ELECTRICAL DEPTH

3.0 Electrical Depth Introduction

Recalculation of new electrical loads due to the changes in the lighting design will be reflected in the following panelboard and relay panel schedules. Sizes of the panels were checked to make sure its rated ampacity could still carry the new loads. Main circuit breakers in the panels were also resized accordingly when appropriate.

Reliability is a crucial issue for a broadcasting facility that requires being online at all times. The following is a performance and reliability analysis comparing a static and rotary UPS for the application in the CNBC broadcasting building. The existing system is comprised of (2) 1,000 kVA static UPS that utilizes (4) flooded cell batteries with 13 minutes of back up. The proposed system is composed of (2) 1,200 kVA rotary UPS that utilizes a flywheel technology that can provide 15 seconds of full load power. The evaluation of theses two UPS systems will come from a performance and cost standpoint. The proposed rotary UPS configuration will be similar to the existing UPS configuration where the two modules operate in parallel and connected to the power-tie control.

Information gathered for the analysis came from manufacturer specifications and text written on UPS with flywheel technology. Case studies and technology performance reports were also examined for buildings that utilized static (battery) UPS and switched over to the rotary (flywheel) UPS.

Furthermore, after investigation of the existing electrical loads of the building, the actual building energy consumption data from the utility service provider reveals an excess of about 1,000 kW that would need to be dropped by the generator set should one of the generators fail. The existing electrical system has (2) 2,000 kW generators that operate in parallel. The system is configured so that one generator only runs at half load so that in case the other generator fails, the other operating generator can assume the other’s load. The actual electricity consumption of the building is 3,000 kW, and means that should one generator fail, the other generator can only assume 2,000 kW and have to drop the other 1,000 kW. The addition of a new generator to pick up the excess load into the existing electrical distribution system so that the entire building load is still backed up will be investigated.

Panelboard Schedules

Introduction

The changes in the lighting redesign of the spaces affects the following electrical loads. The loads were recalculated based on the new lighting design and are reflected on the panelboard and relay schedules that follow.

Panelboard Schedules

All wires for new branch circuit lighting loads are #12 AWG Copper with 75°C temperature rating and ampacity of 20A. Letters in gray denotes existing conditions, while the black letters reflect the changes made to the panelboards.

Cafeteria:

Panel Designation: LP-KIT-1 Location: 1st Floor Cafeteria Closet
Service: 120/208 Volts 3 Phase 4 Wire w/ GRD. Bus
Mains: 225 Amps with 100 Amp Main Bkr.

	Conn. VA			Branch Circuits				Conn. VA			
Service to:	A	B	C	O.C.	No.	No.	O.C.	A	B	C	Service to:
Existing Load	720			20	1	2	20	540			Existing Load
Existing Load		540		20	3	4	20		720		Existing Load
Existing Load			540	20	5	6	20			900	Existing Load
Existing Load	1200			20	7	8	20	1200			Existing Load
Existing Load		1200		20	9	10	20		1200		Existing Load
Existing Load			1200	20	11	12	20			1200	Existing Load
Cafeteria Lighting	1122			20	13	14	20	1287			Cafeteria Lighting
Cafeteria Lighting		1274		20	15	16	20		1254		Cafeteria Lighting
Cafeteria Lighting			1265	20	17	18	20			570	Cafeteria Lighting
Cafeteria Lighting	1265			20	19	20	20	935			Cafeteria Lighting
Spare				20	21	22	20		880		Cafeteria Lighting
Spare				20	23	24	20				Spare
Spare				20	25	26	20				Spare
Spare				20	27	28	20				Spare
Spare				20	29	30	20				Spare
Spare				20	31	32	20				Spare
Spare				20	33	34	20				Spare
Spare				20	35	36	20				Spare
Spare				20	37	38	20				Spare
Spare				20	39	40	20				Spare
Spare				20	41	42	20				Spare
Subtotals	4307	3014	3005					3962	4054	2670	

Total Loads: 8.269 kVA Phase A
7.068 kVA Phase B
5.675 kVA Phase C
Total Conn. Load: 21.01 kVA

Connected Load: 21.01 kVA
Demand Factor: 1.25 (Lighting Load)
Demand Load: 26.27 kVA
x 1.25 Spare: 32.57 kVA
Amps: 90.47 A

Business News:

Panel Designation: LP-SW-1 Location: 1st Fl South West Electrical Closet
Service: 277/480 Volts 3 Phase 4 Wire w/ GRD. Bus
Mains: 400 Amps with N/A Amp Main Bkr. - MAIN LUGS ONLY

	Conn. VA			Branch Circuits				Conn. VA			
Service to:	A	B	C	O.C.	No.	No.	O.C.	A	B	C	Service to:
Spare				20	1	2	20	540			BN Lighting
Spare				20	3	4	20		720		BN Lighting
Spare				20	5	6	20			900	BN Lighting
Existing Load	2640			20	7	8	20	1990			Existing Load
Existing Load		1820		20	9	10	20		2170		Existing Load
Existing Load			1070	20	11	12	20			1840	Existing Load
Existing Load	2640			20	13	14	20	1740			Existing Load
Existing Load		1320		20	15	16	20		1950		Existing Load
Existing Load			1320	20	17	18	20				Spare
Spare				20	19	20	20				Spare
Spare				20	21	22	20				Spare
Spare				20	23	24	20				Spare
Existing Load	12000			3P	25	26	20				Spare
Existing Load		12000		/	27	28	20				Spare
Existing Load			12000	60	29	30	20				Spare
Existing Load	8635			3P	31	32	20				Spare
Existing Load		8635		/	33	34	20				Spare
Existing Load			8635	70	35	36	30			6000	Existing Load
Existing Load	12850			20	37	38	20	12250			Existing Load
Existing Load		11780		20	39	40	20		12165		Existing Load
Existing Load			12270	20	41	42	20			12870	Existing Load
Subtotals	38765	35555	35295					16520	17005	21610	

Total Loads:	55.29	kVA Phase A	Connected Load:	164.8	kVA
	52.56	kVA Phase B	Demand Factor:	1.25	(Lighting Load Only)
	56.91	kVA Phase C	Demand Load:	170.4	kVA
Total Conn. Load:	164.8	kVA	x 1.25 Spare:	211.3	kVA
			Amps:	254.3	A

East Lobby:

Panel Designation:	RP-SE-GF					Location:			Gnd Fl South East Electrical Closet			
Service:	120/208	Volts		3 Phase			4 Wire w/ GRD. Bus					
Mains:	225	Amps		with			70 Amp Main Bkr.					
	Conn. VA			Branch Circuits					Conn. VA			
Service to:	A	B	C	O.C.	No.		No.	O.C.	A	B	C	Service to:
Existing Load	600			20	1		2	20	600			Existing Load
Existing Load		700		20	3		4	20		600		Existing Load
Existing Load			700	20	5		6	20			600	Existing Load
Existing Load	400			20	7		8	20	1200			Existing Load
Existing Load		600		20	9		10	20		1800		Existing Load
Spare				20	11		12	20			1200	Existing Load
Spare				20	13		14	20	1504			East Lobby Lighting
Spare				20	15		16	20		648		East Lobby/Canopy
Spare				20	17		18	20			1604	East Lobby Lighting
Spare				20	19		20	20				Spare
Spare				20	21		22	20				Spare
Spare				20	23		24	20				Spare
Spare				20	25		26	20				Spare
Spare				20	27		28	20				Spare
Spare				20	29		30	20				Spare
Spare				20	31		32	20				Spare
Spare				20	33		34	20				Spare
Spare				20	35		36	20				Spare
Spare				20	37		38	20				Spare
Spare				20	39		40	20				Spare
Spare				20	41		42	20				Spare
Subtotals	1000	1300	700						3304	3048	3404	

Total Loads:	4.304	kVA Phase A	Connected Load:	12.76	kVA
	4.348	kVA Phase B	Demand Factor:	1.25	(Lighting Load)
	4.104	kVA Phase C	Demand Load:	15.95	kVA
Total Conn. Load:	12.76	kVA	x 1.25 Spare:	19.77	kVA
			Amps:	54.92	A

Panel Designation: LP-SE-G Location: Gnd Fl South East Electrical Closet
Service: 277/480 Volts 3 Phase 4 Wire w/ GRD. Bus
Mains: 400 Amps with N/A Amp Main Bkr. - MAIN LUGS ONLY

	Conn. VA			Branch Circuits				Conn. VA			
Service to:	**A**	**B**	**C**	**O.C.**	**No.**	**No.**	**O.C.**	**A**	**B**	**C**	**Service to:**
Existing Load	2000			20	**1**	**2**	20				Spare
Existing Load		1200		20	**3**	**4**	20				Spare
Existing Load			1200	20	**5**	**6**	20				Spare
Existing Load	3000			20	**7**	**8**	20	2520			Existing Load
Existing Load		2280		20	**9**	**10**	20		1560		Existing Load
Existing Load			1080	20	**11**	**12**	20			3240	Existing Load
Existing Load	2400			20	**13**	**14**	20	2400			Existing Load
Existing Load		1440		20	**15**	**16**	20		2160		Existing Load
Existing Load			1080	20	**17**	**18**	20			1500	Existing Load
Spare				20	**19**	**20**	20	986			East Lobby Lighting
Spare				20	**21**	**22**	20				Spare
Spare				20	**23**	**24**	20				Spare
Spare				20	**25**	**26**	20				Spare
Spare				20	**27**	**28**	20				Spare
Spare				20	**29**	**30**	20				Spare
Existing Load	12000			3P	**31**	**32**	20				Spare
Existing Load		12000		/	**33**	**34**	20				Spare
Existing Load			12000	60	**35**	**36**	20				Spare
Existing Load	8635			3P	**37**	**38**	20				Spare
Existing Load		8635		/	**39**	**40**	20				Spare
Existing Load			8635	70	**41**	**42**	20				Spare
Subtotals	28035	25555	23995					5906	3720	4740	

Total Loads: 33.94 kVA Phase A
29.28 kVA Phase B
28.74 kVA Phase C
Total Conn. Load: 91.95 kVA

Connected Load: 91.95 kVA
Demand Factor: 1.25 (Lighting Load)
Demand Load: 114.9 kVA
x 1.25 Spare: 142.5 kVA
Amps: 171.5 A

East Plaza

Panel Designation: RP-SE-GB — Location: Gnd Fl South East Electrical Closet
Service: 120/208 Volts — 3 Phase — 4 Wire w/ GRD. Bus
Mains: 225 Amps with 100 Amp Main Bkr.

	Conn. VA			Branch Circuits				Conn. VA			
Service to:	**A**	**B**	**C**	**O.C.**	**No.**	**No.**	**O.C.**	**A**	**B**	**C**	**Service to:**
Existing Load	1000			20	**1**	**2**	20	1240			Existing Load
Existing Load		1200		20	**3**	**4**	20		1050		Existing Load
Existing Load			1200	20	**5**	**6**	20			980	Existing Load
Existing Load	860			20	**7**	**8**	20	760			Existing Load
Existing Load		970		20	**9**	**10**	20		1100		Existing Load
Existing Load			1140	20	**11**	**12**	20			1230	Existing Load
Existing Load	1320			20	**13**	**14**	20	870			Existing Load
Existing Load		1440		20	**15**	**16**	20		846		Plaza Lighting
Existing Load			1080	20	**17**	**18**	20			846	Plaza Lighting
Spare				20	**19**	**20**	20				Spare
Spare				20	**21**	**22**	20				Spare
Spare				20	**23**	**24**	20				Spare
Spare				20	**25**	**26**	20				Spare
Spare				20	**27**	**28**	20				Spare
Spare				20	**29**	**30**	20				Spare
Spare				3P	**31**	**32**	20				Spare
Spare				/	**33**	**34**	20				Spare
Spare				60	**35**	**36**	20				Spare
Spare				3P	**37**	**38**	20				Spare
Spare				/	**39**	**40**	20				Spare
Spare				70	**41**	**42**	20				Spare
Subtotals	3180	3610	3420					2870	2996	3056	

Total Loads: 6.05 kVA Phase A
6.606 kVA Phase B
6.476 kVA Phase C
Total Conn. Load: 19.13 kVA

Connected Load: 19.13 kVA
Demand Factor: 1.25 (Lighting Load)
Demand Load: 23.92 kVA
x 1.25 Spare: 29.65 kVA
Amps: 82.37 A

Relay Panels

Cafeteria:

Panel Designation	Relay No.	Panel	Circuit No.	Serves	Lighting Zone
Existing Relay R-KIT-1	1 - 4	LP-KIT-1	13,15,17,19	Cafeteria Lighting	1
	5 - 7	LP-KIT-1	14,16 18	Cafeteria Lighting	2
	8,9	LP-KIT-1	20,22	Cafeteria Lighting	3
	10 - 48	-	-	Spare	-

Business News:

Panel Designation	Relay No.	Panel	Circuit No.	Serves	Lighting Zone
Existing Relay R-SW-1	1-23	Existing	Relays	Misc	Misc
	24 - 26	LP-SW-1	2,4	Business News	4
	27	ELP-SW	35	Business News	4
	28	LP-SW-1	6	Business News	5
	29 - 48	-	-	Spare	-

East Lobby and Plaza:

Panel Designation	Relay No.	Panel	Circuit No.	Serves	Lighting Zone
Existing Relay R-SE-G	1-16	Existing	Relays	Misc	Misc
	17	LP-SE-G	20	East Lobby	6
	18	RP-SE-GF	18	East Lobby	6
	19	RP-SE-GF	14	East Lobby	7
	20	RP-SE-GF	16	Canopy	9
	21,22	RP-SE-GB	16,18	Plaza	10
	23 - 48	-	-	Spare	-

* Zone 8 is the lobby desk lighting that is separately switched by the desk occupant.

UPS Performance and Reliability Analysis

Introduction

Reliability is a crucial issue for a broadcasting facility that requires being online at all times. The following is a performance and reliability analysis comparing a static and rotary UPS for the application in the CNBC broadcasting building. The existing system is comprised of (2) 1,000 kVA static UPS that utilizes (4) racks of flooded cell batteries with 13 minutes of back up. The proposed system is composed of (2) 1,200 kVA rotary UPS that utilizes a flywheel technology that can provide 15 seconds of full load power. The evaluation of these two UPS systems will come from a performance and cost standpoint. The proposed rotary UPS configuration will be similar to the existing UPS configuration where the two modules operate in parallel and are connected to the power-tie control.

Information gathered for the analysis came from manufacturer specifications and text written on UPS with flywheel technology. Case studies and technology performance reports were also examined for buildings that utilized static (with flooded cell battery) UPS and switched over to the rotary (flywheel) UPS.

Performance Analysis (Battery vs. Flywheel)

To properly compare the static and rotary UPS, it needs to be clarified that the (2) 2,000kW diesel generator set can reliably come to full power and assume the load in 10 seconds or less. This is an important distinction that will come in to play in the following section to be discussed about 13 minute vs. 15 seconds of back up power.

Back Up Duration

UPS with flywheel energy storage provides backup power measured in seconds, typically 15 seconds. Fifteen seconds is reported to be enough time to allow the flywheel UPS to handle a majority of power disruptions that only last at the maximum of 5 seconds. It is also enough time to cover longer outages until a backup generator can come online to full power, which is generally 10 seconds. However, flywheel UPS alone cannot provide enough time for back up power to conduct an orderly shut down process for equipment, typically 15 minutes. The flywheel UPS is a short ride through system that needs integration with a standby generator.

On the other hand, UPS with batteries provide backup power from 5 minutes to up to an hour. Battery UPS typically have 13-15 minutes of backup power that is generally presumed enough time to allow orderly shutdown of equipments. The battery powered UPS provides a longer ride through time that can be used for smaller applications without generator set integration. The need for up to 1 hour of backup came from the assumption that if a generator set fails to support the load; the battery backup allows for time to repair the generator set.


Courtesy of HLW International LLP

According to studies done by Caterpillar systems, 15 minutes is not needed because if the generator set does not start within the first 5 seconds, it will not start in the next 15 minutes. Further analysis done for a generator set at a nuclear power plant shows that generators have about a 1% rate of starting failure and a mean time to repair (MTTR) or 4 hours or more. Thus, 15 minutes to an hour of battery backup would be well below ample time to repair the generator set.

Standby Power
Standby losses for flywheels range from about 0.1 to 1.0% of its rated power. This loss of standby power is due to recharging power used to overcome frictional losses from the rotating flywheel as well as for its auxiliary equipment. Standby losses for battery UPS, called float power, are roughly one tenth of that for flywheels, 0.01 to 0.1%. Both types of energy storage used for backup have standby losses associated with maintain a fully charged condition in the storage unit. Battery backup UPS consumes less standby power.

Design Life
The design life for a flywheel is for about 20 years, while the life a flooded cell battery (the building's existing means of power storage for their UPS) varies from 10 to 20 years. Mechanical bearing replacement for flywheels is usually done every 5 years while flooded cell batteries need replacement every 3 to 5 years.

The MTBF, mean time between failure, for one static UPS module is 170,000 hours (19.4 years) as reported by Liebert, the manufacturer of the building's existing UPS. The MTBF for a rotary UPS module is 200,000 hours (22.8 years). Although not a very significant difference, comparing the MTBF of the flooded cell battery, the source of the static UPS' backup power, shows a big disparity. The MTBF for a typical flooded cell battery is only 80,000 hours (9.1 years). This means that the flywheel energy storage has a 4.3% probability of failure during its one year of operation, while the flooded cell battery energy storage has a 10.4% probability of failure for one year of operation. This is a 58% increase in the likelihood of the battery failure compared to the flywheel.

Probability of failure was calculated using the equation: $P_f = 1 - e^{-(t/MTBF)}$

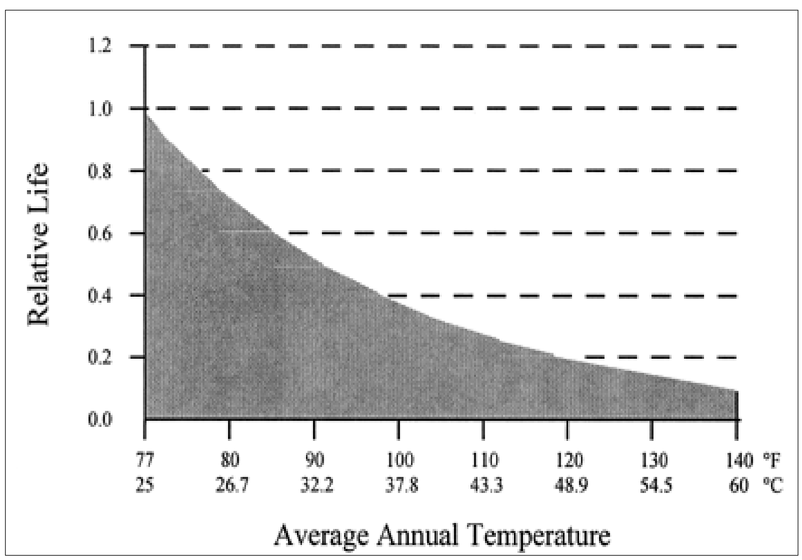
Environmental Conditions Requirements

Rotary UPS		Existing Static UPS	
Min. Operating Temperature	0°F	Min. Operating Temperature	0°F
Max. Operating Temperature	104°F	Max. Operating Temperature	104°F
		Recommended Operating Temperature	77°F **
Humidity (w/o condensation)	5% - 95%	Humidity (w/o condensation)	0% - 95%
Storage Temperature	-13°F - 158°F	Storage Temperature	-4°F - 158°F
		Battery Temperature Requirements	77°F average annual temp.

** Operating at lower temperature of 77°F will extend the equipment life expectancy.

As seen from the chart, batteries require a considerably narrower temperature range for operation. Furthermore, because the existing static UPS uses flooded cell batteries that contain sulfuric acid and water, it requires acid spill containment and forced air ventilation for the hazardous materials. Flooded batteries vent hydrogen gas throughout the life of the battery. Hydrogen gas is very explosive, thus the room containing the batteries must have a complete forced air ventilation system. Flooded cell batteries require to be mounted on open frame racks. The use of flywheels eliminates the stringent ventilation and temperature requirements need to maintain proper operating temperatures for batteries. Furthermore, battery life decreases considerably as the average ambient temperature of its space rises as seen from the table below in Figure 3.1.

Figure 3.1: Battery Life Versus Ambient Temperature (taken from www.ActivePower.com)



Because batteries must be kept at normal indoor air temperature or suffer degradation, there are added operation costs to cool the system.

Maintenance
Flywheel maintenance is less frequent and less involved than for batteries. Common maintenance for flywheels involves changing the cabinet air filters and checking the oil level in the vacuum pump every few months. The magnetic bearings of the flywheel system require no maintenance. Mechanical bearings, however, is expected to be replaced about every 5 to 10 years and the vacuum pump needs replaced about every 7 years. The average annual maintenance cost for flywheel UPS is about $5/kW per year.

Flooded cell batteries require extensive monthly maintenance as well some quarterly and annual maintenance on some other items including monitoring the electrolyte levels (mixture of sulfuric acid and water), ambient and electrolyte temperature, etc. The average annual maintenance cost for batteries is $1.50/kWm (kilowatt-minute of backup time) per year.

Non-Performance Issues

Spare Requirements
The rotary UPS is more compact than the static UPS and more or less only use about 30% of the space required to provide the same power output. With the elimination of batteries, the space that it once occupied can be reclaimed for other purposes. The new layout of the installation of the UPS system shows that one of the three rooms that housed the existing (2) static UPS and the batteries has been reclaimed due to the battery removal.

Cost
Although static UPS has a lower first cost than flywheels, the batteries suffer from a significantly shorter life and higher annual operation and maintenance cost. A present value life cycle cost analysis has been performed for value engineering and as part of the Construction Management Breadth work. For calculation details, please refer to the Construction Management Breadth section of this book.

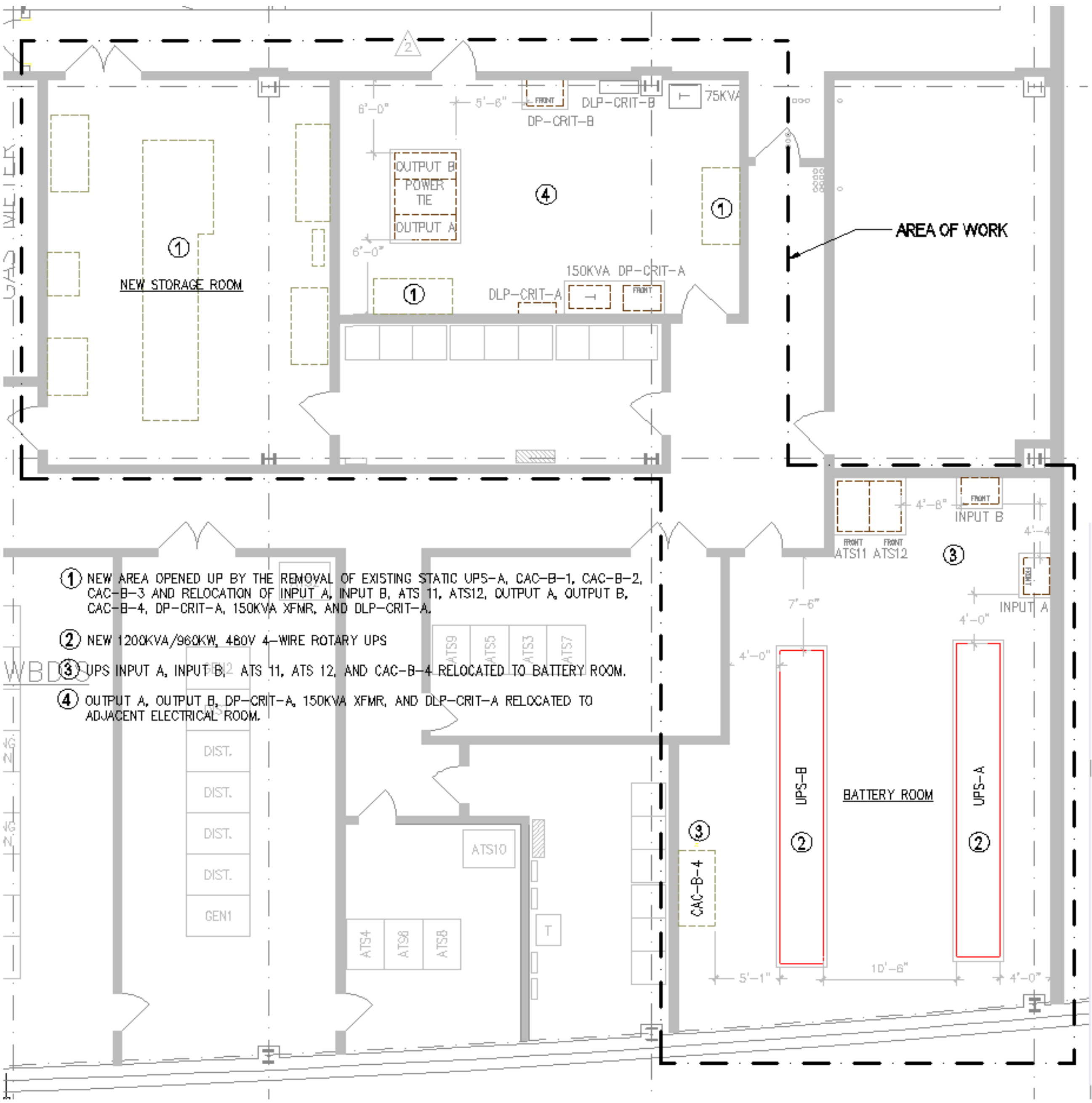
With the rotary UPS system, although higher in its initial cost, the life cycle cost of the system is roughly $126,000 cheaper than the life cycle cost of the existing static UPS. Although not a considerably large amount, the rotary UPS' overall reliability is a price that a broadcasting company would be willing to pay for to be on air at all times. The lower cost from the maintenance and replacement of the rotary UPS helped in its life cycle cost savings.

Conclusion

The rotary UPS using flywheel energy storage was chosen to replace the existing static UPS with flooded cell batteries for energy storage. The rotary UPS is found to be more reliable because it lacked the problems inherent to the flooded cell batteries, such as lower MTBF and degradation due to temperature sensitivities. More frequent and complex maintenance that needs to be performed on the batteries also possibly call for more downtime to the UPS. Furthermore, the elimination of batteries also lessens the forced air ventilation requirements that were once used to prevent the accumulation of hydrogen gas the flooded cells vent. The space that houses the UPS also do not need to meticulously maintained at 77°F for operation and preservation of the battery life and the static UPS. Finally, the life cycle cost for operating a rotary UPS is lower and gives a net savings of $126,000 for an assumed life cycle of 20 years.

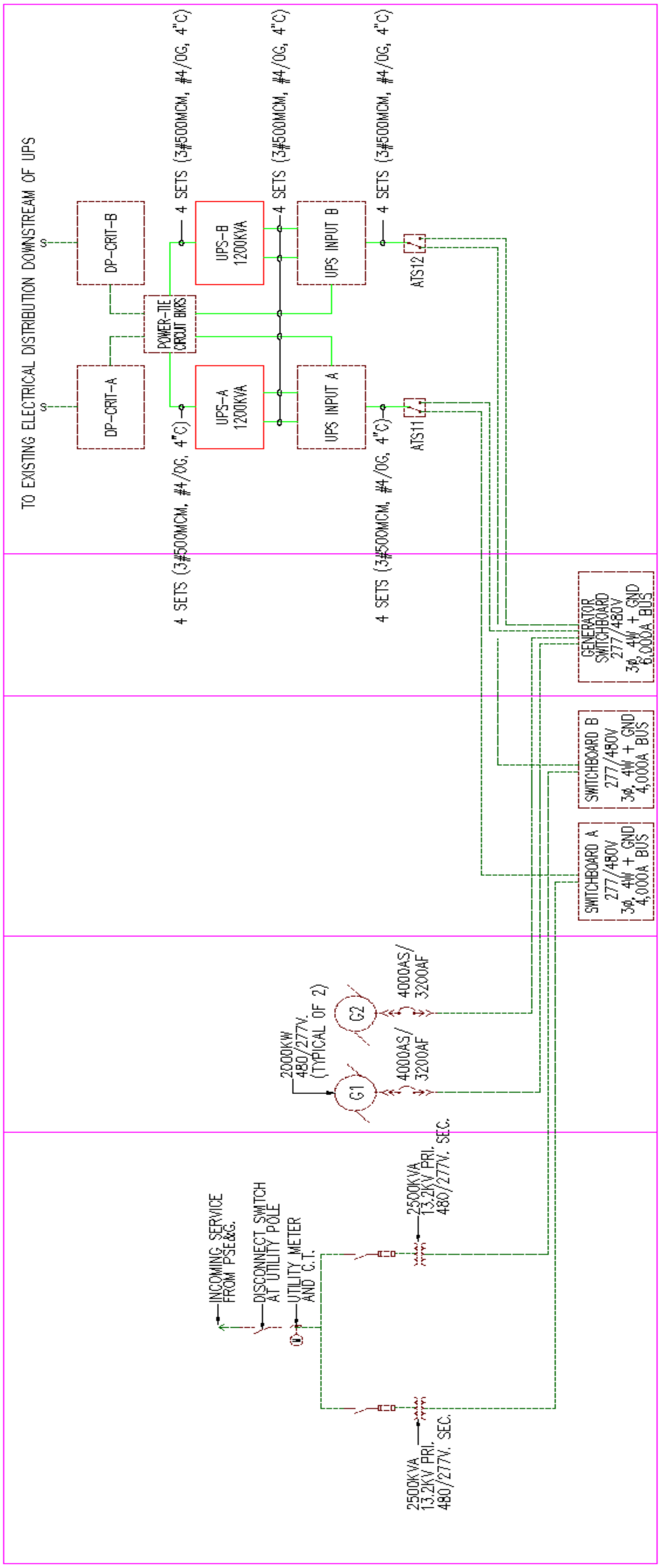
Thus, the system that will be used for the redesign is composed of (2) 1,200 kVA rotary UPS systems from Active Power. Two 1,200 kVA was chosen because it is currently the only rotary system that allows parallel operation of the two UPS. The parallel power tied configuration of the new rotary UPS will mimic that of the existing (2) 1,000 kVA static UPS configuration. The electrical room layout of the new UPS equipment will follow in the next section of this report. Also included is the new single line diagram along with the sizing of feeders into and out of the new UPS system. Cut sheets and specifications for the proposed rotary UPS are located in Appendix B.

New UPS Equipment Layout



Courtesy of HLW International LLP

New UPS Simplified Riser Diagram




Courtesy of HLW International LLP

Generator Addition

Introduction

After investigation of the existing electrical consumption of the building, the actual building energy consumption data reveals an excess of about 1,000 kW that would need to be dropped by the redundant generators. The feasibility and necessity for the additional generator will be further examined and, from which, draw a conclusion if a new 1,000 kW generator should be added.

Existing Building Electrical Load Revisited

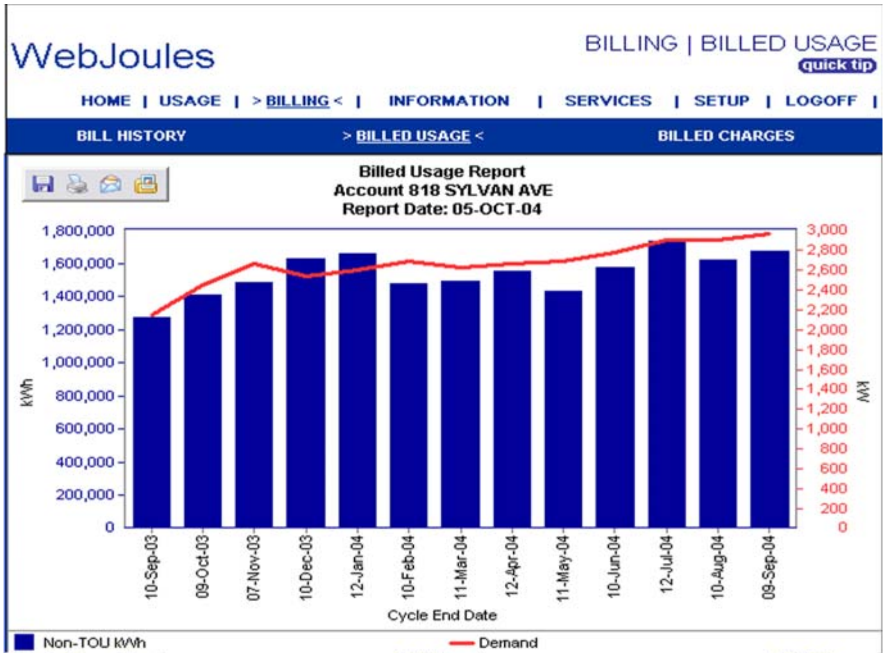
Analysis of the generator concludes that it no longer performs its original design intent. The paralleling generators were designed so that in the event that one fails, the other will be capable of carrying the load of the entire building. The actual energy usage data reports an increasing trend in building load consumption, which may be due to an increase in occupancy in the building. Therefore, (1) 2,000 kW generator can no longer support 3,000 kW of the actual building energy usage. And 1,000 kW of load will have to be dropped according to what load is prioritized and predetermined when programming the ATS.

However, the critical load from broadcasting and technical equipments that need to be on-line at all times is only 1000 kW. Thus, should one of the generator in the generator set fails in a worst case scenario, the entire 1000 kW of critical load is still backed up by the one (1) 2,000 kW operational generator. This also leaves 1000kW of other miscellaneous loads that the generator can carry such as the operation of the emergency lighting and HVAC equipment.

As seen from the actual utility data below, the entire building consumes nearly 3,000 kW. Thus, should the utility fail, the (2) 2,000 kW generator set can still carry all 3,000 kW of the building load up to a maximum of 4,000 kW. Only during the worst-case scenario that one of the generators fails that 2,000 kW can be taken by the remaining one.

However, in essence, it is only 1,000 kW of load that is critical and needs to be on-line at all times. The ATS serving each distribution section of the building have already been pre-programmed to sequentially drop excess load according to their priority with the (2) UPS systems having the first most priority to be backed up by the generators.

Electric Utility Load Data



| Download Spreadsheet | | Bill History | | Billed Charges |

Invoice	From	To	Non-TOU (kWh)	Billing Demand (kW)
2086254	11-AUG-04	09-SEP-04	1,675,265.00	2,964.00
2083544	13-JUL-04	10-AUG-04	1,622,791.00	2,903.00
2081328	11-JUN-04	12-JUL-04	1,733,398.00	2,903.00
2078431	12-MAY-04	10-JUN-04	1,579,397.00	2,782.00
2075465	13-APR-04	11-MAY-04	1,430,170.00	2,691.00
2071898	12-MAR-04	12-APR-04	1,552,272.00	2,661.00
2068560	11-FEB-04	11-MAR-04	1,495,292.00	2,631.00
2066266	13-JAN-04	10-FEB-04	1,479,310.00	2,691.00
2064367	11-DEC-03	12-JAN-04	1,658,044.00	2,601.00
2060656	08-NOV-03	10-DEC-03	1,629,406.00	2,540.00
2057890	10-OCT-03	07-NOV-03	1,484,451.00	2,661.00
2056401	11-SEP-03	09-OCT-03	1,412,729.00	2,449.00
2055198	12-AUG-03	10-SEP-03	1,271,274.00	2,147.00

User Agreement

Conclusion

Because the critical load that absolutely needs a generator back up is only 1,000 kW not 3,000 kW, the worst case scenario of one of the generator sets failing and only being able to carry 2,000 kW of the load is more than enough. Therefore, an additional 1,000 kW that was once proposed will no longer be implemented. An additional generator will only incur extra costs when the existing generator configuration and critical loads are already supported at the worst-case scenario.