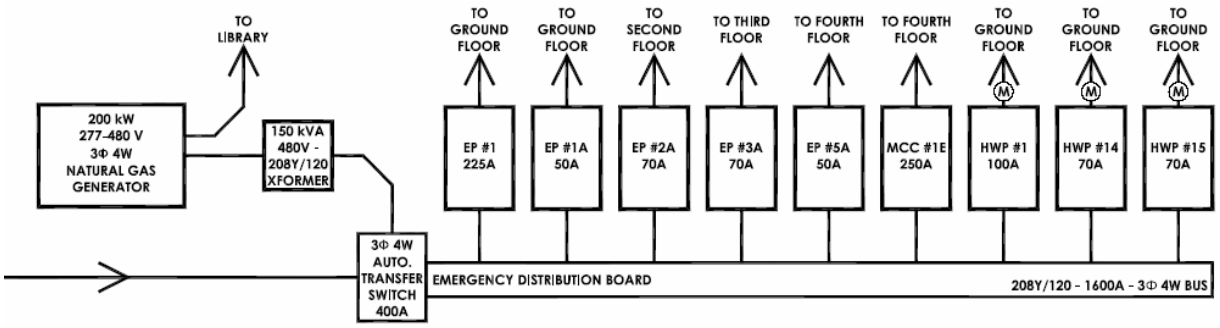
REDESIGN DESCRIPTION

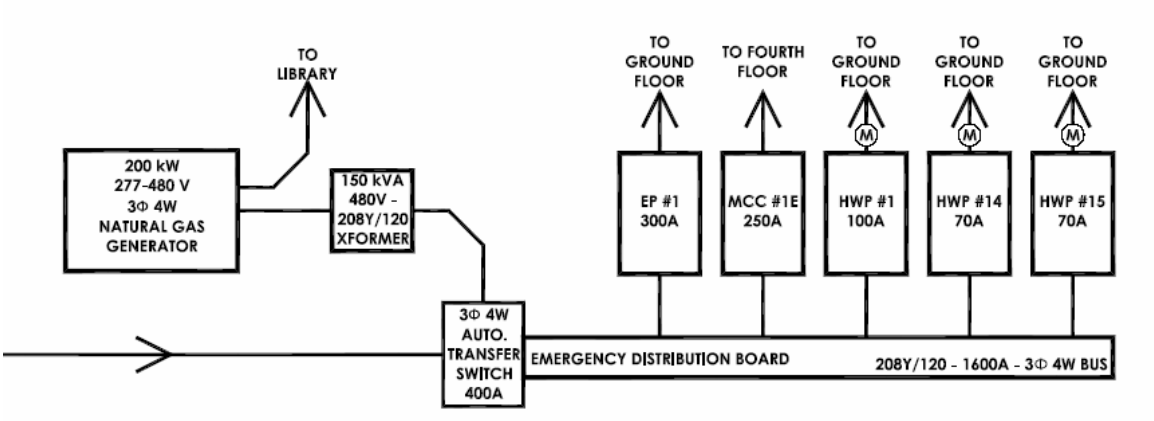
The current electrical system utilizes a 200kW natural gas generator to supply power for emergency mechanical and lighting loads in the facility. Emergency lighting loads are hard wired to the emergency power panel on each floor. This method of powering emergency lighting results in long wiring runs to just a small percentage of the luminaires all across the building. An alternative to this method of emergency lighting is to incorporate emergency ballasts with the emergency lighting luminaires. In this method, all lighting, including emergency lighting, is connected to the normal lighting circuits. The emergency ballast only requires that an un-switched hot lead is connected so that the luminaire may be controlled along with other luminaires in that control zone without the emergency ballast thinking it has lost power. This lead can be run along with the standard controlled wiring. Making the emergency luminaires self sufficient will result in a significant first-cost savings because the cost of wiring the emergency lighting loads separately from the normal lighting will be eliminated.

ANALYSIS

Existing Condition Emergency Riser Diagram



All lighting loads were removed from panels EP-1, EP-1A, EP-2A, EP-3A, and EP-5A. The remaining critical mechanical loads from these panels were combined into the new EP-1, below is the new emergency riser diagram;



Emergency Panel EP-1

Equip	Serves	Volt	Phase	HP	3Φ Amps	Watts	Inverse Time-Delay Circuit Breaker (A)
CUH-1	Vestibule G01	120	1	0.10	1.47	528	15
CUH-2	Vestibule 215	120	1	0.10	1.47	528	15
CUH-3	Vestibule 225	120	1	0.10	1.47	528	15
UH-1	Recycle Closet 231	120	1	0.05	1.47	528	15
UH-2	Elev. Mech. Tower-2	120	1	0.05	1.47	528	15
UH-3	Elev. Mech. 236	120	1	0.05	1.47	528	15
RS-1	Rolling Fire Shutter	120	1	0.25	1.93	696	15
P-3	Elev. Sump Room	120	1	0.33	2.40	864	15
EF-12	Mech. Room G19	208	3	5.00	16.70	6012	50
HWP-5	Fin Radiation	208	3	7.50	24.20	8712	70
HWP-6	Fin Radiation	208	3	7.50	24.20	8712	70
HWP-16	Boiler #1	208	3	3.00	10.60	3816	30
HWP-17	Boiler #2	208	3	3.00	10.60	3816	30
UH-6	Boiler Room G21	120	1	0.25	1.93	696	15
UH-8	Telephone Equipment E20A	120	1	0.05	1.47	528	15
B-1	Boiler 1	208	3	2.00	7.50	2700	20
B-2	Boiler 2	208	3	2.00	7.50	2700	20
JP-1	Jockey Pump	208	3	5.00	16.70	6012	50
AC-1	Air Compressor Control	208	3	15.00	46.20	16632	125
P-4	Boiler Room G21	208	3	5.00	16.70	6012	50
						71076	total
						71.08	kW
						78.97	kVA @ PF=.9
						219.37	full load current
						232.20	ampacity minimum

90°C XHHW 4/0 wire in 2" conduit protected by a 300A circuit breaker.

A panelboard layout for the new EP-1 is included in the appendix.

COST ANALYSIS

The chart below shows the cost savings associated with the change in the emergency lighting system. All costs were taken from the RS Means 2004 Electrical Cost Data and are total cost including overhead and profit. Multiple runs of armored cable wiring and four 100A panelboards were eliminated in this redesign. The cost of the new EP-1 and the emergency ballasts from Bodine (www.bodine.com) were added.

Item	Quantity	Units	Cost/unit	Total Cost
#8 AWG Armored Cable	-126	Average Runs	$585.00	-$73,710.00
100A 20 Circuit Panelboard	-4	each	$715.00	-$2,860.00
400A 42 Circuit Panelboard	1	each	$1,850.00	$1,850.00
Bodine model B33	49	each	$230.00	$11,270.00
Bodine model B84c	77	each	$100.00	$7,700.00
			Cost difference	-$55,750.00

MOTOR CONTROL CENTER

In the control sequence section of the mechanical spec, it is specified that;

> - The DDC system shall monitor a signal from the emergency generator via a set of dry contacts at the emergency generator control panel. If the emergency generator is energized and AHU-7 is indexed to the smoke evacuation mode, the DDC control system shall disable the boilers and place all hot water pumps in the off position. When AHU-7 is indexed to the smoke evacuation mode, the outside air and the exhaust air dampers shall be in the full open position and the return air damper shall close fully. The supply air and return air variable frequency drives shall increase fan speed to provide supply and exhaust at the full design capacity.

This can be interpreted to mean that the AHU-7 fans would never be running off of the generator at the same time as the boilers and hot water pumps. This would result in two emergency operation cases, A and B.

Emergency Case A

Equip	Serves	Volt	Phase	HP	3Φ Amps	Watts
MCC-1E	AHU-7 - Atrium	208	3	113	323.96	116626

116626	total
116.63	kW
323.96	full load current

Emergency Case B

Equip	Serves	Volt	Phase	HP	3Φ Amps	Watts
EP-1	Emergency Loads	208	3	56.33	197.43	71075
HWP-1	AHU Heating Coils	208	3	15	46.2	16632
HWP-14	Boiler Hot Water Loop	208	3	10	30.8	11088
HWP-15	Boiler Hot Water Loop	208	3	10	30.8	11088

109883	total
109.88	kW
305.23	full load current

Luminaires Removed From Generator

Name	Type	Lamp	Quantity	Wattage	Total
FB	2x4' Recessed Static Troffer	(2) F32/T8	2	70.4	140.8
FC	2x4' Recessed Parabolic Troffer	(3) F32/T8	2	105.6	211.2
FD	2x4' Recessed Parabolic Troffer	(2) F32/T8	14	70.4	985.6
FE	1x4' Recessed Static Troffer	(2) F32/T8	7	70.4	492.8
FF	6" Round CF Downlight	(1) 26W HTT	12	28.6	343.2
FG	9" Round CF Downlight	(2) 26W HTT	55	57.2	3146
FI	9"x4' Recessed Parabolic Troffer	(2) F32/T8	5	70.4	352
FL	9" Round CF Downlight	(2) 13W HTT	2	28.6	57.2
FQ	1x4' Surface Wraparound	(2) F32/T8	18	70.4	1267.2
FR	2x2' Recessed Static Troffer	(2) F32/U6	1	70.4	70.4
FS	9" Round CF Downlight	(2) 18W DTT	6	39.6	237.6
I	Wall Mounted Decorative CF	(1) 18W TT	2	19.8	39.6

7343.6	1Φ Power
61.19667	1Φ Amps
20.39889	3Φ Amps

This shows that the critical load from the Emergency Distribution Board will be 324 A after the removal of approximately 20 A of emergency lighting loads. The size of the load reduction is relatively small compared to the other loads supported by the emergency generator. Therefore the generator, transformer, and automatic transfer switch should not be resized. The following calculations determine feeder size, protection size, voltage drop requirements and short circuit current.

Motor Control Center - MCC-1E

Equipment Designation	Motor Rating				Fuse Size
	HP	Voltage	Phase	FLC	(A)
AHU-7 Supply Fan	60	208	3	169.4	250
AHU-7 Return Fan	50	208	3	143	225
Prehat Pump, HWP-21	3	208	3	10.56	20

Required Feeder Ampacity= $1.25*LOAD_{MAX}+1.0*\sum LOAD_{REMAINING}$ = 365.31 A

- select 90º XHHW 400 MCM in 2.5" conduit

Maximum Breaker Trip Size= $2.5*LOAD_{MAX}+1.0*\sum LOAD_{REMAINING}$ =577.06 A

- select 600A

Voltage Drop Maximum=3%

$$LENGTH = 175(FT)$$

$$LENGTH_{ADJUSTED} = 1.1*LENGTH = 192.5(FT)$$

$$V_{DROP} = .051\left(\frac{V}{1000*A*FT}\right)$$

$$CURRENT = 365(A)$$

$$V_{DROP(L-N)} = .051*192.5*365*\frac{1}{1000} = 3.58(V)$$

$$V_{DROP(L-L)} = \sqrt{3}*V_{DROP(L-N)} = 6.2(V)$$

$$V_{DROP(\%)} = \frac{V_{DROP(L-L)}}{V_{(L-L)}}*100 = 2.98\% < 3\% \quad \therefore \quad OK$$

Short Circuit Current

$$I_{ASY} = 110{,}000(A)$$

$$K_0 = 1.3$$

$$I_{SYM} = \frac{I_{ASY}}{K_O} = 84{,}615(A)$$

$84{,}615(A) < 100{,}000(A)$ *highest frame rating availalbe* $\therefore$ *OK*

CONCLUSION

A significant first cost savings of almost $56,000 is achieved by removing the emergency lighting loads from the existing emergency power distribution system. The emergency motor control center should be a Square D Model 6 (www.squared.com) with a 600A bus and a 100,000 frame. It is important that the motor control center is operated in a way that the AHU fans will not operate at the same time as the hot water pumps when running on emergency power. Otherwise, the transformer and automatic transfer switch connected to the generator will be overloaded and are likely to fail.