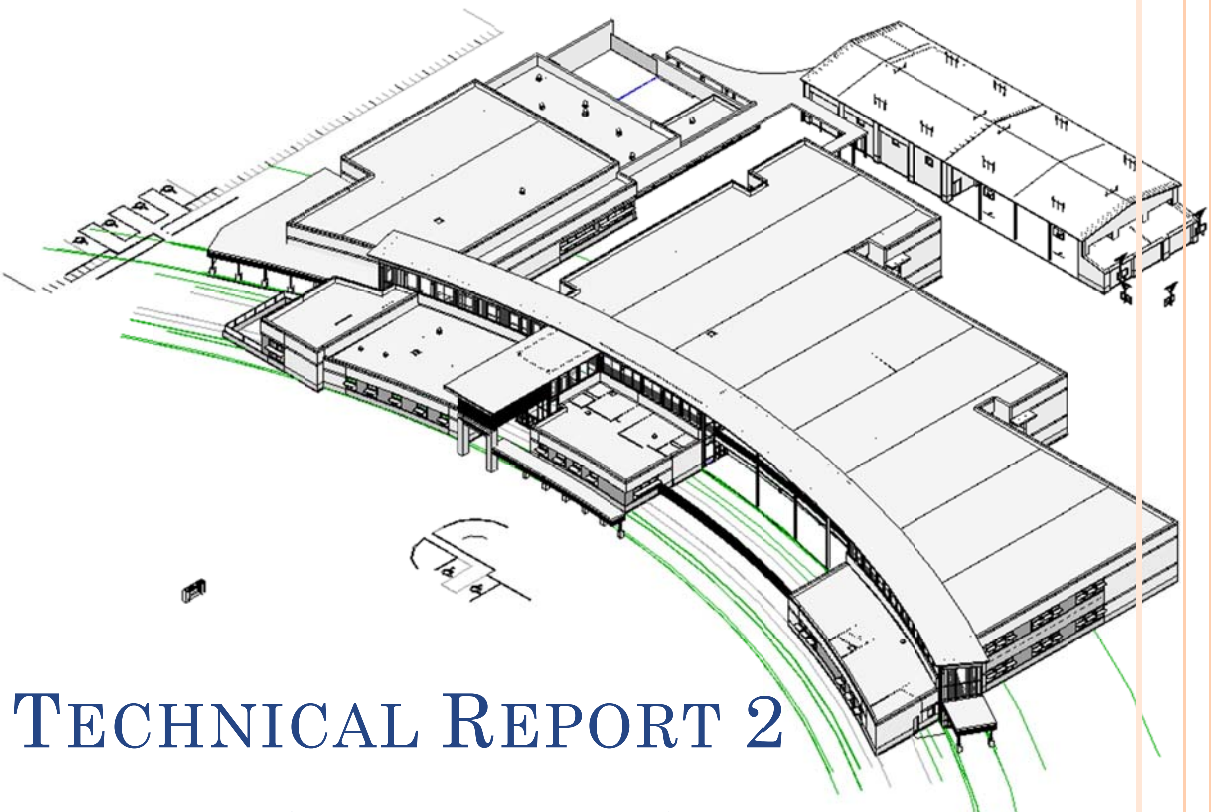

Technical Report 2

Electrical System Criteria and Evaluation of Existing Systems

The electrical design of Cypress Hill Elementary School in Texas is discussed first through the development of design criteria, then an assessment of actual design. An evaluation of the electrical design in the context of the established criteria is then executed.

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Cypress Hill Elementary | Texas

10/14/2013

Executive Summary

This report discusses the electrical systems of Cypress Hill Elementary School located in Texas. The system was first evaluated based on need and use of the occupant. This led to the development of the criteria for the system and the scope of the work. Preliminary loads were assessed based on suggested power densities from ASHRAE Standard and the National Electric Code. Building location was evaluated and a power company and rate schedule was produced. The International Building Code and National Electric Code were then consulted for design guidelines. Finally, other systems were assessed based on all former criteria.

After criteria and scope were established, an actual analysis of the electrical design was carried out. This analysis looked at the connected primary and emergency loads as well as consolation of the IBC and NEC again to further understand how the true design was executed. The design drawings and specifications were then reviewed to learn more about various system components.

The design was then evaluated in comparison to the established design criteria. There were a number of small discrepancies as well as a wealth of consistencies between them. The evaluation led to a list of potential changes that could change the energy use and save the school money in the long run. Ultimately, these possibilities will have to be evaluated in a greater depth to see if they are feasible.

Contents

Building Overview

Location: Bridgeport, Texas

Building Occupant Name: Cypress Hill Elementary School

Occupancy or Function Type: Occupancy type ‘E’, Educational

Levels Above Grade: Two

Construction Time Frame: 9/7/2012 – 11/26/2013

Building Cost: $82.3 Million

Project Delivery Method: Design-Build

Development of Electrical Systems

In order to get an estimate for the school's load in the design phase, a preliminary electrical load calculation was performed using the National Electric Code's suggested power densities for this type of occupancy and use. This analysis takes power, lighting and mechanical loads into account. The table below accurately displays the calculations with the watts/square foot values taken from ASHRAE and NEC. A demand factor of 1.00 for the first 10,000 VA for the receptacles was applied with a demand factor of .5 for every VA after the first 10,000. Because of the informality of this analysis, loads for the stage, kitchen, and media center were not taken into account but it is recognized that they will be needed. Based on the service information, the fuel type is natural gas.

PRELIMINARY LOAD ANALYSIS 480 / 277, 3-PHASE 4-WIRE		
DESCRIPTION		**KVA**
LIGHTING:		
INTERIOR =	115,686 S.F. X 3 W/S.F.	347
POWER:		
RECEPTACLES =	115,686 S.F. X 1 W/S.F.	62
HVAC:		
COOLING/HTG./FANS =	115,686 S.F. X 7 W/S.F.	810
	TOTAL =	1219
SQUARE FOOTAGE = 115,686		

Electrical Service

This area of Texas is served by Center Point Energy based in Houston. They provide electricity for general service less than 500,000 square feet, which this school falls under. Based on proposed use, a preliminary rate schedule has been chosen and can be found in Appendix B.

Electrical System

Priority Assessment

In order to accurate determine where the time should be spent, a priority assessment of what the owner wants should be taken into consideration. In the table below, there are six categories, each with an associated priority level. These varying levels were determined through the actual assessment below which breaks down each component and judges them in the context of the school's occupancy and use.

Criteria	Priority
Reliability	High
Redundancy	Low
Initial Cost	Med
Long Term Ownership Cost	High
Flexibility	Low
Power Quality	Med

Because this is a very large elementary school with hundreds of students occupying it during business hours, reliability is a high priority. This means no outages or surges in the electrical system. Anything that might cause an issue at some point should be considered and taken care of. These children are only in the building for a handful of hours each day so the school must function as designed in order to fully meet their needs.

Redundancy is a low priority. With schools, redundancy goes with the reliability of a system. An electrical system with redundancies is one with many different ways of stopping a specific action from happening. Generally, these actions are not advantageous to the system. As a school however, many redundancies are not needed and are probably an unwarranted cost.

Initial cost is usually an issue if the owner plans to sell the building after it is built for a profit. Because this is a new school and was commissioned by the district, there will be no turnover after construction. In this case, the initial cost is not the highest priority. If the district were to sink more money into the building, upfront, in order to purchase a component that would ultimately save the school money, then that should be factored into this assessment. At the same time, this is a public school paid for by taxes so there must be a degree of awareness that takes everything into consideration. One should look at benchmarking to see how similar schools operate and what their initial cost was. Ultimately, initial cost is graded as a medium priority because quality is needed but it does not need to be a state of the art school.

Long term ownership cost is the other side of that. This is a high priority because schools like this have one long term owner (the district usually). This school is being constructed to last a long time so the necessary money saving electrical components should be considered in a long term context. Equipment like transformers that may have a buy back of a few years but a larger initial cost should be strongly considered. For this category, it is a matter of efficiency and whether money can be saved over the life of the school.

Flexibility is low because there are designated spaces for specific actions. The function of a school is rigid. There should be a degree of flexibility should they need more power systems years down the line. Leaving room for equipment added is usually standard practice, but a large degree of flexibility is probably unwarranted in a school like this.

Power quality was rated as a medium priority because it is important, but not as much as some of the other categories. Power quality ties into the reliability of the system because a system with power quality may be very inefficient. It also ties into the cost assessments. By correcting the power quality of a building, power is more efficiency used and distributed.

Building Utilization Voltage

Based on this, the preliminary building utilization voltage is a 480/277 V in a wye configuration, 3-phase, 4-wire. For each specific system, lighting should be both 120 and 277 V because there will be some incandescent lights used for the stage. The receptacles will be 120V and most of the mechanical equipment will be 480 V 3-phase. Other equipment to consider is the generator, transformers, and switchgears.

Code Requirements

The National Electric Code lists special occupancy requirements for assembly and performance areas, which could both be applied to the cafeteria and stage area. The National Electric Code articles 518 and 520 outline the design considerations concerning 'assembly occupancies' and 'performance areas', respectively.

The National Electric Code was also consulted regarding special equipment needs based on occupancy and use. Articles 620 and 645 were utilized for instruction on elevators and information technology equipment.

International Building Code lists emergency power requirements. Design considerations should be made for stationary generators, smoke control systems, exit signs, means of egress illumination, accessible means of egress elevators, and smokeproof enclosures. Below is a preliminary emergency load analysis. The fuel source for the generator is natural gas.

EMERGENCY LOAD ANALYSIS				
480 / 277,	3-PHASE 4-WIRE			
DESCRIPTION				**KVA**
LIGHTING:				
INTERIOR =	115,686 S.F. X 1 W/S.F.			116
OTHER:				
ELEVATORS =	33000 VA			33
			TOTAL =	149
	SQUARE FOOTAGE = 115,686			

The National Electric Code goes into more depth concerning optional back-up power and if those loads are needed long term or short term. Articles 701 and 702 concern legally required stand by systems and optional standby systems. There does not appear to be any load that needs to be put on optional stand by power.

Other Systems

Cypress Hill Elementary will need other special/communication system because of its nature as a school in Texas. A telephone and data system is needed for general communication and the computer lab in the media center, as well as personal faculty use. Fire protection as per IBC shall include automatic sprinklers, fire areas, fire alarm systems, and pump and rise rooms with the required room for all equipment. A CATV connection should be installed for educational purposes. Overhead paging and intercom systems are a commonality in schools for the paging of students and faculty alike as well as school-wide announcements. There may be certain areas where students should not be which may require the use of access control.

Finally, some type of security system is needed for a school, especially a school of this size. At the least, a security camera system should be implemented.

Some components that are vital to the function of the entire electrical design will require space. The generator needs space to operate in addition to the space it needs for fuel. The major electrical components such as switchgears and transformers are also fairly large. The utility transformer should be pad mounted at the exterior. The NEC lists certain clearance requirements for pieces of equipment like panelboards, which will need to be addressed. Most of these components will be located in an electrical room to consolidate them and guarantee the space needed.

Electrical System as Designed

The designed electrical system for Cypress Hill Elementary uses 15 low voltage panels, 10 high voltage panels, and 16 emergency panels. There are also existing low and high voltage panels serving the detached gymnasium. Below is a summary of all connected loads. The riser diagram can be found in Appendix A.

CONNECTED LOADS			
480 / 277,	3-PHASE 4-WIRE		
DESCRIPTION			**KVA**
LIGHTING:			
INTERIOR =	93,572	VA	93.572
POWER:			
RECEPTACLES =	244,700	VA	244.7
KITCHEN =	93,964	VA	93.964
OTHER:			
COOLING/HTG./FANS =	299,787	VA	299.787
MISC. =	325,059	VA	325.059
		TOTAL =	1057.08
	SQUARE FOOTAGE = 115,686		

Electrical Service

The school is provided energy by Center Point Energy. The generation source is natural gas to generate electricity for service. The school uses general service rates for buildings under 500,000 square feet. See Appendix B for the rate schedule.

Electrical System

The power from the utility is stepped down to 277/480 volts by a pad mounted transformer at the exterior. From there, power goes to the main switchboard rated for 3000 amps which then feeds the 10 high voltage panels at 277/480 volts. The building is broken into four different sections and labeled A-D. The panelboards are labeled corresponding to their section of the school. The high voltage panelboards feed the low voltage boards in their respective sections through a step down transformer providing power at 120/208 volts. Relay panels are also connected to the high voltage panelboards. The low voltage panelboards also have transient voltage surge suppression systems in case of power quality issues.

An automatic transfer switch is attached to the main switchboard and the natural gas generator should power fail. From there, the generator powers the emergency distribution panel going to 8 emergency 277/480 voltage panels which feed 8 120/208 voltage panels through step down transformers. The elevator bussman for elevator power is also fed through the generator in the emergency panel section. Like the primary power system, there are relay panels coming off each high voltage emergency panel.

Building Utilization Voltage

The receptacle power is all 120 volts coming from the low voltage panels. Most lighting is 277 volts but the ballasts are rated for both 120 and 277 volts. There are two luminaires that only use 120 volts in the cafeteria. The mechanical equipment is also entirely 480 volts but there are a few fans that are supplied 208 volts. Of the special equipment, only a mixer for the kitchen runs at 480 volts. The rest of the kitchen equipment is at 208 volts. Below is a table with the emergency power allocation.

EMERGENCY LOADS 480 / 277, 175 kW/ 218 kVA NATURAL GAS GENERATOR 3 Ø, 4W		
DESCRIPTION		**KVA**
LIGHTING: INTERIOR =	26,764 VA	26.764
POWER: RECEPTACLES =	3,700 VA	3.7
OTHER MISC. =	44,758 VA	44.758
	TOTAL =	75.222
SQUARE FOOTAGE = 115,686		

Code Requirements

According to the design documents, considerations were made for any special occupancy requirements found in National Electric Code Chapter 5. Specifically, Article 518 concerning assembly occupancies which are pertinent to the stage area in the cafeteria. These design specifications mostly exist to make sure that all equipment is used correctly and wiring will not be a problem. This implemented design can be found in the enlarged power plan for the cafeteria in the drawings.

There were also considerations made for special equipment as outlined by National Electric Code Chapter 6. Elevator operation and information technology equipment were designed according to NEC Articles 620 and 645, respectively. These designs can be found in the power plans for the elevator and the enlarged power plan drawing for the media center where the IT equipment is located.

Determination and Documentation of Equipment

Below, the major components of the electrical system are discussed in a greater depth. All information is from the specifications and the one-line diagram (the latter can be found in Appendix A). A number of these systems are located in the mechanical rooms and electrical rooms located around the school. The total square footage for all of these rooms is about 6000 S.F. or approximately 5% of the total building area.

Main Service and Distribution

The school has a 480/277 volt main switchboard which feeds the high density panelboards serving most equipment and low density panelboards. The main switchboard is located in ELEC B116.2.

Main Service Transformer

Outdoor single ended utility service from Center Point is deliver to an exterior pad mounted utility owned dry type transformer.

Step Down Transformers

Step down transformers are between almost every 277/480 volts panelboard to feed associated 120/208 panelboards. Below is the transformer schedule for the building.

TRANSFORMER SCHEDULE							
MARK	KVA	PRIMARY	SECONDARY	MOUNTING	REMARKS	DEGREES OF PHASE SHIFT	NOTES
TLK	112.5	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	GENERAL PURPOSE		
T1LA	112.5	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
T1LA2	45	480V., 3PH.	120/208V., 3PH., 4W.	SUSPENDED	PQI DV SERIES	30°	1
T1LB	45	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
T1LC	112.5	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
T1LD	75	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
T1LD2	45	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
T1LE	45	480V., 3PH.	120/208V., 3PH., 4W.	SUSPENDED	PQI DY SERIES	0°	1
T2LC	112.5	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
T2LD	75	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
TLM	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
TDR	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
TE1LA	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
TE1LB	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
TE1LC	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1
TE1LD	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
TE1LE	30	480V., 3PH.	120/208V., 3PH., 4W.	SUSPENDED	PQI DY SERIES	0°	1
TE2LC	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DV SERIES	30°	1
TE2LD	30	480V., 3PH.	120/208V., 3PH., 4W.	FLOOR	PQI DY SERIES	0°	1

Panelboards

All panelboards are main lugs only, bolt-in, with copper bus. There are both 277/480V and 120/208V panelboards. Because of the size of the building, there are multiple electrical rooms. The panelboards can be found in ELEC B116.2.

Main Risers and Feeders

All risers and feeders are copper conductors in conduit. Below is the building's feeder schedule.

FEEDER SCHEDULE			
COPPER CONDUCTORS			FEEDER DESCRIPTION
SETS	CONDUCTOR SIZE	CONDUIT (INCHES)	
1	4#10, 1#10 G.	3/4"C	30A
1	4#8, 1#10 G.	1"C	40A
1	4#8, 1#10 G.	1"C	50A
1	4#6, 1#10 G.	1"C	60A
1	4#4, 1#8 G.	1 1/4"C	70A
1	4#4, 1#8 G.	1 1/4"C	80A
1	4#3, 1#8 G.	1 1/4"C	90A
1	4#3, 1#8 G.	1 1/4"C	100A
1	4#1, 1#6 G.	1 1/2"C	125A
1	4#1/0, 1#6 G.	1 1/2"C	150A
1	4#2/0, 1#6 G.	2"C	175A
1	4#3/0, 1#6 G.	2"C	200A
1	4#4/0, 1#4 G.	2 1/2"C	225A
1	4#250KCMIL, 1#4 G.	2 1/2"C	250A
1	4#350KCMIL, 1#4 G.	3"C	300A
1	4#500KCMIL, 1#3 G.	4"C	350A
1	4#500KCMIL, 1#3 G.	4"C	400A
2	4#4/0, 1#2 G.	2 1/2"C	450A
2	4#250KCMIL, 1#2G.	2 1/2"C	500A
2	4#350KCMIL, 1#1G.	3"C	600A
2	4#500KCMIL, 1#1/0G.	4"C	700A
2	4#500KCMIL, 1#1/0G.	4"C	800A
3	4#500KCMIL, 1#2/0G.	4"C	1000A
4	4#350KCMIL, 1#3/0G.	3"C	1200A
5	4#500KCMIL, 1#4/0G.	4"C	1600A GROUND NOT REQUIRED ON SERVICE LATERAL
6	4#500KCMIL, 1#250KCMIL G.	4"C	2000A GROUND NOT REQUIRED ON SERVICE LATERAL
7	4#500KCMIL, 1#350KCMIL G.	4"C	2500A GROUND NOT REQUIRED ON SERVICE LATERAL
8	4#500KCMIL, 1#400KCMIL G.	4"C	3000A GROUND NOT REQUIRED ON SERVICE LATERAL
10	4#500KCMIL, 1#500KCMIL G.	4"C	3500A GROUND NOT REQUIRED ON SERVICE LATERAL
11	4#500KCMIL, 1#500KCMIL G.	4"C	4000A GROUND NOT REQUIRED ON SERVICE LATERAL
14	4#500KCMIL, 1#700KCMIL G.	4"C	5000A GROUND NOT REQUIRED ON SERVICE LATERAL

Conductors

All conductors are made of copper.

Conduit

Flexible metal conduit is used for vibration isolation and limited to 3 feet in length when terminating to vibrating equipment. Rigid hot-dipped galvanized steel conduit and rigid aluminum conduit are used for all other applications.

Receptacles

All receptacles are grounded using the branch circuit grounding conductor. Receptacles shall use an approved grounding yoke. UL Class A ground fault circuit protection shall be provided on all receptacle circuits serving wet areas. Specified receptacles are self-grounding.

Switch and Receptacle Faceplates

All switches are rocker style in gray plastic and receptacle faceplates are gray metal except when specified as emergency, in which case they are red.

Motor Starters

Motor starters are Square D Company Class 8536 across-the-line magnetic type, full-voltage, non-reversing starters. Controls shall have hand-off-automatic switches.

UPS

There are no UPS systems currently in this electrical design.

Other Systems

There are no systems that operate on optional back-up power. Although there is a natural gas engine generator, it does not power any optional systems not required by code.

Telephone and data systems are present in the design for communication in classrooms and internet use in the media center. The telephones are integrated into the overhead intercom system which is present throughout the school for contacting faculty, staff, and students. Also integrated into the intercom is the fire alarm system. The fire alarm utilizes smoke detectors, heat detectors, visual alarms, auditory alarms, and fire suppression. Security cameras are another system in the building. Security cameras are present throughout the school to maintain the safety of the students. A general alarm system is in place should something compromise the safety of the inhabitants of the school. This is tied in to the intercom. Cable television is available in certain areas such as class rooms and the media center.

There are no energy reduction techniques implemented in this design and the building is not LEED certified.

Evaluation of Designed System

The preliminary connected load analysis calculated from values suggested by ASHRAE Standard and National Electric Code was 1219 kVA and the actual designed connected load was only 1057 kVA. This discrepancy of around 160 kVA could be caused by a number of factors. The preliminary analysis used a very conservative estimate for lighting and mechanical loads which is why I think there is a difference. This difference is only just outside the acceptable 10%, however, so although those power densities used were conservative, I do not feel they were very far off. Also, there were some factors I just could not estimate such as how much power to allocate for plumbing or the kitchen equipment, which is usually done by a food service designer.

The building utilization voltage for the building and the utilization voltages for certain systems are all essentially what I outlined in the preliminary analysis and they match up with the actual design. The overall voltage of 277Y/480 makes sense to me for a school of this size. Cypress Hill Elementary has a large amount of services and a good number of them are going to require 277/480 as well 120/208. By keeping the building utilization voltage at 277/480, it can be stepped down downstream for other systems. I would prefer to have all the lighting at 277 volts but it is inevitable that there may be some that need a 120 V supply. The luminaires that are supplied 120 volts are incandescent stage lights and that is the best source for that application so I would not change that. The mechanical loads use both 277/480V and 120/277V. An alternative for the mechanical equipment is viable. Without doing a larger assessment of the mechanical loads, it is premature to suggest another avenue, but variable speed drives could help limit loads and save energy. All other miscellaneous loads, such as food service, are dictated by the actual equipment so I have no insight on changes for them.

Electrical Service

Center Point Energy actually offers very little variety when it comes to its rates so I cannot suggest any alternate rate schedules or riders. Because this school is located in Texas, I would suggest co-generation on site (which will be elaborated on later) which could potentially save the school a large amount of money, long term. Cypress Hill Elementary's location in Texas is important for this because Texas's power grid is about 15% less efficient than the rest of the continental United States, making it prime for co-generation.

Code Requirements and Emergency Service

There were no discrepancies between the suggested code compliance and the actual design. The emergency power is served by a natural gas engine generator which is already a very efficient fuel source (compared to the diesel generators that are fairly common). A suggestion would be alternative energy sources like solar (although not good for emergency power) and fuel cells (whose emissions are supposedly cleaner). If the generator were to be changed from a natural gas engine to a fuel cell generator, a line would be needed for hydrogen gas, as well as storage. In addition, the generator may need to be moved also.

There were no designed optional-back up power or UPS systems but I would add both to the design. Cypress Hill Elementary School is located in Texas so I would consider putting some of the mechanical equipment on the generator along with the security system. The safety of the inhabitants is the largest priority so if the power were to fail they would be exposed without any kind of security measures. These two suggestions are impeded by one major factor, which is the size and cost of the generator. The mechanical loads are very large in this school so adding any of them to the generator would mean upsizing the generator, potentially a very large amount. In order to curtail this issue, one could just only put some of these loads on the generator, but then the design needs to consider which mechanical equipment and why. The security system should only be a small load so that should not be as large of a problem.

Implementation of an uninterruptable power source was considered and could benefit the school, but ultimately, I do not feel it is worth the cost. The IT equipment in the media center and personal computers for the faculty could benefit from a UPS, but computers are a tool for the students and faculty and not a major part of their day to day. One might generally see UPS set ups in very computer heavy work environments where it is critical there is no power loss, like companies with server support. This, coupled with the fact that you have to replace the UPS every three years, means the cost is not acceptable for the potential benefits.

Other Systems

The main switchboard feeding all the panels in the building seems to be good solution. I have no suggestions for most of the outlined existing equipment from the section "Determination and Documentation of Equipment". There did seem to be a large amount of step down transformers but I do not have a better solution except having a low density distribution panel so only one transformer is used from the main switchboard to another board. That suggestion would affect the very layout of the building however, since it guts the existing distribution system. There is also a cost associated with another board. It may have been cheaper or more energy efficient to design it with all those transformers instead.

There are a few possibilities that could potentially save both energy and money in the long term. The first is the implementation of photovoltaic cells for solar energy. Co-generation could be a large boon because of the inefficiency of Texas's grid. It's also a large possibility too because the footprint of the building is so large and all the roofs are flat. That means there is a large amount of surface area to work with. PV could also be used on the south façade for an even greater amount of energy. There are high initial costs associated with using photovoltaics however. Integration into the grid is costly, along with the needed inverter, storage, and the cost of the solar panels themselves. Ultimately, without a cost estimation and buy back schedule, nothing can be determined for certain, but it could end up saving both energy and money.

Another change could be new transformers. There are transformers from the 277/480 panels feeding the smaller 120/208 panels downstream but they are all dry type transformers that could be improved upon. There are enough transformers in the building that this change in equipment and efficiency might save the building energy, but I am not sure if the upfront cost associated with a small amount of increase in efficiency is worth it.

Geothermal heating could also benefit the school. Again, the upfront cost is potentially very high and heating is not the largest priority in a Texas based school, but it should still be considered and reviewed.

Daylighting could save the school a lot of energy, also. The south façade is already very large to let light in and monitors could be built into the roofs for classroom daylighting. There is already a lot of flexibility in the design to allow this and the cost would not be substantial compared to the gains. An unwanted gain is solar heat, though. This could increase the cooling loads significantly and as a result, the mechanical equipment would be running at a larger load leading to energy loss.

Integrating all these systems and better equipment (like variable speed drives) could end up saving the school a large amount of energy and money as well as push the building well into LEED certification but the initial cost may be too great for some of these systems.

ONE LINE DIAGRAM GENERAL NOTES:

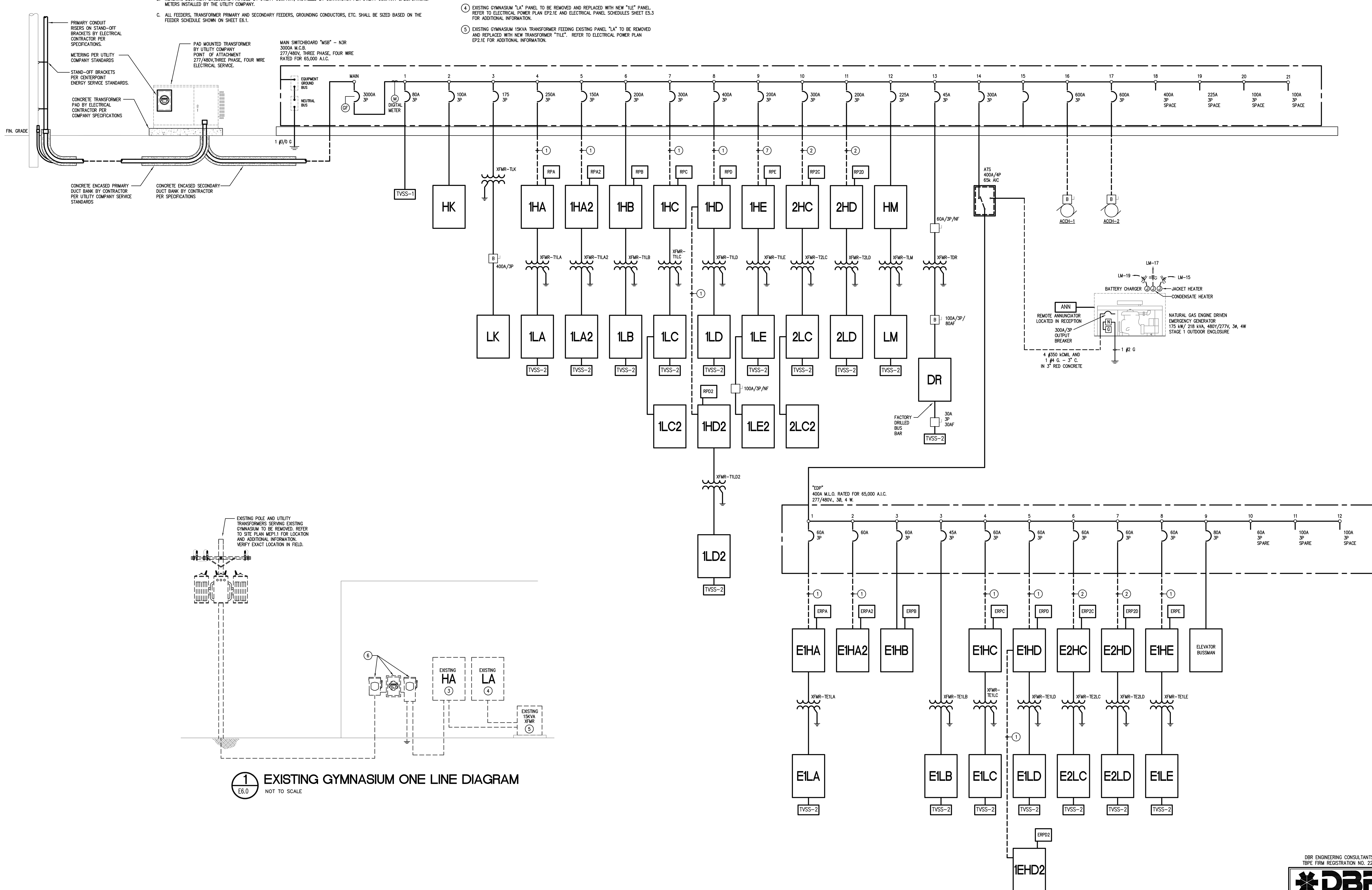
A. MANUFACTURER OF ELECTRICAL GEAR SHALL PROVIDE A COORDINATION STUDY FOR THE ENTIRE ELECTRICAL SYSTEM IN ORDER TO SET REFER TO SPECIFICATIONS. MANUFACTURER SHALL ALSO PROVIDE A FAULT CURRENT STUDY FOR THE ENTIRE SYSTEM IN ORDER TO SELECT INTERRUPTING RATINGS OF ALL CIRCUIT BREAKERS, DISTRIBUTION PANELS, LIGHTING CLASS PANELS, ETC. A SERIES RATED SYSTEM SHALL BE USED. SUBMIT THE INTERRUPTING RATING FOR ALL ELECTRICAL GEAR IN SUBMITTALS. CONTRACTOR SHALL SUPPLY WITH THEIR SUBMITTALS ON ALL NEW EQUIPMENT, THE MANUFACTURER'S U.L. DATA LISTING FOR THE SERIES RATING OF ALL EQUIPMENT. THIS SWITCHBOARD AND ALL NEW EQUIPMENT CONNECTED DOWNSTREAM SHALL BEAR LABELS INDICATING "SERIES RATED EQUIPMENT" ON THEIR EXTERIOR AS INDICATED IN THE SPECIFICATIONS. CONTRACTOR SHALL INSTRUCT THE MANUFACTURER TO INCLUDE IN THEIR SUBMITTALS, ALL TRIP CURVES AND LITERATURE INDICATING THE INTERRUPTING RATING CHARACTERISTICS OF EQUIPMENT BEING SUPPLIED.

B. METERING EQUIPMENT ENCLOSURE PROVIDED BY UTILITY COMPANY, INSTALLED BY CONTRACTOR PER UTILITY COMPANY SPECIFCATIONS. METERS INSTALLED BY THE UTILITY COMPANY.

C. ALL FEEDERS, TRANSFORMER PRIMARY AND SECONDARY FEEDERS, GROUNDING CONDUCTORS, ETC. SHALL BE SIZED BASED ON THE FEEDER SCHEDULE SHOWN ON SHEET E6.1.

ONE LINE DIAGRAM KEYED NOTES:

1. PROVIDE SCHEDULE 40 PVC CONDUIT UNDERGROUND TO ROOM SERVING ELECTRICAL PANEL/EQUIPMENT.
2. PROVIDE SCHEDULE 40 PVC CONDUIT UNDERGROUND TO FIRST FLOOR MECHANICAL ROOM. PROVIDE EMT CONDUIT FROM FIRST FLOOR MECHANICAL ROOM TO 2ND FLOOR MECHANICAL ROOM SERVING ELECTRICAL PANEL/EQUIPMENT.
3. EXISTING GYMNASIUM "HA" PANEL TO BE REMOVED AND REPLACED WITH NEW "1HE". REFER TO ELECTRICAL POWER PLAN EP2.1E AND ELECTRICAL PANEL SCHEDULE SHEET E5.1 FOR ADDITIONAL INFORMATION.
4. EXISTING GYMNASIUM "LA" PANEL TO BE REMOVED AND REPLACED WITH NEW "1LE" PANEL. REFER TO ELECTRICAL POWER PLAN EP2.1E AND ELECTRICAL PANEL SCHEDULES SHEET E5.3 FOR ADDITIONAL INFORMATION.
5. EXISTING GYMNASIUM 15KVA TRANSFORMER FEEDING EXISTING PANEL "LA" TO BE REMOVED AND REPLACED WITH NEW TRANSFORMER "T1LE". REFER TO ELECTRICAL POWER PLAN EP2.1E FOR ADDITIONAL INFORMATION.
6. EXISTING GYMNASIUM SERVICE DISCONNECT, METER AND PANEL "HA" DISCONNECT TO BE REMOVED.
7. PROVIDE SCHEDULE 40 PVC CONDUIT UNDERGROUND TO EXTERIOR WALL OF EXISTING GYMNASIUM. RE-USE EXISTING EXTERIOR PENETRATION OF EXTERIOR WALL FOR NEW CONDUIT ROUTING.



1 E6.0 EXISTING GYMNASIUM ONE LINE DIAGRAM
NOT TO SCALE

1 E6.0 ELECTRICAL ONE LINE DIAGRAM
NOT TO SCALE

pfluger
office: 713.222.1141 | fax: 713.222.1174
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New Frostwood Elementary School - Re-Bid

Spring Branch Independent School District
12214 Memorial Dr.
Houston, TX 77024

Spring Branch Independent School District
955 Campbell St.
Houston, TX 77024
PH: 713.644.1511

STATE OF TEXAS
ERIK M. MacDONALD
105068
LICENSED PROFESSIONAL ENGINEER
07.12.12

PROJECT NO. 10-022
DATE 07/13/2012
REVISIONS:

DBR ENGINEERING CONSULTANTS
TBPE FIRM REGISTRATION NO. 2234
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DBR Project Number 11063.000

CS	AJ	EM	DL

E6.0
Electrical One-Line Diagram

7/3/2012 14:29:21

CenterPoint Energy Houston Electric, LLC
Applicable: Entire Service Area CNP 8018

6.1.1.1.4 PRIMARY SERVICE

AVAILABILITY
This schedule is applicable to Delivery Service for non-residential purposes at primary voltage when such Delivery Service is to one Point of Delivery and measured through one Meter.

TYPE OF SERVICE
Delivery Service will be single or three-phase, 60 hertz, at a standard primary voltage. Delivery Service will be metered using Company's standard Meter provided for this type of Delivery Service. Any Meter other than the standard Meter will be provided at an additional charge and/or will be provided by a Meter Owner other than the Company pursuant to Applicable Legal Authorities. Where Delivery Service of the type desired is not available at the Point of Delivery, additional charges and special contract arrangements may be required prior to Delivery Service being furnished, pursuant to Section 6.1.2.2, Construction Services, of this Tariff.

MONTHLY RATE

I. Transmission and Distribution Charges:

Customer Charge			
	Non-IDR Metered	$ 3.58	per Retail Customer per Month
	IDR Metered	$ 76.73	per Retail Customer per Month
Metering Charge			
	Non-IDR Metered	$181.35	per Retail Customer per Month
	IDR Metered	$138.40	per Retail Customer per Month
Transmission System Charge			
	Non-IDR Metered	$1.7033	per NCP kVA
	IDR Metered	$2.1546	per 4CP kVA
Distribution System Charge		$2.002820	per Billing kVA

II.	**System Benefit Fund:**	See Rider SBF
III.	**Transition Charge:**	See Schedules TC, TC2, TC3, SRC, and TC5
IV.	**Nuclear Decommissioning Charge:**	See Rider NDC
V.	**Transmission Cost Recovery Factor:**	See Rider TCRF

VI.	**Competition Transition Charge:**		See Rider CTC
VII.	**Competitive Metering Credit:**		See Rider CMC
VIII.	**Other Charges or Credits:**		
	A. Municipal Account Franchise Credit (see application and explanation below)	$(.699012)	per Billing kVA
	B. Rate Case Expenses Surcharge		See Rider RCE
	C. Advanced Metering System Surcharge		See Rider AMS
	D. Energy Efficiency Cost Recovery Factor		See Rider EECRF
	E. Accumulated Deferred Federal Income Tax Credit		See Rider ADFITC

COMPANY SPECIFIC APPLICATIONS

DETERMINATION OF BILLING DEMAND FOR TRANSMISSION SYSTEM CHARGES

Determination of NCP kVA The NCP kVA applicable under the Monthly Rate section shall be the kVA supplied during the 15 minute period of maximum use during the billing month.

Determination of 4 CP kVA The 4 CP kVA applicable under the Monthly Rate section shall be the average of the Retail Customer's integrated 15 minute demands at the time of the monthly ERCOT system 15 minute peak demand for the months of June, July, August and September of the previous calendar year. The Retail Customer's average 4CP demand will be updated effective with the February billing month of each year and remain fixed for a year. Retail Customers without previous history on which to determine their 4 CP kVA will be billed at the applicable NCP rate under the "Transmission System Charge" using the Retail Customer's NCP kVA.

DETERMINATION OF BILLING DEMAND FOR DISTRIBUTION SYSTEM CHARGES

Determination of Billing kVA For loads whose maximum NCP kVA established in the 11 months preceding the current billing month is less than or equal to 20 kVA, the Billing kVA applicable to the Distribution System Charge shall be the NCP kVA for the current billing month. For all other loads, the Billing kVA applicable to the Distribution System Charge shall be the higher of the NCP kVA for the current billing month or 80% of the highest monthly NCP kVA established in the 11 months preceding the current billing month (80% ratchet). The 80% ratchet shall not apply to seasonal agricultural Retail Customers.

OTHER PROVISIONS

Primary Service This rate schedule is applicable only to Retail Customers taking service directly from feeder lines of at least 12,470 volts but less than 60,000 volts. This rate schedule is applicable to Delivery Service provided for Electric Power and Energy supplied by Retail Customer's REP for Temporary service subject to the provisions of Section 6.1.2.2, Construction Services in this Tariff. The Electric Power and Energy delivered may not be re-metered or sub-metered by the Retail Customer for resale except pursuant to lawful sub-metering regulations of Applicable Legal Authorities. Retail Customer's previous metered usage under this or any other Rate Schedule will be used, as needed, in determining the billing determinants under the Monthly Rate section.

Service Voltages Company's standard service voltages are described in 6.22, Standard Voltages and in the Company's Service Standards.

Municipal Account Franchise Credit A credit equal to the amount of franchise fees included in the Transmission and Distribution Charges will be applied to municipal accounts receiving service within the incorporated limits of such municipality which imposes a municipal franchise fee upon the Company based on the Billing kVA within that municipality and who have signed an appropriate Franchise Agreement.

Adjustment To The Charges Applied To Retail Customer's Demand Measurement If data to determine the Retail Customer's *Demand Measurement* becomes no longer available, the Company will determine a *Conversion Factor* which will be used as an adjustment to all per unit charges that will then be applied to the *New Demand Measurement*. *Demand Measurement* shall include the Billing kVA, the 4 CP kVA, NCP kVA or any other demand measurement required for billing under this Rate Schedule or any applicable Rider(s) or any other applicable schedule(s). *New Demand Measurement* shall be the billing determinants which replace the *Demand Measurement*. The *Conversion Factor* will apply to unit prices per kVA such that when applied to the *New Demand Measurement*, the revenue derived by the Company under demand based charges shall be unaffected by such lack of data.

This adjustment may become necessary because of changes in metering capabilities, such as, Meters that record and /or measure kW with no ability to determine kVA or Meters which meter data in intervals other than 15 minutes. This adjustment also may become necessary due to changes in rules, laws, procedures or other directives which might dictate or recommend that Electric Power and Energy, electric power related transactions, wire charges, nonbypassable charges and/or other transactions measure demand in a way that is inconsistent with the definitions and procedures stated in the Company's Tariff. This adjustment is applicable not only in the instances enumerated above but also for any and all other changes in *Demand Measurement* which would prevent the Company from obtaining the necessary data to determine the kVA quantities defined in this Rate Schedule, applicable Riders and other applicable schedules.

The Conversion Factor shall render the Company revenue neutral to any change in *Demand Measurement* as described above.

Metering Adjustment The Company may at its option measure service on the secondary side of the Retail Customer's transformers in which event the kVA and kWh recorded by the Billing Meter will be adjusted to compensate for transformer losses as follows: (1) where the Retail Customer's installed substation capacity is 600 kVA or less, the kVA will be increased by 2% and the kWh will be increased by 3%; or (2) where the Retail Customer's installed substation capacity is in excess of 600 kVA, the kVA and kWh will be increased by proper respective adjustments based upon data furnished by the manufacturer. In the event the manufacturer is unable to supply the necessary data, the adjustment will be based on tests conducted on the Retail Customer's transformers by the Company.

NOTICE
This Rate Schedule is subject to the Company's Tariff and Applicable Legal Authorities.