Study for the Electrical Distribution Upgrades at Centennial Office Building

Capitol Complex St. Paul, Minnesota

EEA Project No. 5710
RECS Project No. 02559COX

June 25, 2010

ERICKSEN ELLISON
and Associates Inc.

305 SECOND STREET NW ■ SUITE 105 ■ NEW BRIGHTON, MN 55112-3279 TEL 651.632.2300 FAX 651.632.2397

CERTIFICATIONS

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

	23427
Signature	License Number
Todd Peterson, PE	June 25, 2010
Print Name	Date

ERICKSEN ELLISON
and Associates Inc.

305 SECOND STREET NW ■ SUITE 105 ■ NEW BRIGHTON, MN 55112-3279 TEL 651.632.2300 FAX 651.632.2397

I. STUDY OVERVIEW

A. The electrical distribution system at the Centennial Office Building has been through numerous revisions as a part of multiple remodeling projects over many years, however, the system itself has never been reviewed as a whole and a master plan developed as to where this system should be and what specific needs of the overall building should be addressed. This study takes a look at the system from a building wide approach and provide a long term assessment of what should be done for this building to meet the needs of its occupants long into the future. We also address safety, code and maintenance issues of the building distribution system.

B. The current life safety "emergency" distribution system does not meet current applicable codes.

C. With Office of Enterprise Technology (OET) occupying the entire fifth floor and some space on other floors and their unique requirements for very redundant and robust power system intermixed with the remainder of the building can cause problems for both entities. A workable solution for this needs to be found.

D. The study shall provide the following information:

1. Indicate work required to provide adequate, code compliant life safety emergency and exit lighting throughout the building. Indicate improvements/revisions to the distribution system to bring it in compliance with the current applicable codes.

2. Determine the magnitude of existing and future electrical loads to be supported by the building electrical service for both OET and the remainder of the building tenants. Determine an electrical distribution system that meets the needs of all building occupants and their needs.

   a. Indicate electrical loads to be supported by the emergency/standby generator separately into the following categories:

      1. Emergency/life safety loads
      2. OET loads
      3. Optional standby loads for remainder of the building

   b. Indicate generator capacity required, number of generators required, and location of generators.

   c. Electrical service capacity: Capacity needed to support all building electrical loads plus spare capacity for future growth.

   d. Electrical system safety issues.

   e. Electrical system code issues

   f. Electrical system maintenance issues.

3. Determine options for better management of low voltage cables in the lower level corridor.

II. SAFETY ISSUES

A. The following items were noted during our surveying of the existing building.

1. Limited access to bus duct in the basement and parts of the vertical risers makes it impossible and potentially unsafe for maintenance on the bus duct.

2. Poor or incorrect labeling of equipment and switches could cause a problem isolating a problem area.

3. The existing medium voltage switchgear in the electrical room has improper bus supports and accesses are poorly covered.

III. CODE ISSUES

A. The following codes have been reviewed associated with the requirements for building electrical system.

1. International Building Code (IBC) 2006
2. National Electrical Code (NEC) 2008

B. NEC exiting requirements in the basement electrical rooms is not currently being met. Rooms of this size require two exits and there is only one exit from these rooms. There is a code exception that allows one exit if clearances are doubled but we do not meet this exception.

C. Currently all building lighting is connected to the generator. However, the code requires a separate system for building emergency (life safety) lighting and this lighting is supposed to be separate from all other building wiring. This building does not meet this requirement.

D. Some of the bus duct runs in the basement are not accessible and do not meet code.

E. The existing fire pump is not connected per the NEC. Code requires the fire pump be connected ahead of the building main disconnect as well as a separate connection to the generator via its own circuit breaker.

IV. MAINTANENCE ISSUES

A. The limited access to bus duct make periodic maintenance difficult or impossible and therefore is not being done when it should be.

B. Incorrect labeling hampers maintenance of the building system.

C. Much of the electrical gear was installed in 1958 and has passed the end of its planned service life. This type of gear has a planned life of 30years. Current gear is almost 50 years old.

D. Due to the extreme age of the gear, replacement parts are not available and if any can be found, they are usually refurnished parts of varying quality.

305 SECOND STREET NW ■ SUITE 105 ■ NEW BRIGHTON, MN 55112-3279 TEL 651.632.2300 FAX 651.632.2397

E. The efficiency of modern electrical gear is much greater that the current gear resulting in increased operating costs and wasted energy.

V. EXISTING LOAD SUMMARY

A. The following is a summary of the existing loads taken from meters on the four building substations and recorded in the complexes SCADA system.

	Load	Min	Avg.	Max.	Date
1.	Unit substation #1	0 kW	265 kW	399 kW	11-6-08
2.	Unit substation #2	0 kW	272 kW	347 kW	8-14-08
3.	Unit substation #3	0 kW	278 kW	446 kW	8-4-08
4.	Unit Substation #4	0 kW	417 kW	573 kW	3-6-08
	Total	0 kW	1232 kW	1765 kW	

The total estimated peak load on the current building is 1765 kW. Since all the peaks are not at the same time, this number is probably slightly higher than the actual peak but it is all we have to work with and gives us a pretty good idea of building electrical loads.

B. There is no current electrical demand meter for the OET electrical equipment. Information on electrical energy consumption is available for the past several years. Since the electrical demand of their equipment rooms is fairly constant as the equipment runs 24/7. We took the highest month for electrical usage from September 2008 and a usage of 659,836 kwh and divided by 744 hours per month (24 hours per 31 days) and got an estimated 887 kW peak. Since this is not an actual measured peak, we put an25% safety factor on this load for an estimated peak of 1110 kW. Taking a possible 50% growth factor, we estimate that OET loads could approach 1700 kW. This equates to 2045 amps at 480 volts so a 2500 amp service would be required for OET.

C. Out of the current 1765 kW maximum, OET is 887 kW is 50% of that total, if we subtract OET from the total we get an approximate peak demand for the remainder of the building of 878 kW. If we assume a 25% growth factor, we get a future estimated peak demand of 1098 kW or 1320 amps at 480 volts so a 1500 amp service would be required for the remainder of the building.

VI. ENERGY SAVINGS

A. The proposed design would use cast coil transformers at the main service. This would allow one of the two transformers to be turned off all the time. The building still has redundant transformers for reliability but we don't have to spend money to energize both transformers at the same time. Saving the no load loss of one transformer over the entire year. A 2500 KVA transformer has no load losses of 6.5 kW and a 1500 KVA transformer has no load losses of 4.7 kW.

With the OET transformer off for 12 months, 6.5 kW * 8640 hrs * $ 0.07/kwh = $ 3,931.
With the bldg transformer off for 12 months, 4.7 kW * 8640 hrs * $ 0.07/kwh = $ 2,843.

If both building services run on only one transformer the state could save $ 6,774 per year. There is no upfront additional cost as the cast coil transformers are a complex standard. Therefore there is no payback time on this, the savings begin as soon as the plan is implemented. However, due to redundant power needs for data centers, it is doubtful that OET would want to this to be done as the energy savings do not outweigh the risks and costs of an accidental power outage to the data center.

In addition, the new transformers would be much more energy efficient, as much as 1% more efficient versus a 50 year old transformer. Even 1% on 4000 kW of transformers is 40 kW. With a savings of 40 kW * 8640 hrs * $ 0.07/kwh = $ 24,192 savings per year.

B. The proposed design consolidates many step down transformers (from 480 volts to 120/208 volts). By removing the bus duct and installing a separate 208 volt feeders from the basement to each floor, we are removing 20 smaller dry-type transformers and replacing them with 4 larger dry-type transformers. The new transformers are more efficient do to improvements in transformer efficiency and energy codes plus fewer larger transformers are more efficient. The building currently has 20 step-down transformers totaling 1,342.5 kVA with energy losses of 13,313 watts. Proposed distribution system has 600 kVA worth of transformers with energy losses of 3,476 watts.

Existing transformer loss cost 13.313 kW * 8640 hrs * $0.07/kwh = $ 8,052
Proposed transformer loss cost 3.476 kW * 8640 hrs * $ 0.07/kwh = $ 2,102
The new system saves $ 5,950 in energy losses per year.

Both items in A and B would also qualify for rebates from Xcel Energy on top of the actual energy savings calculated above. Rebates for transformers are not prescriptive, which means they are handled on an individual basis and would have to be applied for at the time of design and construction but the amount of the rebate could be substantial. Potential rebates could be as much as $ 50,000 to $ 75,000.

VII. ELECTRICAL RECOMMENDATIONS

A. Due to the very different electrical needs, we recommend that the OET have its own separate electrical distribution system in the building. Their system should start with two redundant single ended unit substations with a tie breaker between them. Each substation will be sized to carry the entire load by itself. We recommend cast coil transformers which will allow one transformer to be shut down, however, typical operation and needs of a data center would probably not shut down one transformer. For additional redundancy we recommend a second generator of similar size be installed. Both generators will be connected to a generator bus and separate connections to each unit substation. Generators will be setup for synchronous and parallel operation giving the system the most redundancy. This will allow all the existing automatic transfer switches to be removed and provide an electrical system found in modern data centers. All OET loads would be connected to this system. For improved reliability and operational and maintenance considerations, we recommend that the OET substations be installed in separate location from the main building substations. Further, if possible, each substation should be in its own room. These rooms should have redundant cooling from the glycol loop and campus chilled water system as well as a pre-action wet sprinkler system.

B. The OET data center in this building is only fed with a single backup generator. A typical tier 3 data center would have 2 generators with one generator capable of running the entire data center in the event of a failure (N + 1 redundancy). Currently OET needs to bring in a rental generator whenever any maintenance needs to be done on the current generator. Also it would be best if the OET generator was dedicated to only OET loads not OET loads plus building emergency life safety loads. Location of second generator needs to be determined, one option being considered is to use the existing peak shaving generator located at the Transportation Building as the second generator. This generator is currently being used only for peak shaving and would be an excellent backup generator for the OET system. The generator is the correct size, it is already owner and maintained. A feeder would have to be run through the existing duct bank system to bring power and control from DOT to COB. The DOT generator should also have its control system upgraded as a part of this change in its use. This scenario is still much less costly that providing a second generator ($ 750,000 vs $ 1.3 million) plus there is no additional maintenance costs to the State of Minnesota. It also addresses an issue of no good location near the COB to install a second generator. It would more than likely have to be installed inside a vault which increases its cost.

C. The building currently has four existing unit substations that serve the entire building. Only two have a tie breaker between them. We propose removing all of these substations and installing two new single ended substations with a tie breaker. Each substation will be sized to carry the entire load by itself. We recommend cast coil transformers which will allow under normal operating conditions that one transformer be shut down which will save energy due to transformer losses. All the remaining electrical loads (non OET loads) would be connected to this system.

D. We recommend installing a separate generator for the building life safety loads (emergency) and fire pump. This generator would feed emergency lighting and fire pump. The state currently owns a 350 kW generator located at 321 Grove Street that is not currently being used, this generator would have adequate capacity for this use. The generator is in a weather proof enclosure and could be located along the street on the south east side of the building. A new separate emergency power distribution system will be setup within the building with emergency panels on each floor. Emergency egress lights will be connected to this system

E. Building bus duct should be removed. We can get better energy savings by reducing the number of smaller transformers into four larger transformers. Each transformer would be located in the basement along with a distribution panel and would feed one stack of electrical rooms in the building (four total). This will also create more room in the on floor electrical rooms by removing the transformers and the heat they produce.

F. The Armory building should be removed from the Capitol Complex electrical distribution system and have its own electrical service from Xcel Energy. This has been reviewed with Xcel Energy who has indicated it is acceptable to them but there will be a cost of $ 50,000 for a new service.

G. Low voltage cable trays should be installed in the basement ceiling space. We suggest installing two separate cable trays, one for OET cables and one for all other low voltage cables. We would install the OET cable tray overhead in the rooms south of the corridor and the other cable tray over rooms north of the corridor. By removing the cable tray from the basement corridor, we can relieve congestion from an already crowded corridor.

H. If OET were to leave this building, then basically we recommend that all the work in the OET portion of the building be eliminated and the basic building electrical upgrade work would be the basis for the new building electrical distribution system. Since OET is the majority owner of the

existing generator, we assume that relocating the generator from 321 Grove is still what we need to do for emergency building power.

VIII. COST OPTION SUMMARY

An estimated construction cost for items A – G in section VII is listed below. All cost numbers are in 2009 dollars.

Cost estimate entire project

Architectural	$ 30,000
Mechanical	$ 171,000
Electrical	$ 5,000,000
Subtotal	$ 5,201,000
General Conditions (12%)	$ 624,120
Overhead and profit (4%)	$ 233,005
Construction Cost Escalation (5%)	$ 302,906
Total Construction cost	**$ 6,361,031**
Construction contingency (10%)	$ 636,103
Design fees (8%)	$ 559,771
Total project cost	**$ 7,556,905**

If funding for the entire project cannot be secured in one chunk, some possible phasing of the work should be considered. If the project has to be broken down into pieces, the first piece that should be done is the new service substations for OET. This is key to be done first as this allows the other substations to be removed as well as rework of the generators. Further, the second generator should be installed before or at the same time as the new OET substations as then the new substations can be setup with a generator backup and the existing generator stays in place to backup loads remaining on the existing system. This way generator backup is maintained on all loads during the entire transition process. The following is a possible phased construction process and approximate costs for each phase. In a phased construction process, it would be desirable to do all design at the beginning as that way all design coordination issues are resolved before construction starts and the phases can be implemented as money is available.

Phase 1 (connection of DOT generator)	**$ 750,000**
Phase 2 (installation of equipment serving. OET data center and Transfer of loads to new system. Rework existing generator and provide new OET electrical rooms)	**$ 4,800,000**
Phase 3 (installation of building electrical substations)	**$ 1,800,000**
Phase 4 (relocation of 321 Grove generator and rework of building emergency system. This project could be done at any time, even before OET work as a separate project if desired.)	**$ 150,000**
Phase 5 (separation of Armory form COB. This project could be done at any time, even before OET work as a separate project if desired)	**$ 60,000**
Phase 6 (Installation of cable tray for low voltage wiring. This project could be done at any time, even before OET work as a separate project if desired)	**$ 37,000**

If OET is out of the building then the total project consists of Phases 3, 4, 5, and 6 for a total cost of $ 2,047,000.