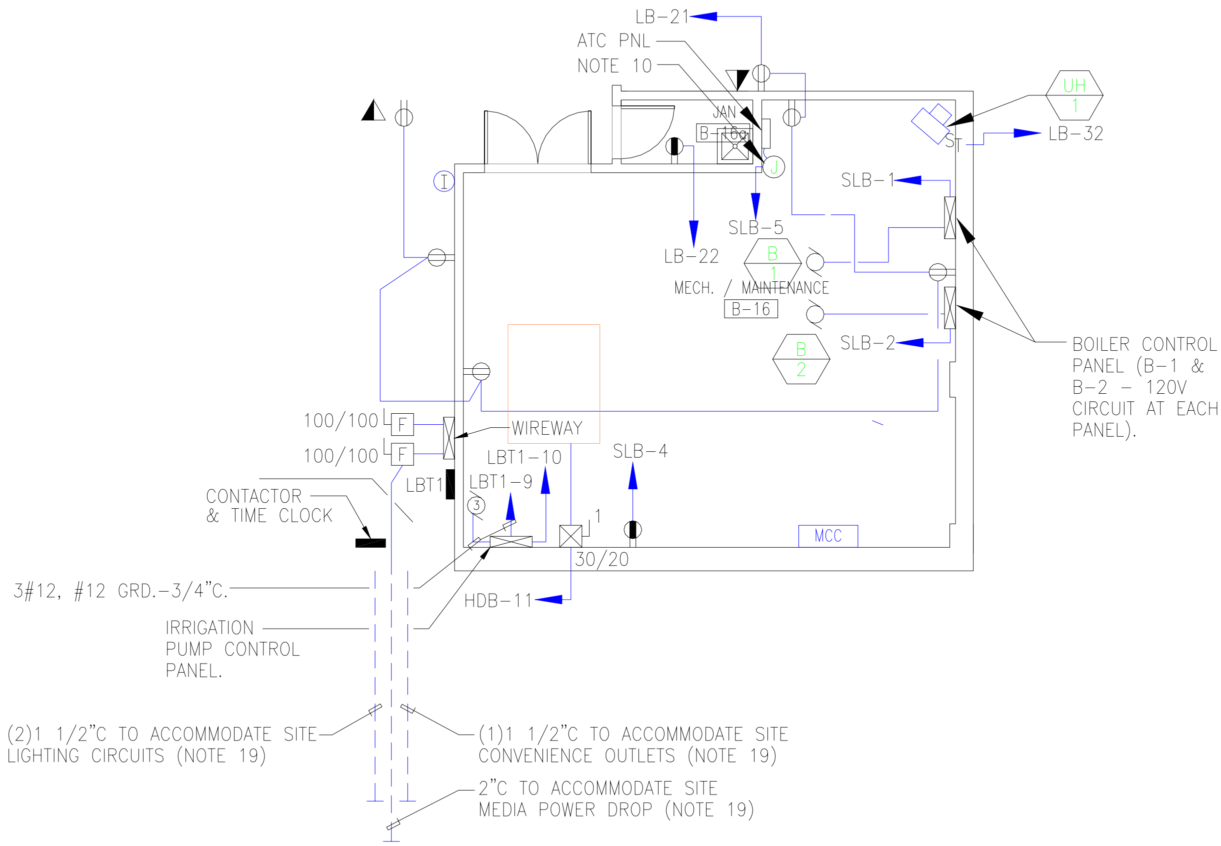

Figure 2.2: Redesign of Room B-16 with Motor Control Center

Table 2.1 shows the equipment that has been moved from its original location in Room B-16 to the motor control center. This includes all of the equipment from panelboard HDB which is located in room B-16. Panelboard HDB can be removed with the multiple pumps and other equipment located on the panelboard or in the room.

The necessary components needed to know about each motor going into the motor control center is the voltage, phases, horsepower, full load amps, and type of starter. All of this is detailed for each piece of equipment in Table 2.1. There are two types of starters used: FVNR, Full Voltage Non-Reversing, and 2 Speed.

MOTOR CONTROL CENTER

Mechanical/maintenance Room B-16

Equipment	Volts	Phases	HP	Type of starter	Full load Amps	Amps w/ correction factor	Location on MCC
SF-3	480	3	0.25	FVNR	1.1	1.375	1/A
SF-4	480	3	0.25	FVNR	1.1	1.375	1/C
P-1	480	3	7.5	FVNR	11	13.75	1/E
P-2	480	3	7.5	FVNR	11	13.75	1/G
P-3	480	3	7.5	FVNR	11	13.75	1/I
Storm Sump Pump #4	480	3	1	FVNR	2.1	2.625	1/K
Storm Sump Pump #4	480	3	1	FVNR	2.1	2.625	1/M
Waste Water Pump #2	480	3	1	FVNR	2.1	2.625	1/O
Waste Water Pump #2	480	3	1	FVNR	2.1	2.625	1/Q
Domestic Water Pump	480	3	5	FVNR	7.6	9.5	1/S
Domestic Water Pump	480	3	5	FVNR	7.6	9.5	1/U
Sewage Ejector Pump	480	3	2	FVNR	3.4	4.25	1/W
Booster Pump (Boiler)	480	3	0.75	FVNR	1.6	2	2/A
Kitchen General Pump	480	3	0.75	FVNR	1.6	2	2/C
Jockey Pump	480	3	0.75	FVNR	1.6	2	2/E
HV-2	480	3	7.5	2 SPEED	11	22	2/G
Spare	480	3	7.5	FVNR	11	13.75	2/S
Main Breaker					125		2/N
					Total	119.5	

Table 2.1: Equipment characteristics and location on Motor Control Center

ASSUMPTIONS:

NEC Article 430-24 states to multiply the amps for the largest motor by 125% and keep the other amps at 100%. This is only a minimum standard which good engineering practice calls to exceed in certain cases, one case being multi-motor feeders in which we have here. The two worst case scenarios would be having all of the motors start simultaneously or having them all run continuously. Since it is unknown if either of these cases may occur, it is best to be conservative and multiply the largest motor by 200% and all other motors by 125%. This is how I approached the Amps with Correction column on Table 2.1. Spares were then considered to take up approximately 10% of the total ampacity. I added one spare that is slightly larger than the 10%. The full load amps were determined from NEC Table 430-150.

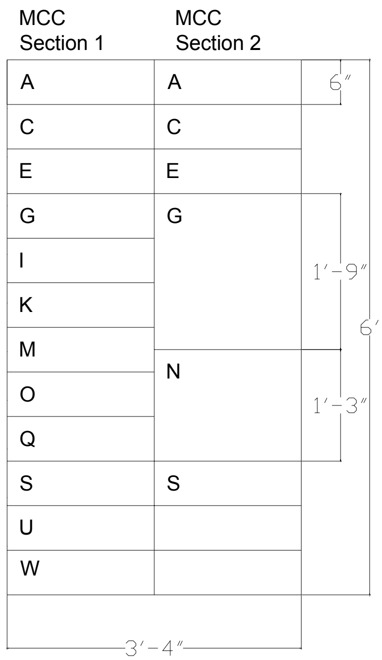

Figure 2.3: Motor Control Center Layout and Dimensions

The motor control center is Model 6 from Square D. In order to size the space needed for each piece of equipment, I used Full Voltage Non-reversing Starters with MAG-GARD Circuit Breakers and Full Voltage 2-Speed 2-Winding Starters with MAG-GARD Circuit Breakers.

Section 1 of the MCC has all COMPAC 6 NEMA/EMAC rated six inch units. These units are mounted in standard 20" wide by 15" deep Model 6 sections. The units used here are all NEMA Size 1. Section 2 unit G is for the Full-Voltage 2-Speed 2-Winding Starters with constant horsepower. This is NEMA size 1 as well. The dimensions are 21" tall, 20" wide, and 15" deep. Section 2 unit N is the main circuit breaker for the entire MCC. Its dimensions are 15" tall, 20" wide, and 15" deep. Figure 2.3 shows how the MCC is set up. Refer to Table 2.1 to determine which equipment is in which unit.

CALCULATIONS:

SIZING OF FEEDER:

Total Ampacity = 119.5 A
Conductor Size = 1 MCM THW Copper 75° (rated 130A)
**Note: Used NEC Table 310-16

Conduit Size = 1 ¼"C (3 conductors)
**Note: Use NEC Chapter 9, Table 3A

VOLTAGE DROP CALCULATIONS

The maximum allowable voltage drop for feeders is 3% according to NEC Article 215-2(d) FPN No. 2, but regular practice assumes a maximum of 2%.

Length of feeder calculation

The length of the feeder was calculated by adding together Running flat on the ceiling from Mechanical Room from MSB to Room B-16 to the Motor Control Center then the distance from ceiling to floor was added in as a maximum possible distance with ceiling height of 9'6"

Length = 121.026'
Length + 10% = 121.026 * 1.1 = 133.1286 ≈ 133.2'
Feeder Current (load current) = 119.5A
Power Factor = 1.0
Frequency = 60 Hz
Voltage (l-n) = 277V
Feeder Size = 1 MCM
V_{drop} = .150

**Note: Assuming Copper feeder and Magnetic Conductor from Table 11.5 courtesy of Canada Wire and Cable Limited

Amp-feet = 119.5A * 133.2' = 15,917.4 A-ft = 15.918 * 1000 A-ft
V_{drop} (l-n) = .150*15.918 = 2.39 V
V_{drop} (l-l) = √3 * 2.39V = 4.14 V
$V_{source} - V_{load}$ = 4.14 V
V_{source} = 480 V
% V_{drop} = (V_{source}-V_{load} / V_{source})* 100 = (4.14 / 480) *100 = 0.863%
% V_{drop} = 0.863% < 2%   OK

SHORT-CIRCUIT CALCULATIONS

Short-circuit calculations were not performed because no new equipment was added to the system. Equipment that already existed was simply reconfigured with the same ampacity.

CONCLUSION

By redesigning the arrangement of the equipment into a motor control center, space is saved and time is saved to install and maintain the equipment.