



December 22, 2010

Kansas Department of Administration
900 WS Jackson Street, Suite 600
Topeka, KS 66612

Attn: George Werth

Subject: Summary of work performed on electrical distribution system in the Docking Building.

Dear Mr. Werth:

Capital Electric Construction was contracted to perform maintenance and cleaning of the 13.2kV electrical distribution system in the Docking Building. The work was started on Wednesday, November 24 and completed on Saturday, November 27. This report summarizes our findings.

To perform our work, power to the Docking building was turned off and maintenance to the Main Electrical gear and bus riser took place. During this maintenance, several medium voltage (M.V). switches were cleaned and repaired along with the main riser bus that runs the length and height of the building. The protective metal covers on the bus were removed where assessable and the electrical bus was visually inspected and cleaned. Included with this report are several photos of different items of concern that need varying degrees of attention.

Below is a list of our concerns:

1. Nameplates on the equipment indicate that the gear was manufactured/installed in the mid 1950's. This makes this equipment between 50 and 60 years old. It is generally expected that electrical gear has a life expectancy of 15-30 years. Many factors affect the life expectancy, including ambient temperature, environmental conditions, electrical load (and the characteristics of the load) on the equipment, maintenance, and other factors. Assuming all of these factors have been ideal, the gear would still be considered to have out-lived its normal life expectancy.
2. Many of the sections of the bus are inaccessible. This means that these sections have never been cleaned or maintained. Routine maintenance is not possible on these sections. There was an extreme amount of dust/dirt accumulation in all areas of the system. We were able to clean many of the areas, but these particular areas could not be accessed, so they remain with over 50 years of dirt accumulation. The presence of the dust/dirt and in some areas oil and moisture

could lead to tracking (unwanted current flow from phase to phase or phase to ground). The result of this could potentially be severe damage to the equipment and building, and also potential safety risk to people in the building. An electrical outage affecting the entire building could also result.

3. The age of the electrical equipment is such that replacement parts are unavailable or difficult to find. Repairs may require custom fabrication, which could require extensive engineering or re-engineering.
4. The gear is 13.2kV. Any maintenance or repairs requires special equipment, tools, and training.
5. The gear is very open in design and allows air flow into the bus duct thru the M.V. switches. With these transformer housings being in the air handler rooms and the elevator exhaust ports feeding into these rooms the accumulation is much more than normal. The bus is covered and has taped joints but those tape joints are showing some tracking and age. To re-tape these joints would extend the life of the bus but would be very labor intensive and require a very lengthy outage to do so.
6. Transformer TRN-0015 has bus that is wrapped in 20,000v electrical blanket and extremely close to the access points of the transformer housing. It is possible that during the removal of the transformer housing covers that the bus could become exposed and cause significant hazards to the personnel working on the gear. Due to the nature of these pieces of electrical gear every precaution should be taken to protect any personnel inspecting these items. A detailed safety agenda should be followed and all personnel should adhere to any and all PPE requirements of NFPA 70e. An arc flash incident is highly possible with gear of this nature if the proper precautions are not followed extensively. The consequences of an arc flash in this gear and in these confined locations would be very severe and would likely result in death to the personnel working on the gear. It is highly recommended that only qualified and trained personnel have access to this gear for maintenance purposes.
7. As mentioned above the M.V. switches are open into the bus area. These had varying degrees of dust and dirt accumulation as well. These however can be de-energized and maintenance performed on a regular basis to extend their life span. While energized a visual inspection of these switches and of the transformers would be recommended along with an IR scan on a routine maintenance schedule. With the exception of one transformer this is recommended.
8. An arc flash study is recommended for this and all electrical gear in the Docking building. This would include the proper labeling of the arc hazard and calorie requirements onto all electrical doors.
9. It was also observed during the maintenance that some of the fuses were not seated properly and that the switches were not engaging fully. The only reason this had not been an issue was due to the amount of load on these switches. If these had additional load on them when not fully seated it would result in arcing and heating issues.
10. It was noted on the first and basement floors that the wires feeding off the load side of the switches have corrosion developing at the insulators holding them in place. These were cleaned and re-taped but this is not a permanent fix and



these should be replaced in the near future before the insulation breaks down to the point of failure.

11. Mechanical mechanisms in some of the MV switches have failed. These are a safety mechanism that keeps the door of the enclosure closed when the switch is in the energized state. Because these could not be repaired, we were forced to install padlocks on the doors as the only means of safety. Signage should be installed on these switches to alert personnel of the danger.

SUMMARY

We believe the electrical distribution system in the Docking Building is nearing the failure point, and we recommend a complete replacement of the system.

- Insulation in the system is deteriorating and may fail.
- The equipment is obsolete and replacement parts are not available.
- Safety mechanisms are failing.

I have attached the Emerson Test Report for the switches and equipment that were tested during the project. Their report includes additional recommendations.

Please contact me if there are any questions or additional information is required.

Thank you.

Mark Hurshman
Capital Electric



Electrical Reliability Services, Inc.
Kansas City Area Office

348 N.W. Capital Drive
Lee's Summit, MO 64086
T (816) 525-7156
F (816) 524-3274

December 6, 2010

Capital Electric
P.O. Box 410079
Kansas City, MO 64141

Attention: Mr. Mark Hurshman

Subject: Electrical Equipment Maintenance Test Report
Reference No. 3126895

Dear Mr. Hurshman:

Enclosed is the subject test report as prepared by our lead field engineer. It was our pleasure to be of service to you on this project. If you have any questions, or if we can be of further assistance, please do not hesitate to call.

Sincerely,

Electrical Reliability Services, Inc

A handwritten signature in blue ink, appearing to read "Bob Ross".

Bob Ross
Service Center Manager

Enclosures



Electrical Reliability Services, Inc.
Kansas City Area Office

348 N.W. Capital Drive
Lee's Summit, MO 64086
T (816) 525-7156
F (816) 524-3274

**Electrical Equipment Maintenance
Test Report**

At

DOCKING STATE OFFICE BLDG
Topeka, KS

for

Capital Electric
P.O.Box 410079
Kansas City, MO 64141

Attention: Mr. Mark Hurshman
Order No: PO#196031, JOB#56763

Reference No. 3126895

Submitted By: David Duncan
Field Engineer

December 6, 2010

Reviewed By:


Bob Ross
Service Center Manager

1 PURPOSE

- 1.1 The equipment and components listed in Section 3.0 of this report have been inspected and tested to help assure their proper and safe operation. Defective or marginal equipment can be identified, repaired, replaced or scheduled for future repairs without costly or unexpected interruptions during normal operating periods.
- 1.2 The test results are particularly valuable when kept for comparison with past and future maintenance test results. This historic database enables one to predict the probability of equipment failure and thus schedule facility production and financial budgets to accommodate preventive maintenance or repair rather than breakdown maintenance.

2 SUMMARY

- 2.1 This project was initiated by Mr. Mark Hurshman with Capital Electric. All testing was performed by Electrical Reliability Services Field Engineers David Duncan and Charles Howell on Saturday, November 27, 2010.
- 2.2 Please refer to Section 5 "Results and Recommendations" for complete details of the testing.

3 EQUIPMENT TESTED AND INSPECTED

- 3.1 **Three (3)** medium voltages disconnect switches, S&C, SM-5, and 400 Amp.
- 3.2 **Seventeen (17)** medium voltages disconnect switches, electrical engineering equipment co, S.O. # 50542, 300 Amp.

4 PROCEDURES

4.1 Medium Voltage Air Switches

4.1.1 Visual and Mechanical Inspection

- .1 Compared equipment nameplate data with drawings and specifications.
- .2 Inspected for physical damage, proper installation, required area clearances, anchorage and grounding. Cleaned interior, insulators, arc chutes and interphase barriers.
- .3 Performed mechanical operator tests in accordance with manufacturer's instructions. Cleaned and lubricated contacts and mechanism as applicable. Confirmed correct application of manufacturer's recommended lubricants.
- .4 Checked contact alignment, wipe and pressure.
- .5 Inspected for correct phase barrier materials and installation.
- .6 Checked fuse linkage and element for proper holder and current rating. Recorded fuse data.
- .7 Verified tightness of accessible bolted electrical connections by calibrated torque-wrench method.
- .8 Verified that fuse sizes and types were in accordance with drawings and power system studies.
- .9 Inspected all indicating and control devices for correct operation.
- .10 Tested all interlocking systems for correct operation and sequencing. Checked key interlock for proper operation and proper key distribution.
- .11 Verified arc interrupter operation.

4.1.2 Electrical Tests

- .1 Performed contact resistance test across each switch blade and fuse link.
- .2 Measured fuse resistance.
- .3 Performed insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute.

5 RESULTS AND RECOMMENDATIONS

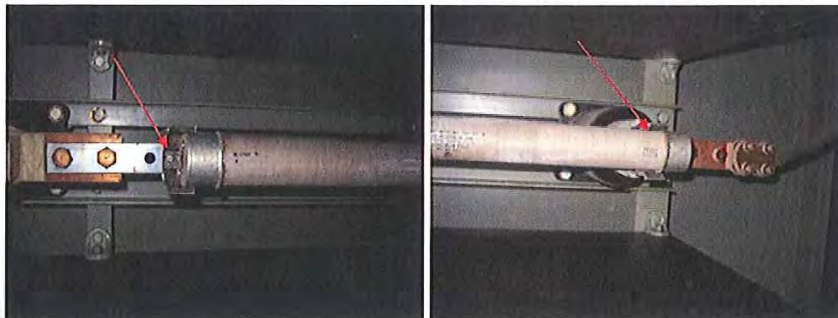
- 5.1 The following is a list of problems discovered during this testing project along with any corrective action that was made by Electrical Reliability Services. Those corrections beyond the scope of the project that require your additional corrective action are in bolded text.
- 5.1.1 If the equipment tested in Section 3 is not discussed in this section, the results of the tests indicate the equipment to be satisfactory.
- 5.2 Feeder #10 - A phase contact resistance was found to be higher than the other two phases and was outside of NETA contact resistance tolerances. This could cause contact heating of the other two phases, deterioration, and eventual failure of the switch. This problem was corrected at time of testing by ERS personnel. No further action required at this time.
- 5.3 Feeders 9 & 10 automatic transfer operator could not be tested because of customer restrictions. Because of the age, condition, and unavailability of repair parts the customer did not want the transfer mechanism operated. The customer is aware of the deficiencies with the ATS System and is attempting to have it repaired or replaced.
- **It is recommended that the ATS System should be tested once repairs have been made. Electrical Reliability Services would be pleased offer this service.**
- 5.4 Riser #7 B phase contact resistance was found to be higher than the other two phased and was outside of NETA contact resistance tolerances. This could cause contact heating of the other two phases, deterioration, and eventual failure of the switch. This problem was corrected at time of testing. No further action required at this time.

- 5.5 During the outage for Capital Electric Inc. to perform low voltage retrofits, on down stream equipment, it was discovered that a large percentage of the transformer disconnects were not closing fully. The cause of the problems was found to be the mechanical door interlocks which are bent out of shape. State of Kansas personnel directed Electrical Reliability Services personnel to remove the interlocking mechanism and State of Kansas personnel would install locks and signs to adjust for the safety issues.
- 5.6 During the inspection of Medium Voltage Air Switch LUCS 18, on the (14th) floor it was discovered that the moving contacts were not fully engaging the stationary contact. This could cause contact heating, deterioration, and eventual failure of the switch. Electrical Reliability Services personnel corrected this condition. This same condition was found at the following locations:
- LUCS 17, on the (14th) floor
 - LUCS 16, on the (12th) floor
 - LUCS 15, on the (11th) floor
 - LUCS 14, on the (10th) floor
 - LUCS 9, on the (9th) floor
 - LUCS 10, on the (8th) floor
 - LUCS 11, on the (7th) floor
 - LUCS 12, on the (6th) floor
 - LUCS 13, on the (5th) floor
 - LUCS 5, on the (3rd) floor

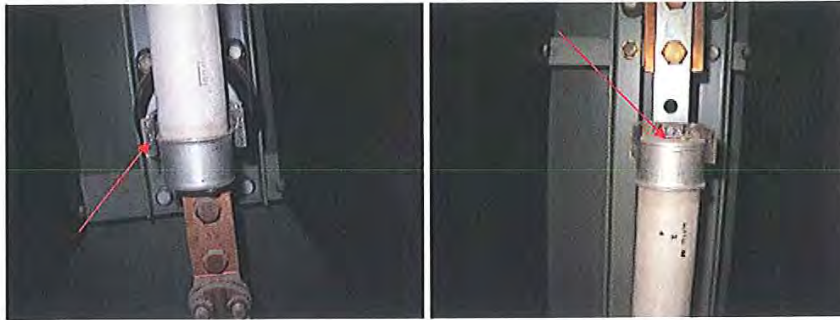
The pictures below are examples of this condition. The left picture is the before adjustment picture and the right picture is after corrections were made.



- It is recommended that all the switches be cleaned and tested. Electrical Reliability Services would be please to provide this service.
- 5.7 LUCS 5, on the (3rd) floor was found with the B phase fuse improperly inserted into the fuse clip. This could cause overheating, premature aging of the fuse and unscheduled outages. Capital Electric Personnel were to correct this problem before restoring service. The left picture is the line side of the fuse and the right picture is load side of the fuse.

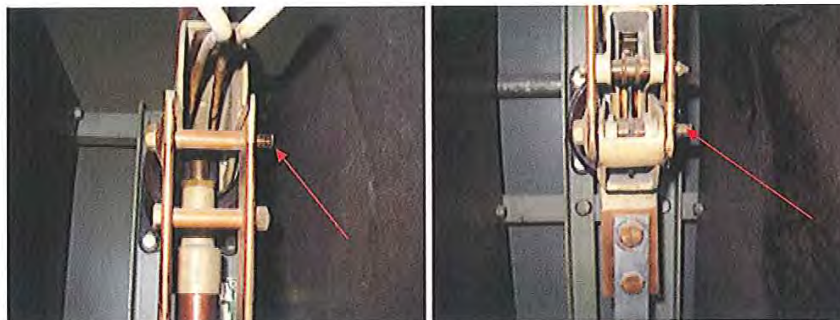


- 5.8 LUCS 5, on the (3rd) floor was found with the C phase fuse improperly inserted into the fuse clip. This could cause overheating, premature aging of the fuse and unscheduled outages. Capital Electric Personnel were to correct this problem before restoring service. The left picture is the load side of the fuse and the right picture is line side of the fuse.



- 5.9 LUCS 3, on the (1st) floor was found with the knife blades fully penetrating the stationary contacts. However the C phase knife switch was found to be missing a nut and cup washer on the line and load side of the switch. This could cause contact heating, deterioration, and eventual failure of the switch. This problem was corrected before restoring utility power by Capital Electric personnel. The left picture is the moving portion of the switch, and the right picture is the elbow or pivot part of the switch. No further mechanical action required at this time.

- It is suggested that a complete cleaning and maintenance test be performed at the next scheduled outage. Electrical Reliability Services would be pleased offer this service.



Ross, Bob [NETPWR/ERS/LEE']

Subject: FW: Docking M.V. switches

Importance: High

-----Original Message-----

From: White, Ben [mailto:bwhite@capitalelectric.com]

Sent: Friday, November 26, 2010 9:32 AM

To: Steele, George [FM]; Flowers, Clifford [FM]

Cc: Werth, George [FM]; Lour, Mike [FM]; Howell, Chuck [NETPWR/ERS/LEE']; Hurshman, Mark

Subject: RE: Docking M.V. switches

Importance: High

Gentlemen this is to document our earlier conversation today in which the door latches were discussed. As directed we will have Emerson Reliability Services remove the door latch mechanism from the throw rod so as to allow complete operation of the switches off the Bus Duct riser only. These components will be placed in the bottom of the cabinets for future needs if it is desired to repair and reattach these at a later date.

In cleaning these switches we noticed the knife blades not fully engaged. During further inspection it was noted that the latch rods have been bent during operation and are obstructing the switches from engaging fully and properly. These latch rods are part of the mechanism that holds the door shut while in the energized state. These will be removed off all these common disconnect switches on the Bus riser so no further issues arise in the event of operating these switches.

It is understood that you will have padlocks in place that only allow Authorized personnel access to these when the switch when they are in the closed position. In addition signage will be placed on all these disconnects to signify this modification and the hazards involved with opening these while energized. I would also suggest signage being added that signifies the proper PPE require to open these switches and the proper CAL requirement for Arc Flash.

Your response to this email will serve as our authorization to perform this work.

Thanks,
Ben White
Capital Electric Construction Company
Service Division
816-215-6691 (cell)

From: Steele, George [FM] [mailto:George.Steele@da.ks.gov]

Sent: Thu 11/25/2010 4:50 PM

To: White, Ben; Hurshman, Mark; Flowers, Clifford [FM]

Cc: Werth, George [FM]; Lour, Mike [FM]

Subject: RE: Docking M.V. switches

We agree with having Emerson look at, repair and modify all switches off the Buss Duct on a Time and Material Basis.

George Steele
900 SW Jackson, Suite 600
Topeka, KS 66612
785-296-4693
Cell 785-215-5709

-----Original Message-----

From: White, Ben [mailto:bwhite@capitalelectric.com]
Sent: Thursday, November 25, 2010 4:17 PM
To: Steele, George [FM]; Hurshman, Mark; Flowers, Clifford [FM]
Subject: Docking M.V. switches

Gentlemen this is to confirm our earlier conversations today about the Switches that are not engaging as they should feeding the transformers on each floor off the Bus Duct run.

We will as discussed remove the safety latch that holds the doors closed while energized. It is understood that the padlock on the door handle will become the safety and labeling will be attached to the doors to identify the voltage hazard. As discussed this is being done so that it can be verified that the knife switches have engaged the switch fully.

Secondly we will have Emerson Reliability Services look at and repair or modify all the switches off the Bus Duct run we have been working on to verify the functionality of all the switches. They will make the necessary adjustments to the two switches in the penthouse.

All this work is on a T&M basis. Please respond to this email as our work authorization.

Thanks,
Ben White
Capital Electric Construction Company
Service Division
816-215-6691 (cell)

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895					
LOCATION: 915 SW HARRISON ST			ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS	FEEDER IDENTIFICATION: RISER NO # 7	TEST EQUIP. ASSET NO: 41-01045/1280	CALIBRATION DATE: 05/26/2010						
NAMEPLATE DATA									
MANUFACTURER: S & C	TYPE: N/A	STYLE/SERIAL NUMBER: CD28082	CURRENT RATING: 400	VOLTAGE RATING: 15K					
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4			SYSTEM VOLTAGE: 13.8 KV						
INSPECTION									
CHECK POINT	CONDITION	NOTES	CHECK POINT	CONDITION	NOTES				
PHYSICAL DAMAGE	A		CONTACT ALIGNMENT	A					
CLEANLINESS	C		CONTACT WIPE	A					
MECHANICAL OPERATOR	N/A	(1)	CONTACT PRESSURE	A					
MAIN CONTACTS	A		PHASE BARRIERS	A					
ARC CONTACTS	A		HARDWARE TIGHTNESS	A					
ARC CHUTES	N/A		FUSE HOLDERS	A					
ARC INTERRUPTER SEQUENCE	A		INTERLOCKS	A					
ELECTRICAL TESTS									
		A-PHASE	B-PHASE	C-PHASE					
CONTACT RESISTANCE IN MILLIOHMS		0.373/.112	0.832/.118	.184/.139					
FUSE RESISTANCE IN MILLIOHMS		0.410	0.376	0.386					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS	SWITCH CLOSED						SWITCH OPEN		
	A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
	2.953	3.045	3.099	(4)	(4)	(4)	7040	6150	6200
NOTE									
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED TO TESTIUNG PROCEDCURS									
NOTE 2:) "B" PHASE KNIFE SWITCH HAS HIGHER RESISTANCE THAN OTHER TWO PHASES. ERS CORRECTED WITH AJUSTMENT TO KNIFE SWITCH.									
NOTE 3:) CLOSED INSULATION TEST WERE DONE WITH BUSS RISER ATTACHED.									
NOTE 4:) CANNOT TEST DUE TO METERING EQUIPMMENT CONNECTIONS IN PRIMARY CABINET OWNED BY UTILITY COMPANY.									
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE									

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895					
LOCATION: 915 SW HARRISON ST			ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS		FEEDER IDENTIFICATION: FEEDER # 09		TEST EQUIP. ASSET NO: 41-01045/1280	CALIBRATION DATE: 05/26/2010				
NAMEPLATE DATA									
MANUFACTURER: S & C		TYPE: N/A	STYLE/SERIAL NUMBER: CD28082		CURRENT RATING: 400				
					VOLTAGE RATING: 15K				
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4				SYSTEM VOLTAGE: 13.8 KV					
INSPECTION									
CHECK POINT	CONDITION	NOTES	CHECK POINT	CONDITION	NOTES				
PHYSICAL DAMAGE	A		CONTACT ALIGNMENT	A					
CLEANLINESS	C		CONTACT WIPE	A					
MECHANICAL OPERATOR	N/A	(1)	CONTACT PRESSURE	A					
MAIN CONTACTS	A		PHASE BARRIERS	A					
ARC CONTACTS	A		HARDWARE TIGHTNESS	A					
ARC CHUTES	N/A		FUSE HOLDERS	A					
ARC INTERRUPTER SEQUENCE	A		INTERLOCKS	A					
ELECTRICAL TESTS									
		A-PHASE		B-PHASE					
CONTACT RESISTANCE IN MILLIOHMS		0.135		0.122					
				C-PHASE					
				0.101					
FUSE RESISTANCE IN MILLIOHMS		0.369		0.385					
				0.391					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS	SWITCH CLOSED						SWITCH OPEN		
	A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
	178.5	192.8	177.9	335.2	310.8	470	2779	2983	3181
NOTE									
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED FOR TESTING PROCEDURES									
NOTE 2:) CABLES & ARRESTORS WERE DISCONNECT FOR TESTING PURPOSES.									
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE									

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895					
LOCATION: 915 SW HARRISON ST			ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS	FEEDER IDENTIFICATION: FEEDER # 10	TEST EQUIP. ASSET NO: 41-01045/1280	CALIBRATION DATE: 05/26/2010						
NAMEPLATE DATA									
MANUFACTURER: S & C	TYPE: N/A	STYLE/SERIAL NUMBER: CD28082	CURRENT RATING: 400	VOLTAGE RATING: 15K					
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4			SYSTEM VOLTAGE: 13.8 KV						
INSPECTION									
CHECK POINT	CONDITION	NOTES	CHECK POINT	CONDITION	NOTES				
PHYSICAL DAMAGE	A		CONTACT ALIGNMENT	A					
CLEANLINESS	C		CONTACT WIPE	A					
MECHANICAL OPERATOR	N/A	(1)	CONTACT PRESSURE	A					
MAIN CONTACTS	A		PHASE BARRIERS	A					
ARC CONTACTS	A		HARDWARE TIGHTNESS	A					
ARC CHUTES	N/A		FUSE HOLDERS	A					
ARC INTERRUPTER SEQUENCE	A		INTERLOCKS	A					
ELECTRICAL TESTS									
CONTACT RESISTANCE IN MILLIOHMS (2)		A-PHASE	B-PHASE	C-PHASE					
		0.584/.144	0.234/.123	0.232/.143					
FUSE RESISTANCE IN MILLIOHMS		0.338	0.339	0.346					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS	SWITCH CLOSED						SWITCH OPEN		
	A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
	245.9	228.3	178.3	443	275	418	3381	3065	3265
NOTE									
NOTE 1: TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED FOR TESTING PROCEDCURS									
NOTE 2: "A" PHASE KNIFE SWITCH HAS HIGHER RESISTANCE THAN OTHER TWO PHASES. ERS CORRECTED WITH AJUSTMENT TO KNIFE SWITCH.									
NOTE 3: CABLES & ARRESTORS WERE DISCONNECT FOR TESTING PURPOSES.									
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE									



Electrical Reliability Services

Project Status Report / Work Authorization

CLIENT	CAPITAL ELECTRIC	JOB NO.	3126895	
PROJECT	915 SW HARRISON ST.	ENGINEER	CH/DD	DATE 11/26/2010

THIS DOCUMENT IS INTENDED TO PROVIDE PRELIMINARY INFORMATION AS TO THE STATUS OF THIS PROJECT. A FORMAL REPORT WILL BE SUBMITTED AT THE PROJECT COMPLETION.

- ☐ THE FOLLOWING ITEMS REQUIRE REPLACEMENT, REPAIR AND/OR ADJUSTMENT:
- ☐ THE FOLLOWING TESTS AND/OR INSPECTIONS ARE REQUIRED PRIOR TO PROJECT COMPLETION:
- ☒ THE FOLLOWING WORK IS AUTHORIZED:

VISUAL INSPECTION AND REMOVAL OF INTERLOCK ARM PER CUSTOMER REQUEST
(SEE E-MAIL) AS PER BEN WHITE ON FLOORS 1-14
OPEN MAIN SWITCHES IN BASEMENT FOR VISUAL INSPECTION BY CUSTOMER.

LCUS "18" 14TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE- PHOTOS
LCUS "17" 14TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "16" 12 FLOOR- REMOVAL OF INTERLOCK-PHOTOS
LCUS "15" 11TH FOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "14" 10TH FLOOR- REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "9" 9TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "10" 8TH FLOOR-REMOVAL OF INTERLOCK
LCUS "11" 7TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "12" 6TH FLOOR-REMOVAL OF INTERLOCK
LCUS "13" 5TH FLOOR REMOVAL OF INTERLOCK -PHOTOS
LCUS "8" 3TH FLOOR NO REMOVAL REQUIRED, SWITCH RETOR-FITED WITH NEW SW
LCUS "7" 3TH FLOOR REMOVAL OF INTERLOCK
LCUS "6" 3TH FLOOR REMOVAL OF INTERLOCK
LCUS "5" 2TH FLOOR REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
FUSE B&C ARE MISALIGNED IN HOLDER - SEE PHOTOS
LCUS "4" 2TH FLOOR REMOVAL OF INTERLOCK
LCUS "3" 1ST FLOOR REMOVAL OF INTERLOCK - C PHASE OF SWITCH IS MISSING
NUTS AND WASHERS ON PIVOT POINT & TENTION POINT - PHOTOS
LCUS "2" BASEMENT-REMOVAL OF INTERLOCK

CUSTOMER SIGNATURE	AUTHORIZATION NO.
N/A	SEE EMAIL

WHITE COPY - FILE

PINK COPY - CUSTOMER

PAGE 1 OF 1



Electrical Reliability Services, Inc.
Kansas City Area Office
1012 "B" N.E. Jib Court
Lee's Summit, MO 64064

T (816) 795-7795
F (816) 795-7798

Thermographic Survey Report

at

**Docking State Office Building
Topeka, KS**

for

Ace Electric
223 Southeast 53rd Street
Topeka, KS 66609

Attention: Mr. Steve Jones

Reference No. 3029129

Submitted By: Paul Ekermans
Field Engineer

November 1, 2005

Reviewed By:

A handwritten signature in black ink, appearing to read 'Bob Ross', written over a horizontal line.

Bob Ross
Service Center Manager

1 PURPOSE

- 1.1 The purpose of infrared inspections is to provide information relative to the physical condition of the electrical distribution system. Loose and poor connections, unbalanced loads, and loose bus joints can be located. These conditions are characterized by increased resistance and accompanied by a temperature rise, which is detected by infrared scanning. The survey was performed while the system was loaded, representative of a "normal" workday.

2 SUMMARY

- 2.1 This project was initiated by Mr. Steve Jones with Ace Electric. The Survey was performed by Electrical Reliability Services Field Engineer Paul Ekermans on Tuesday, October 25, 2005.
- 2.2 Please refer to Section 5 "Results and Recommendations" for complete details of the testing.

3 EQUIPMENT TESTED AND INSPECTED

3.1 Please refer to the attached thermographic survey equipment data sheet.

4 PROCEDURES

4.1 Infrared Inspection

4.1.1 Visual and Mechanical Inspection

- .1 Contractor personnel removed all equipment covers to allow visual access to current carrying conductors.
- .2 Visually inspected physical, electrical and mechanical condition of all components for potentially dangerous conditions.
- .3 Scanned each load current carrying piece of equipment using an infrared camera.
- .4 Documented problem areas with a still photograph to clarify problem identification and location.
- .5 Contractor personnel reinstalled covers to all equipment.
- .6 Identified inaccessible and/or unobservable areas and/or equipment.

4.1.2 Electrical Tests

- .1 Recorded instantaneous current measurements of all safely accessible problem areas. This data can be utilized for determining the equipment load during the infrared inspection.
- .2 Verified actual temperature of problem areas relative to reference temperatures noted during thermographic survey.

5 RESULTS AND RECOMMENDATIONS

- 5.1 The following is a list of problems discovered during this testing project along with any corrective action that was made by Electrical Reliability Services. Those corrections beyond the scope of the project that require your additional corrective action are in bolded text.

5.1.1 If the equipment tested in Section 3 is not discussed in this section, the results of the tests indicate the equipment to be satisfactory.

- 5.2 Main switchboard circuit breaker DSOB Chiller #1 was found with a higher than normal operating temperature on the C-phase circuit breaker contact. A higher operating temperature indicates a higher contact resistance and high resistance contacts can cause contact failure due to overheating and also may provide an ignition source to any flammable substance.

- **It is recommended that the switch contact be inspected, cleaned and checked for sufficient contact pressure according to manufacturer's specifications.**

- 5.3 Chiller #1 control panel was found with a higher than normal operating temperature at the main circuit breaker load side A & B phase conductor terminations. A higher operating temperature indicates a higher resistance and high resistance terminations can cause insulation and/or termination failure due to overheating and also may provide an ignition source to any flammable substance.

- **It is recommended that the conductor terminations be inspected, cleaned and tightened to the manufacturer's torque specifications.**

- 5.4 Chiller #3 was found with a higher than normal operating temperature at the control power fuse F4 line side fuse clip. A higher operating temperature indicates a higher resistance and high resistance fuse clips can cause fuse and/or fuse clip failure due to overheating and also may provide an ignition source to any flammable substance.

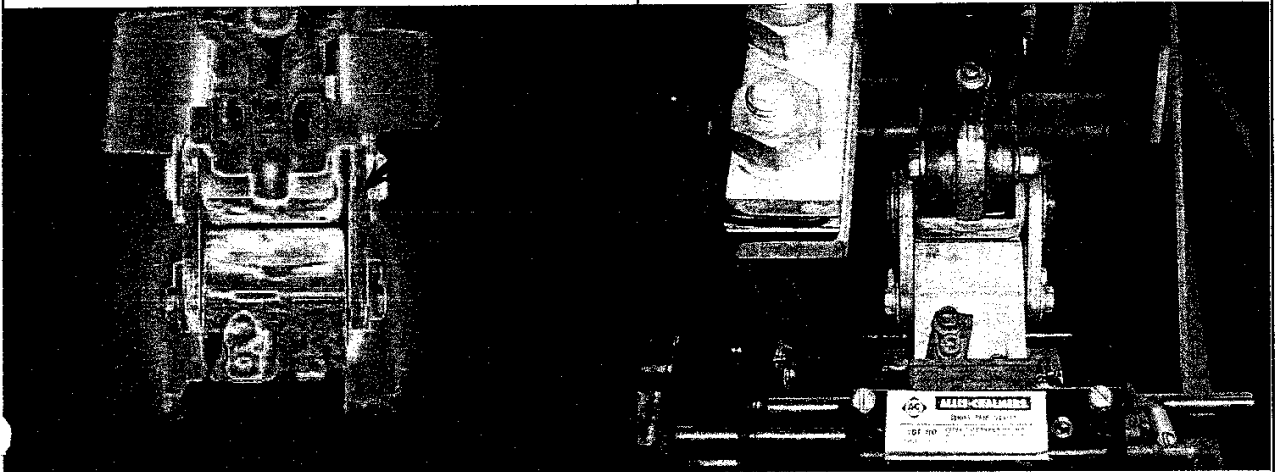
- **It is recommended that the fuse and fuse clip be inspected, cleaned and checked for sufficient clip tension according to the manufacturer's specifications and replaced if necessary.**

INFRARED SCAN PHOTOGRAPH SHEET

Electrical Reliability Services

CLIENT: ACE ELECTRIC		JOB NUMBER: 3029129
LOCATION: ROBERT DOCKING STATE BUILDING, TOPEKA, KS		DATE: October 25, 2005
TEST EQUIPMENT / ASSET NO.: MICRON MICROSCAN 7515/4102033	ENGINEER: Paul Ekermans	REFERENCE REPORT SECTION: 5.2

EQUIPMENT PHOTOGRAPHS



EQUIPMENT IDENTIFICATION: DSOB CHILLER #1	LOCATION: CHILLER ROOM	
ITEM: CIRCUIT BREAKER C-PHASE CONTACT	OBJECT TEMPERATURE: 120F	REFERENCE TEMPERATURE.: 109F

COMMENTS:
Main switchboard circuit breaker DSOB Chiller #1 was found with a higher than normal operating temperature on the C-phase circuit breaker contact. A higher operating temperature indicates a higher contact resistance and high resistance contacts can cause contact failure due to overheating and also may provide an ignition source to any flammable substance.

RECOMMENDATIONS:
It is recommended that the switch contact be inspected, cleaned and checked for sufficient contact pressure according to manufacturer's specifications.

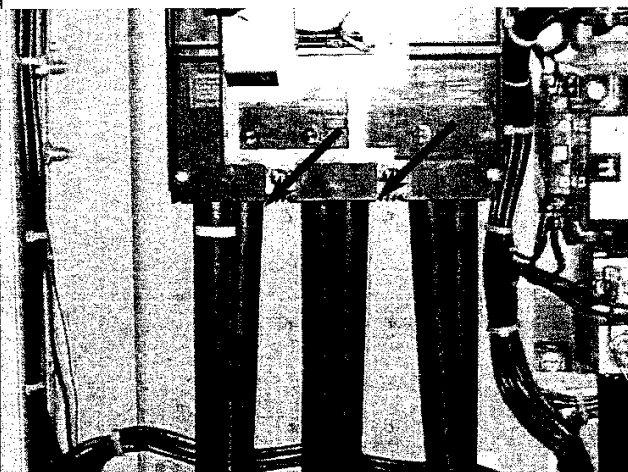
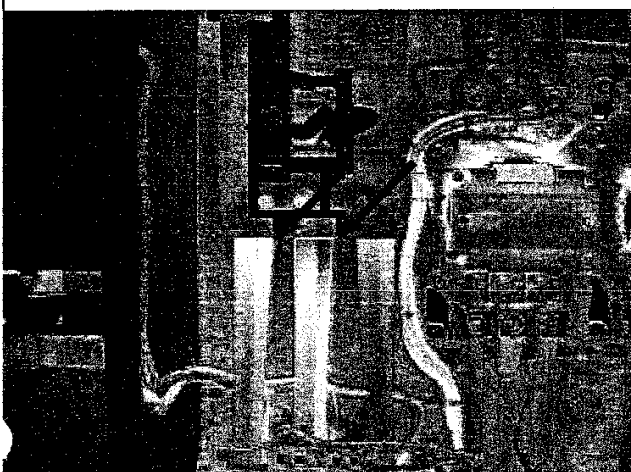
CURRENT MEASUREMENTS IN AMPERES: Aph: N/A Bph: N/A Cph: N/A	VOLTAGE DROP READINGS IN MILLIVOLTS: Aph: N/A Bph: N/A Cph: N/A
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INFRARED SCAN PHOTOGRAPH SHEET

Electrical Reliability Services

CLIENT: ACE ELECTRIC		JOB NUMBER: 3029129
LOCATION: ROBERT DOCKING STATE BUILDING, TOPEKA, KS		DATE: October 25, 2005
TEST EQUIPMENT / ASSET NO.: MICRON MICROSCAN 7515/4102033	ENGINEER: Paul Ekermans	REFERENCE REPORT SECTION: 5.2

EQUIPMENT PHOTOGRAPHS



EQUIPMENT IDENTIFICATION: CHILLER #1 CONTROL PANEL	LOCATION: CHILLER ROOM	
ITEM: CIRCUIT BREAKER WIRE TERMINATIONS	OBJECT TEMPERATURE: 118F	REFERENCE TEMPERATURE: 110F

COMMENTS:

Chiller #1 control panel was found with a higher than normal operating temperature at the main circuit breaker load side A & B phase conductor terminations. A higher operating temperature indicates a higher resistance and high resistance terminations can cause insulation and/or termination failure due to overheating and also may provide an ignition source to any flammable substance.

RECOMMENDATIONS:

It is recommended that the conductor terminations be inspected, cleaned and tightened to the manufacturer's torque specifications.

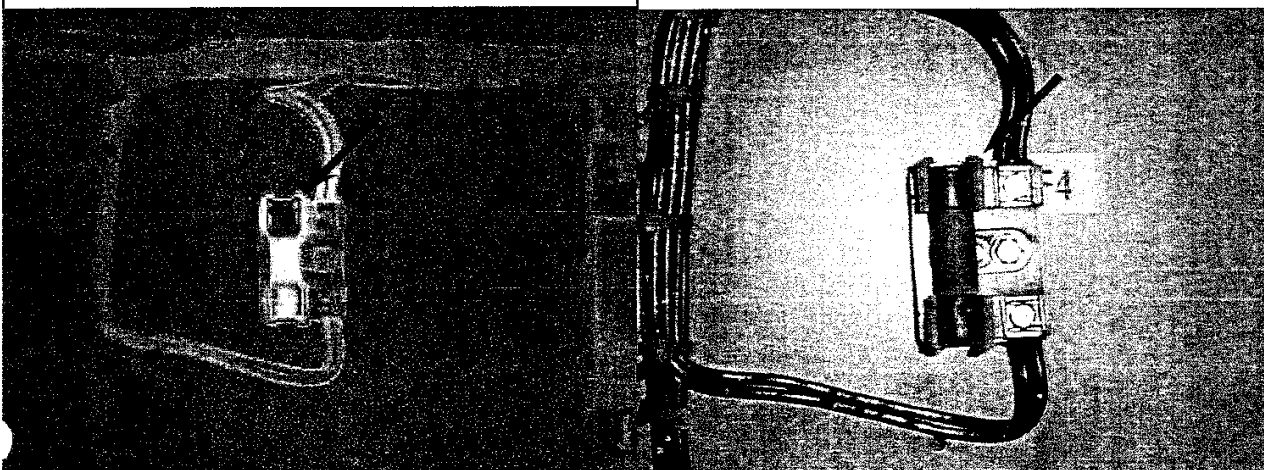
CURRENT MEASUREMENTS IN AMPERES: Aph: N/A Bph: N/A Cph: N/A	VOLTAGE DROP READINGS IN MILLIVOLTS: Aph: N/A Bph: N/A Cph: N/A
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INFRARED SCAN PHOTOGRAPH SHEET

Electrical Reliability Services

CLIENT: ACE ELECTRIC		JOB NUMBER: 3029129
LOCATION: ROBERT DOCKING STATE BUILDING, TOPEKA, KS		DATE: October 25, 2005
TEST EQUIPMENT / ASSET NO.: MICRON MICROSCAN 7515/4102033	ENGINEER: Paul Ekermans	REFERENCE REPORT SECTION: 5.2

EQUIPMENT PHOTOGRAPHS



EQUIPMENT IDENTIFICATION: CHILLER #3 CONTROL PANEL	LOCATION: CHILLER ROOM	
ITEM: FUSE F4 LINE SIDE FUSE CLIP	OBJECT TEMPERATURE: 268F	REFERENCE TEMPERATURE: 128F

COMMENTS:
Chiller #3 was found with a higher than normal operating temperature at the control power fuse F4 line side fuse clip. A higher operating temperature indicates a higher resistance and high resistance fuse clips can cause fuse and/or fuse clip failure due to overheating and also may provide an ignition source to any flammable substance.

RECOMMENDATIONS:
It is recommended that the fuse and fuse clip be inspected, cleaned and checked for sufficient clip tension according to the manufacturer's specifications and replaced if necessary.

CURRENT MEASUREMENTS IN AMPERES: Aph: 17 Bph: N/A Cph: N/A	VOLTAGE DROP READINGS IN MILLIVOLTS: Aph: 1.2 Bph: N/A Cph: N/A
--	---

THERMOGRAPHIC SURVEY EQUIPMENT DATA SHEET

[illegible]

LOCHNER

BWR Division

Study of:

Docking State Office Building Electrical Upgrade



TMA #1667

Submitted to:

Kansas Department of Administration

February 11, 2011

KANSAS DEPARTMENT OF ADMINISTRATION

DOCKING STATE OFFICE BUILDING ELECTRICAL UPGRADE STUDY

TMA #1667



LOCHNER
BWR Division

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engineering | planning | architecture

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1. EXECUTIVE SUMMARY

The existing 13,200 Volt (13.2 kV) electrical equipment, located in the basement and routed up the center core of the building, is antiquated and has become unsafe due to limited maintenance and years of accumulated dust and contaminants. Installed when the building was constructed in 1954, this equipment has remained out of sight and out of mind. Recent cleaning and maintenance of the equipment and copper bus duct has uncovered many operational and safety concerns chief among these being the following:

1. Parts of the bus duct could not be accessed to clean, however visual inspection did show it to have a significant amount of dust/dirt on the bus bars. Additionally, the bus duct is not a sealed system so building air continues to deposit dust and dirt on all parts of it including those that were recently cleaned.
2. The 13.2 kV switches, located on each floor to supply step-down transformers, are in a state of disrepair and are obsolete (cannot be repaired). This combined with their dangerous location makes their use unsafe and possibly life threatening to maintenance personnel.
3. The 13.2 kV distribution system is showing signs of a major short circuit to ground potential. This was seen in transformers where the insulation had partially melted or burnt off electrical conductors.

If any of the above conditions leads to a failure, it will likely result in either an explosion, fire or both. This compounded with the fact the building lacks a fire suppression system makes it imperative that replacement of the distribution system begin as soon as possible.

A total of six options were investigated to replace the existing system with a modern, low maintenance electrical distribution system that will provide years of reliable and safe service. All the options investigated looked to replace the 13.2 kV distribution system with a 480 Volt distribution system which is the standard in office buildings. The 480 Volt system will be both easier and safer to maintain. To accomplish this, all the options look

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at placing transformers on the outside of the building or near the electrical service entrance. These transformers reduce the 13.2 kV power that Westar provides down to 480 Volt which is then distributed throughout the building.

The top three options are included in this executive summary. The options and estimated costs are as follows:

Option 2: New substation transformers, located below grade, on the south end of the building, in the old cooling tower areaway with overhead bus duct routed to a new 480 Volt electrical switchgear in the sub-basement, also located on the south end of the building. A new ductbank will be constructed on the west side of Harrison Street to 10th Street and then extended west to the existing south areaway. The transformers and bus duct will be installed in an existing areaway and concealed out of view. New 480 Volt transformers will be installed on each floor to transform the voltage down to 120 Volts for convenience use. Cost \$7,150,000.

Option 4: New switchgear and step-down transformers, located at the north end of the building in the basement. The 13.2 kilovolt primary electrical feeders will be routed into the building from Westar Energy and connected to 3,750 kVA transformers to convert the voltage to 480 Volts. There will be two transformers, one on each end of the line-up, feeding into 480 Volt switchgear that supplies the transformers located on each floor to convert the voltage to 120 Volts for convenience use. Cost \$7,100,000.

Option 5: New substation transformers, located at below grade in a new electrical vault, on the north side of building with overhead bus duct routed in a new utility tunnel to new 480 Volt electrical switchgear in the basement, on the north end of the building. New 480 Volt transformers will be installed on each floor to transform the voltage down to 120 Volts for convenience use. Cost \$6,400,000.

Our recommendation is to select Option 5 to provide an electrical vault dedicated to the electrical equipment and providing direct access into the basement space. This will require the minimum exterior excavation and will keep the electrical supply close to the Westar Energy manhole at 9th and Harrison. The disadvantage is the need to convert additional space in the basement area to electrical equipment space and the modifications required to the ceilings to route the new 480 Volt bus duct from the north end of the building to the mechanical equipment located on the south end.

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2. INTRODUCTION AND HISTORY

2.1 Purpose of Study

The purpose of this report is to determine the feasibility of upgrading the electrical distribution system within the Docking State Office Building. This upgrade would remove the existing 15 kV distribution system from within the facility and replace with a 480/277 Volt system. Various options to accomplish this task were investigated and are summarized in this report.

2.2 History

The existing electrical distribution system consists of electrical switchgear, rated for 15 kV, located in the northeast corner of the basement. Cabling, carrying 13.2 kV, is routed from a Westar Energy manhole in the northeast corner of Harrison and 9th Street. A recently constructed ductbank, containing three (3) 6-inch conduits, is routed from this manhole to the electrical room in the basement of the building. Two separate circuits (#9 and #10) are routed in this ductbank and supply electrical power to the 15 kV electrical switchgear. Of the two circuits, Circuit #10 is the preferred circuit and is normally utilized to supply power to the building.

Each of the electrical circuits feeds into the automatic throw-over switch in the switchgear. The automatic throw-over switch allows the switchgear to be fed from one of the two electrical feeder circuits. Typical operation is to have Circuit #10, from Westar Energy, supplying power to the switchgear through the automatic throw-over switch allows for energizing of the switchgear line-up.

If the preferred circuit is lost, the system is designed to automatically, if so selected, disconnect from the failed utility feeder and switch the "automatic throw-over switch" to energize the switchgear from the alternate source. With the current operation of operating only on Circuit #10, the loss of Circuit #10 would cause the system to disconnect from Circuit #10 and close the Circuit #9 switch to re-energize the switchgear from this source.

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From the switchgear, which is operating at 13.2 kV, the electricity is distributed throughout the building with either 15 kV cable or 15 kV bus duct. Three of the electrical loads are fed with #2 AWG, 15 kV cable (CCM-1, CCM-2, and LCUS No. 1). The medium voltage switches, controlling these feeders, are contained in the medium voltage (15 kV) switchgear in the northeast corner of the basement. The remainder of the electrical loads is connected to a 15 kV electrical bus duct that is routed from the northeast corner of the basement, to the east of the north-south corridor, northeast of the bank of elevators, to the electrical room located north of the elevator banks, on the basement level. This 15 kV bus duct is then routed vertically through the building to the penthouse. At each floor, except at the sub-basement and fourth floor, at least one tap is made to this vertical bus. The tap is routed to a medium voltage switch which feeds a 300kVA step-down transformer to convert the 13.2 kV to 120/208 volt. The 120/208 volt is considered the utilization voltage of each floor. The chillers and other large electrical loads are operated on 480 volts and are supplied by a 13.2 kV to 480 volt step-down transformer.

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3. EXISTING CONDITIONS

3.1 Site Investigation

During the period of November 24th to November 27th, 2010, Capital Electric was on site to perform routine maintenance on the 15 kV system in the facility. During this time, the electrical power to the building was turned "off" and the system was inspected, cleaned, and repaired. A copy of this report is included in Appendix A of this report. The findings of the report included excessive dust/dirt accumulation on the electrical gear and 15 kV bus duct, medium voltage switches not fully engaged, medium voltage fuses improperly installed, taped joints on the 15 kV bus duct needing repair, equipment out of adjustment and not fully engaged, transformer windings dangerously close to metal enclosures, and corrosion developing on insulators, just to name a few.

3.1.1 Dangers and Concerns

The dangers presented with the existing equipment include the possibility for an arc to be started with the displacement of the existing dust. Refer to Photographs 1 and 2 for pictorial representation of the extent of dirt/dust accumulation. The dust itself is explosive. If an electrical arc is started due to the conductivity of the dust particles, the addition of the fault electrical current could lead to an explosion in the electrical bus duct causing sever damage to the electrical equipment and harm to any personnel in the area.



Photograph 1: 15 kV Vertical Copper Bus (Side view)



Photograph 2: 15 kV Copper Bus (Bottom view)

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In addition to the unsafe conditions discovered during the maintenance, the existing electrical distribution system is over 50 years old. The normal life of such electrical equipment is 20 – 30 years. Also, the existing equipment is now obsolete and finding parts is not only difficult and expensive, but in some instances may be impossible. This would require remanufacturing of some parts are substantial expense.

3.2 Present Building Electrical Loading

Historical loading information was provided by Westar Energy for the last three year's usage on the Docking State Office Building. The peak demand electrical loading of this facility was 3,168 kW/kVA recorded in June of 2009. The data provided by Westar Energy is included in Appendix B. The demand loading for a building is defined as the maximum electrical loading for a facility, over a 15 minute period. Based upon the rough square footage of the building, this equates to approximately 10 watts per square foot, which is typical for an office building loading.

This peak loading is used to determine the size of electrical equipment required to supply adequate power to the building. This value is used in developing options for possible upgrades.

Combining the existing electrical peak loading with the desire for a redundant electrical supply system, the step-down transformers to convert the incoming Westar Energy supplied 13.2 kV to 480/277 Volts will require a minimum of two (2) 3,750 kVA transformers. The maximum size of transformer that Westar Energy is able to provide is rated at only 2,500 kVA. Therefore, in order to meet the redundancy request, the state will be required to purchase and maintain the step-down transformers.

3.3 Building Layout

A site plan and the building floor plans are included in Appendix C to provide information on the existing building layout and electrical arrangement. Sheet E601 shows the existing one-line diagram of the 13.2kV distribution system and the major electrical loads. The main electrical gear is located in the northeast corner of the basement level. The

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distribution system is routed vertically through the center core of the building, directly north of the north bank of elevators. The mechanical equipment such as chillers, and pumps, are located in the south end of the building on the basement and sub-basement levels.

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4. ELECTRICAL UPGRADE OPTIONS

4.1 Option 1

Replace existing switchgear with new, exterior mounted pad mounted transformers on the north side of the building and new 480 volt switchgear in basement.

This option involves the installation of two (2) new, 3,750 kVA, 13.2kV-480Y/277 Volt pad mounted transformers on the north side of the building. See Photograph 3, below, for approximate area for new transformers. The existing electrical, primary voltage feed is routed in a ductbank from a manhole at the northeast corner of Harrison and 9th Street. This ductbank consists of three (3) 6-inch conduits, concrete encased. To supply the new pad mounted transformers, a new ductbank, consisting of three (3) 6-inch conduits (two for conductors and one spare) would be routed from an intersecting point with the existing ductbank, where a new manhole would be installed, to the new transformers location.



Photograph 3: North Side Docking State Office Building

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The new primary conductors would be installed by Westar Energy from the manhole to the pad mounted transformers. Final electrical connections would also be performed by Westar Energy.

The secondary voltage of the transformers would be 480Y/277 Volts with a full load rating of 4,510 Amps, each. This would allow the entire load of the Docking State Office Building to be supplied by just one of the transformers, providing total redundancy. To carry the 4,510 full load amps, either conduit with conductors or weatherproof bus duct would be required, rated for a minimum of 5,000 Amps.

To place adequate raceway and conductors underground to carry the 5,000 Amps would require 44 conduits (Refer to calculations in Appendix D). The large number of conduits is required due to the derating effect from mutual heating from multiple conduits placed in a ductbank. A viable alternative is to install 5,000 Amp weatherproof ductbank from the transformers to the new electrical switchboard. Being that the electrical bus duct cannot be installed underground, an overhead routing from the secondary of the pad mounted transformers would be required. Support structures would be required to be placed along the route of the bus duct from the pad mounted transformers to the exterior of the building, on the north side of the drive.

Once routed to the exterior wall of the building, the 5,000 Amp bus duct would be routed vertically to below grade, into a small vault to allow for penetration of the basement wall, and then the 5,000 Amp bus ducts would be routed horizontally into the basement level and the new electrical switchgear room. This new electrical room would be created directly west across the hallway from the existing electrical room on the north end of the basement, next to the tunnel entrance. The new electrical room, the current auditorium, would need



**Photograph 4: North End
Basement Hallway**

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to be expanded to the west to allow for the installation of the electrical switchgear.

Photograph 4 shows the existing electrical room door to the right, the existing doors to the tunnel in the center, and the existing door to the auditorium on the left.

The new switchgear would be rated for 5,000 Amps at 480Y/277 Volts. This gear, placed on a housekeeping pad, would consist of metering cabinets on each end to allow for Westar Energy's use. Next to the metering cabinets would be the main, 5,000 Amp switch, one for each of the feeds from the pad mounted transformers. One would be identified Circuit #9 and one Circuit #10. The main switch on each end would then feed distribution panels, rated at 5,000 Amps. In the middle of the new switchgear would be an automated tie-breaker. This tie-breaker would allow for the automatic connection of the two halves of the switchgear, to allow it to be fed from either of the two feeder circuits. The existing switchgear is presently connected to Circuit #10 (preferred source). With the new switchgear, both of the circuits from Westar Energy would be energized to allow for heating of the pad mounted transformers and thereby preventing condensation in the transformer.

Upon the loss of one of the feeder circuits, the switchgear would open the lost feeder circuit and automatically close the tie-breaker to allow for the entire switchgear to be fed from the remaining feeder circuit. Upon restoration of service to the affected feeder circuit, a manual or automatic retransfer shall occur to separate the two halves of the switchgear and the restored feeder circuit reconnected to half of the switchgear.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, both located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt

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to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 1.

4.2 Option 2

Replace existing switchgear with new, exterior mounted substation transformers on the south side of the building in the existing areaway and new 480 volt switchgear in basement.

This option involves the installation of two (2) new, 3,750 kVA, 13.2 kV-480Y/277 Volt substation transformers in the existing areaway on the south side of the building. Photographs 5 and 6, below, show the existing areaway at the south end of the building. The existing electrical, primary voltage feed is routed in a ductbank from a manhole at the northeast corner of Harrison and 9th Street, into the north side of the building. This ductbank consists of three (3) 6-inch conduits, concrete encased. To supply the substation transformers, a new ductbank, consisting of three (3) 6-inch conduits (two for conductors and one spare) would be routed from an intersecting location with the existing ductbank. A new manhole would be installed at this location and the ductbank would extend to the new transformers location. A new manhole would also be required along the route due to the length of the raceway routing.



Photograph 5: South Side of DSOB Areaway



Photograph 6: DSOB South Areaway

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The new primary conductors would be installed by Westar Energy from the manhole to the pad mounted transformers. Final electrical connections would also be performed by Westar Energy.

The secondary voltage of the transformers would be 480Y/277 Volts with a full load rating of 4,510 Amps, each. This would allow the entire load of the Docking State Office Building to be supplied by just one of the transformers, providing total redundancy. To carry the 4,510 full load amps, weatherproof bus duct would be required, rated for a minimum of 5,000 Amps.

With the transformers placed in the existing areaway, the primary conductors would be routed overhead to the transformers from the new ductbank. The secondary weatherproof bus duct would be routed overhead, into the subbasement level to the new 480 Volt switchgear. The new gear would be located in the subbasement level where existing chillers are proposed to be removed as part of a chiller renovation project. The chillers will need to be removed to make a viable option. The switchgear would be enclosed in a 2-hour enclosure with two exits.

The new switchgear would be rated for 5,000 Amps at 480Y/277 Volts. This gear, placed on a housekeeping pad, would consist of metering cabinets on each end to allow for Westar Energy's use. Next to the metering cabinets would be the main, 5,000 Amp switch, one for each of the feeds from the pad mounted transformers. One would be identified Circuit #9 and one Circuit #10. The main switch on each end would then feed distribution panels, rated at 5,000 Amps. In the middle of the new switchgear would be an automatic tie-breaker. This tie-breaker would allow for the automatic connection of the two halves of the switchgear, to allow it to be fed from either of the two feeder circuits. The existing switchgear is presently connected to Circuit #10 (preferred source). With the new switchgear, both of the circuits from Westar Energy would be energized to allow for heating of the pad mounted transformers and thereby preventing condensation in the transformer.

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Upon the loss of one of the feeder circuits, the switchgear would open the lost feeder circuit and automatically close the tie-breaker switch to allow for the entire switchgear to be fed from the remaining feeder circuit. Upon restoration of service to the affected feeder circuit, a manual or automatic retransfer shall occur to separate the two halves of the switchgear and the restored feeder circuit reconnected to half of the switchgear.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, both located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 2.

4.3 Option 3

Construct new Westar Energy Ductbank along the east side of Harrison Street to the intersection of 10th Street.

This option involves the extension of the Westar Energy ductbank along the east side of Harrison Street from the existing manhole at the intersection of 9th and Harrison to the 10th and Harrison intersection. At this location, a new manhole would be installed and a three (3) 6-inch conduit ductbank would be constructed to the west to feed the new exterior transformers in the existing south areaway.

The extension of the existing Westar Energy ductbank would allow for expanding of the Westar underground distribution system and allow the ability to serve future loads east

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of 10th and Harrison. The extension of the ductbank would be performed by Westar and reimbursed by the state of Kansas.

4.4 Option 4

Replace existing switchgear with new double-ended switchgear in basement at north end of building, including transformers.

This option involves the installation of the new 13.2kV to 480/277 Volt transformers in the basement. The transformers would be part of a new 5,000 Amp electrical line-up. A new ductbank with three (3) 6-inch conduits would be routed from an intersecting point along the existing ductbank a new manhole would be installed. Two (2) of the conduits would be utilized for feeder circuits 9 and 10 from Westar Energy. The ductbank would extend to the exterior wall of the Docking State Office Building, at the basement level, on the north end of the building. The raceway would enter the building in the space that is currently the auditorium. This room would be converted into a new electrical room and would require some modifications.

The switchgear would consist of a medium voltage switch (15kV) on each end, feeding a 3,750 kVA step-down transformer to convert from 13.2kV to 480/277 Volt. On the secondary of the step-down transformer would be connected half of the 480 Volt switchgear. The gear would have an automatic tie-breaker switch in the middle. Each half of the switchgear would be fed with one of the feeder circuits (9 or 10) from Westar Energy. Upon the loss of one of the feeder circuits, the corresponding main switch would open and the automatic tie-breaker would close to allow for operation of the entire 480 Volt switchgear from one feeder circuit. Upon the restoration of the feeder circuit, the automatic tie-breaker would open and the corresponding main switch would close to restore power to each half of the switchgear. Normal operation would be to utilize both feeders to allow for energizing of the 13.2kV to 480/277 Volt transformers to prevent condensation buildup.

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From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, all located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 4.

4.5 Option 5

Replace existing switchgear with new, below grade mounted substation transformers located in an electrical vault, on the north side of the building and new 480 volt switchgear in basement.



Photograph 7: North Side Docking State Office Building

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This option involves the installation of two (2) new, 3,750 kVA, 13.2kV-480Y/277 Volt substation transformers on the north side of the building. See Photograph 7 for approximate area for new transformers and vault. The existing electrical, primary voltage feed is routed in a ductbank from a manhole at the northeast corner of Harrison and 9th Street. This ductbank consists of three (3) 6-inch conduits, concrete encased. To supply the new substation transformers, a new ductbank, consisting of three (3) 6-inch conduits (two for conductors and one spare) would be routed from a new manhole that is installed at the intersection with the existing ductbank.

The new primary conductors would be installed by Westar Energy from the manhole to the substation transformers. Final electrical connections would also be performed by Westar Energy.

The secondary voltage of the transformers would be 480Y/277 Volts with a full load rating of 4,510 Amps, each. This would allow the entire load of the Docking State Office Building to be supplied by just one of the transformers, providing total redundancy. To carry the 4,510 full load amps, either conduit with conductors or weatherproof bus duct would be required, rated for a minimum of 5,000 Amps.

A new 5,000 Amp weatherproof ductbank from the transformers to the new electrical switchboard would be routed from the electrical vault to the new switchgear room in the basement. To allow for ready access to the bus duct, the new vault would be install directly on the outside of the basement wall.

Once routed through the exterior wall of the basement, the connection would be made to the new switchgear in the new electrical switchgear room. This new electrical room would be created



Photograph 8: North End
Basement Hallway

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directly west across the hallway from the existing electrical room on the north end of the basement, next to the tunnel entrance. The new electrical room, the current auditorium, would need to be expanded to the west to allow for the installation of the electrical switchgear.

Photograph 8 shows the existing electrical room door to the right, the existing doors to the tunnel in the center, and the existing door to the auditorium on the left.

The new switchgear would be rated for 5,000 Amps at 480Y/277 Volts. This gear, placed on a housekeeping pad, would consist of metering cabinets on each end to allow for Westar Energy's use. Next to the metering cabinets would be the main, 5,000 Amp switch, one for each of the feeds from the pad mounted transformers. One would be identified Circuit #9 and one Circuit #10. The main switch on each end would then feed distribution panels, rated at 5,000 Amps. In the middle of the new switchgear would be an automated tie-breaker. This tie-breaker would allow for the automatic connection of the two halves of the switchgear, to allow it to be fed from either of the two feeder circuits. The existing switchgear is presently connected to Circuit #10 (preferred source). With the new switchgear, both of the circuits from Westar Energy would be energized to allow for heating of the pad mounted transformers and thereby preventing condensation in the transformer.

Upon the loss of one of the feeder circuits, the switchgear would open the lost feeder circuit and automatically close the tie-breaker to allow for the entire switchgear to be fed from the remaining feeder circuit. Upon restoration of service to the affected feeder circuit, a manual or automatic retransfer shall occur to separate the two halves of the switchgear and the restored feeder circuit reconnected to half of the switchgear.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, both located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various

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floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 5.

4.6 Option 6

Replace existing switchgear with new, exterior mounted substation transformers on the southeast side of the building in the existing areaway and new 480 volt switchgear in basement.

This option involves the installation of two (2) new, 3,750 kVA, 13.2 kV-480Y/277 Volt substation transformers in the existing areaway on the southeast side of the building. A proposed chiller renovation project will need to be completed to remove the existing



Photograph 9: Southeast Areaway

cooling towers in this areaway to make room for the transformers. Photograph 9 shows the existing areaway at the southeast corner of the building. The existing electrical,

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primary voltage feed is routed in a ductbank from a manhole at the northeast corner of Harrison and 9th Street. This ductbank consists of three (3) 6-inch conduits, concrete encased. To supply the new substation transformers, a new ductbank, consisting of three (3) 6-inch conduits (two for conductors and one spare) would be routed from a new manhole installed at an intersecting location with the existing ductbank. A new manhole would also be required due to the length of the raceway routing.

The new primary conductors would be installed by Westar Energy from the manhole to the substation transformers. Final electrical connections would also be performed by Westar Energy.

The secondary voltage of the transformers would be 480Y/277 Volts with a full load rating of 4,510 Amps, each. This would allow the entire load of the Docking State Office Building to be supplied by just one of the transformers, providing total redundancy. To carry the 4,510 full load amps, weatherproof bus duct would be required, rated for a minimum of 5,000 Amps.

With the transformers placed in the existing areaway, the primary conductors would be routed overhead to the transformers from the new ductbank. The secondary weatherproof bus duct would be routed overhead, into the basement level to the new 480 Volt switchgear. The new gear would be located in the subbasement level where existing chillers are proposed to be removed as part of a chiller renovation project. The switchgear would be enclosed in a 2-hour enclosure with two exits.

The new switchgear would be rated for 5,000 Amps at 480Y/277 Volts. This gear, placed on a housekeeping pad, would consist of metering cabinets on each end to allow for Westar Energy's use. Next to the metering cabinets would be the main, 5,000 Amp switch, one for each of the feeds from the pad mounted transformers. One would be identified Circuit #9 and one Circuit #10. The main switch on each end would then feed distribution panels, rated at 5,000 Amps. In the middle of the new switchgear would be an automatic tie-breaker. This tie-breaker would allow for the automatic connection of the two halves of the switchgear, to allow it to be fed from either of the two feeder

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circuits. The existing switchgear is presently connected to Circuit #10 (preferred source). With the new switchgear, both of the circuits from Westar Energy would be energized to allow for heating of the pad mounted transformers and thereby preventing condensation in the transformer.

Upon the loss of one of the feeder circuits, the switchgear would open the lost feeder circuit and automatically close the tie-breaker switch to allow for the entire switchgear to be fed from the remaining feeder circuit. Upon restoration of service to the affected feeder circuit, a manual or automatic retransfer shall occur to separate the two halves of the switchgear and the restored feeder circuit reconnected to half of the switchgear.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, both located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 6.

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5. REVIEW OF OPTIONS

5.1 Option 1

Replace existing switchgear with new, exterior pad mounted transformers on the north side of the building and new 480 volt switchgear in basement.

Refer to Site Plan, in Appendix C, for a proposed location for the pad mounted transformers. The ductbank would be installed from a new manhole installed at an intersecting location with the existing ductbank on the south side of 9th Street. The transformers would need to be placed on approximately 10-foot square concrete pads, for support. The primary conductors will be routed underground from the existing Westar Energy manhole at the northeast corner of 9th and Harrison.

On the secondary of the transformers, the use of conduit and wiring to route the 5,000 Amps, at 480 Volts, is not a viable option. Please refer to the Appendix D for calculations for a 44 duct underground ductbank. The mutual heating from adjacent conduits greatly limits the current carrying capacity of the ductbank conductors. Therefore, the only viable option is the use of 5,000 Amp weatherproof bus duct. The bus duct would need to be routed overhead as the bus duct cannot be installed underground. From the secondary of each transformer the bus duct would be routed on a support structure to allow the bus duct to get to the outside wall of the north end of the building. The bus duct would be routed vertically, on the north end of the building, down into a new small vault area that extends below the ceiling of the basement level. The bus duct would enter the basement exterior wall through a new small vault to prevent burial in earth.

The existing auditorium in the basement is too small for the installation of the new electrical gear. The existing interior wall would need to be removed and a new wall, another column line west, would need to be constructed. Per the National Electrical Code (NEC) two emergency exits are required from this room. Some modifications may need to be made at the corridor door to allow for an outward swinging door into the

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hallway. A second exit door could be installed either at the west end of the new room or into the room to the south.

The new transformers and overhead weatherproof bus duct will be exposed on the north side of the building which may not be an ascetically pleasing view from the Capitol.

5.2 Option 2

Replace existing switchgear with new, exterior mounted substation transformers on the south side of the building in the existing areaway and new 480 volt switchgear in basement.

Refer to Site Plan, in Appendix C, for a proposed location for the outdoor mounted transformers. The new ductbank will be routed from a new manhole installed at an intersection location with the existing ductbank, located in the eastbound lane of 9th Street. From this location, a ductbank would be routed on the west side of Harrison Street, to the south end of the building. Here the ductbank would travel west to the existing areaway where cooling towers were originally housed. The primary conductors will be routed underground from the existing Westar Energy manhole at the northeast corner of 9th and Harrison to the south areaway.

There is a large amount of ductbank to be installed to get the underground electrical service to this location. Along Topeka Boulevard there is an existing 12.5kV overhead electrical line. The disadvantages to utilizing this circuit to supply power to the building are two fold. The first is that the line is overhead and is susceptible to squirrels, trees, and lightning strikes. The second is that there is only one circuit thereby not allow for a redundant feed.

Placing the transformers in the existing areaway allows for the transformers to be placed outside of the building, yet placing them in an area that is not visible at grade level. The heat from the transformers is kept out of the building so the building cooling load would be less than the existing.

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Routing of the 5,000 Amp overhead weatherproof bus duct from the transformers into the building can also be contained below grade level. All supports are below grade and the exterior wall penetrations are below grade, but not underground.

The placement of the 480 Volt switchgear on the south end of the building puts the electrical gear closer to the larger loads, thereby eliminating the need to route 2,000 Amp bus duct from the north end of the building to the large electrical loads on the south end of the building.

5.3 Option 3

Construct new Westar Energy Ductbank along the east side of Harrison Street to the intersection of 10th Street.

The existing underground electrical network, around the Capitol complex, does not currently extend south to the 10th and Harrison intersection. As an option to installing a three (3) 6-inch conduit ductbank along the west side of Harrison from 9th to 10th, another possible option is have Westar Energy install a ductbank meeting their requirements, along the east side of Harrison, extending the existing underground network. This will allow for future load expansion to the east of this location.

With this option, a larger ductbank, than what is required to feed the new building transformers located in the south areaway, will be required to be built.

5.4 Option 4

Replace existing switchgear with new double-ended switchgear in basement at north end of building, including transformers.

As indicated in Option 1, the new switchgear could be installed in the area of the existing auditorium. This option, however, adds the new 13.2kV to 480/277 Volt transformers to this line-up. This allows the ductbank to be built along the north side of the Docking State Office Building and the ductbank would enter the building below grade, thereby not being visible and somewhat unsightly.

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The transformers would add heat to this area and the need for cooling/ventilation would need to be addressed.

The biggest concern is being able to place the transformers in the basement room. The transformers are approximately 5-feet wide and 8-feet long. This becomes a problem to navigate the transformer through the building. The transformer is 102-inches tall and would require the removal of lighting fixtures, smoke detectors, and the opening of several doorways to allow for passage. Additionally, each transformer weighs approximately 10 tons. The existing floor design of the basement hallway will not support this great of a load without shoring up the floor from below. Photograph 10 shows one of the doorways that would need to be opened to make room for the transformers. Additionally, the existing lighting fixture, exit sign, and fire alarm annunciator would need to be removed to allow for passage of the 102-inch tall transformer.



Photograph 10: North-South Hallway,
Basement Level, Looking North

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5.5 Option 5

Provide new transformers in new vault at north end of building.

To help conceal the new transformers, a new vault would be constructed, outside of the basement wall, to allow for the placement of the transformers. A new ductbank would be routed to the new vault and then new weatherproof bus duct would be routed between the vault and the electrical switchgear, located in the basement. With the new vault, the transformers would be placed below grade and not visible from street level. Also, the weatherproof bus duct would be routed below grade out of sight.

5.6 Option 6

Replace existing switchgear with new, exterior mounted substation transformers on the southeast side of the building in the existing areaway and new 480 volt switchgear in basement.

Refer to Site Plan, in Appendix C, for a proposed location for the outdoor mounted substation transformers. The new ductbank will be routed from a new manhole installed at an intersection location with the existing ductbank, located in the eastbound lane of 9th Street. From this location, a ductbank would be routed on the west side of Harrison Street, to the southeast corner of the building. Here the ductbank would travel west to the existing areaway where cooling towers were originally housed. The primary conductors will be routed underground from the existing Westar Energy manhole at the northeast corner of 9th and Harrison to the southeast areaway.

As described in Option 2, there is a large amount of ductbank to be installed to get the underground electrical service to this location. Along Topeka Boulevard there is an existing 12.5kV overhead electrical line. The disadvantages to utilizing this circuit to supply power to the building are two fold. The first is that the line is overhead and is susceptible to squirrels, trees, and lightning strikes. The second is that there is only one circuit thereby not allow for a redundant feed.

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Placing the transformers in the existing areaway allows for the transformers to be placed outside of the building, yet placing them in an area that is not visible at grade level. The heat from the transformers is kept out of the building so the building cooling load would be less than the existing.

Routing of the 5,000 Amp overhead weatherproof bus duct from the transformers into the building can also be contained below grade level. All supports are below grade and the exterior wall penetrations are below grade, but not underground.

The placement of the 480 Volt switchgear on the south end of the building puts the electrical gear closer to the larger loads, thereby eliminating the need to route 2,000 Amp bus duct from the north end of the building to the large electrical loads on the south end of the building. It also eliminate the need to disturb ceilings from the north end of the building to south of the elevator lobby.

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6. PROJECT APPROACH

Upgrading of the existing electrical system while the building is occupied will require careful planning and execution. The existing electrical system will need to remain energized until all of the existing electrical building loads are transferred to the new electrical distribution system. The first step will be to place the new transformers and switchgear in place. With any of the investigated options, a new electrical room is required. A new switchgear room will allow for the new switchgear to be placed and new distribution bus duct and cable to be routed and readied for connection to the existing motor control centers and new step-down transformers and distribution panels with minimal utility interruptions.

The existing 480 Volt motor control center (MCC) will be modified to remove the existing step-down transformer and connect to the existing MCC bus. The existing 120/208 Volt MCC will have a new 1,500 kVA transformer installed to convert from 480 Volt to 120/208 Volt.

The new vertical bus ducts will be routed vertically through the building. Once installed each existing power station consisting of a step-down transformer and distribution panel will be replaced with new transformers and electrical distribution panels. Existing loads will be transferred to the new panels after hours to limit disruption in the building.

Once all of the existing building loads have been transferred to the new electrical distribution system, the existing 15 kV switchgear, cable runs, and vertical bus will be removed.

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7. SUSTAINABILITY

H. W. Lochner, Inc. is committed to designing projects with sustainability in mind. This project will have salvageable materials, such as copper bus and wiring and metal enclosures that will be removed from the building as part of the demolition work. The new equipment, consisting of metal enclosures, copper bus duct, copper wiring, copper wound transformers, and new concrete, are all recyclable materials that, once they have served their useful life, can be removed and recycled for reuse. The need to keep the building operational does not allow for the existing material to be reused in the new electrical construction.

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8. ESTIMATED CONSTRUCTION COSTS

The costs for each option were assembled to provide a basic order of magnitude. A 30% contingency has been added to each option to cover any unforeseen construction expenses that will only become known during the design portion of the project. The source of the costs varies from Westar Energy, Square D Schneider Electric, to RSMeans Electrical Cost Data 2011. Backup information is available in the Appendix H for the demolition and construction portion of the project. The estimates below also include costs for design and construction administration, estimated at 10% of total construction costs.

Option 1 - \$6,400,000

Option 2 - \$7,150,000

Option 3 - \$8,000,000

Option 4 - \$7,100,000

Option 5 - \$6,400,000

Option 6 - \$7,050,000

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9. CONCLUSION

9.1 Summary

Several options were identified and investigated to determine a general approach and basic order of magnitude cost for the electrical upgrade. The age of the existing equipment along with the potential operational hazards of routing metal enclosed, open copper bussing, through the building and vertically through the floors without firestopping at each floor, antiquated equipment, and limited replacement part necessitates the upgrade of the electrical distribution system with new, state-of-the-art equipment.

Refer to Appendix E for a Proposed Line-up of the new electrical distribution system. The placement of the transformers varies depending upon the option presented, but the basic system layout is represented.

The placing of pad mounted transformers on the front lawn (north side) of the building, along with overhead 5,000 Amp weatherproof bus duct makes for an unappealing visual arrangement. However, install a new electrical vault on the north end of the building will allow an accessible location for the new substation transformers and the ability to conceal them from grade level view. Access into the basement level is simplified and reduces the length of 5,000 Amp weatherproof bus duct required to be routed from the transformer secondaries to the 480 Volt switchgear.

Installing new 3,750 kVA, 13.2kV to 480/277 Volt transformers with main-tie-main 480 Volt switchgear in the new electrical room in the basement allows for a confined electrical distribution system arrangement. However, physically installing the new transformers, with a weight of nearly 10 tons provides a structural obstacle as well as the physical dimensions of a 5-foot x 8-foot footprint, with a 102-inch overall height provides a maneuverability obstacle to bringing the transformers in the overhead door near the dock and then transporting down the hallways to the north end of the basement. At least three (3) hallway doorways will need to be modified to slip the transformer in the

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building and structural bracing will be required to roll the transformers on the basement floor.

Installing the new 3,750 kVA transformers in the south areaway, which previously housed cooling towers, or the southeast areaway, which currently is housing cooling towers, allows for placement by crane from an exterior location. The transformers, while still outside of the building, are concealed below the grate cover from view. The new 480 Volt switchgear can be installed in a new electrical room in the south end of the building, closer to the larger electrical loads (CCM1 and CCM2) thereby reducing the required length, and cost, of 2,000 Amp, 480 Volt bus duct. In order to install the new switchgear in the sub-basement level, the proposed chiller renovation project, that will remove the cooling towers from the southeast areaway and the chillers from the sub-basement level of the building, will need to be completed prior to start of electrical upgrade.

If the transformers and new switchgear are located in the south or southeast areaways, Westar has expressed the desire to extend their existing ductbank system to the corner of the 10th and Harrison. From this point, a new ductbank would be extended to the south areaway. This approach varies from Option 2 in the fact that the north-south ductbank will be built by Westar to Westar standards on the east side of the Harrison and the state would only build the ductbank from the 10th Street and Harrison Street intersection manhole, to the west. The state would not need to build the ductbank on the west side of Harrison Street. This approach allows the utility to extend its underground network and the new transformers can be hidden from sight. This also keeps the electrical and mechanical equipment in the utility part of the building and frees up space for storage, meeting, or office space.

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APPENDIX A: CAPITAL ELECTRIC REPORT

December 22, 2010

Kansas Department of Administration
900 WS Jackson Street, Suite 600
Topeka, KS 66612

Attn: George Werth

Subject: Summary of work performed on electrical distribution system in the Docking Building.

Dear Mr. Werth:

Capital Electric Construction was contracted to perform maintenance and cleaning of the 13.2kV electrical distribution system in the Docking Building. The work was started on Wednesday, November 24 and completed on Saturday, November 27. This report summarizes our findings.

To perform our work, power to the Docking building was turned off and maintenance to the Main Electrical gear and bus riser took place. During this maintenance, several medium voltage (M.V.) switches were cleaned and repaired along with the main riser bus that runs the length and height of the building. The protective metal covers on the bus were removed where assessable and the electrical bus was visually inspected and cleaned. Included with this report are several photos of different items of concern that need varying degrees of attention.

Below is a list of our concerns:

1. Nameplates on the equipment indicate that the gear was manufactured/installed in the mid 1950's. This makes this equipment between 50 and 60 years old. It is generally expected that electrical gear has a life expectancy of 15-30 years. Many factors affect the life expectancy, including ambient temperature, environmental conditions, electrical load (and the characteristics of the load) on the equipment, maintenance, and other factors. Assuming all of these factors have been ideal, the gear would still be considered to have out-lived its normal life expectancy.
2. Many of the sections of the bus are inaccessible. This means that these sections have never been cleaned or maintained. Routine maintenance is not possible on these sections. There was an extreme amount of dust/dirt accumulation in all areas of the system. We were able to clean many of the areas, but these particular areas could not be accessed, so they remain with over 50 years of dirt accumulation. The presence of the dust/dirt and in some areas oil and moisture

could lead to tracking (unwanted current flow from phase to phase or phase to ground). The result of this could potentially be severe damage to the equipment and building, and also potential safety risk to people in the building. An electrical outage affecting the entire building could also result.

3. The age of the electrical equipment is such that replacement parts are unavailable or difficult to find. Repairs may require custom fabrication, which could require extensive engineering or re-engineering.
4. The gear is 13.2kV. Any maintenance or repairs requires special equipment, tools, and training.
5. The gear is very open in design and allows air flow into the bus duct thru the M.V. switches. With these transformer housings being in the air handler rooms and the elevator exhaust ports feeding into these rooms the accumulation is much more than normal. The bus is covered and has taped joints but those tape joints are showing some tracking and age. To re-tape these joints would extend the life of the bus but would be very labor intensive and require a very lengthy outage to do so.
6. Transformer TRN-0015 has bus that is wrapped in 20,000v electrical blanket and extremely close to the access points of the transformer housing. It is possible that during the removal of the transformer housing covers that the bus could become exposed and cause significant hazards to the personnel working on the gear. Due to the nature of these pieces of electrical gear every precaution should be taken to protect any personnel inspecting these items. A detailed safety agenda should be followed and all personnel should adhere to any and all PPE requirements of NFPA 70e. An arc flash incident is highly possible with gear of this nature if the proper precautions are not followed extensively. The consequences of an arc flash in this gear and in these confined locations would be very severe and would likely result in death to the personnel working on the gear. It is highly recommended that only qualified and trained personnel have access to this gear for maintenance purposes.
7. As mentioned above the M.V. switches are open into the bus area. These had varying degrees of dust and dirt accumulation as well. These however can be de-energized and maintenance performed on a regular basis to extend their life span. While energized a visual inspection of these switches and of the transformers would be recommended along with an IR scan on a routine maintenance schedule. With the exception of one transformer this is recommended.
8. An arc flash study is recommended for this and all electrical gear in the Docking building. This would include the proper labeling of the arc hazard and calorie requirements onto all electrical doors.
9. It was also observed during the maintenance that some of the fuses were not seated properly and that the switches were not engaging fully. The only reason this had not been an issue was due to the amount of load on these switches. If these had additional load on them when not fully seated it would result in arcing and heating issues.
10. It was noted on the first and basement floors that the wires feeding off the load side of the switches have corrosion developing at the insulators holding them in place. These were cleaned and re-taped but this is not a permanent fix and

these should be replaced in the near future before the insulation breaks down to the point of failure.

11. Mechanical mechanisms in some of the MV switches have failed. These are a safety mechanism that keeps the door of the enclosure closed when the switch is in the energized state. Because these could not be repaired, we were forced to install padlocks on the doors as the only means of safety. Signage should be installed on these switches to alert personnel of the danger.

SUMMARY

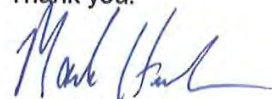
We believe the electrical distribution system in the Docking Building is nearing the failure point, and we recommend a complete replacement of the system.

- Insulation in the system is deteriorating and may fail.
- The equipment is obsolete and replacement parts are not available.
- Safety mechanisms are failing.

I have attached the Emerson Test Report for the switches and equipment that were tested during the project. Their report includes additional recommendations.

Please contact me if there are any questions or additional information is required.

Thank you.



Mark Hurshman
Capital Electric



Electrical Reliability Services, Inc.
Kansas City Area Office

348 N.W. Capital Drive
Lee's Summit, MO 64086
T (816) 525-7156
F (816) 524-3274

December 6, 2010

Capital Electric
P.O. Box 410079
Kansas City, MO 64141

Attention: Mr. Mark Hurshman

Subject: Electrical Equipment Maintenance Test Report
Reference No. 3126895

Dear Mr. Hurshman:

Enclosed is the subject test report as prepared by our lead field engineer. It was our pleasure to be of service to you on this project. If you have any questions, or if we can be of further assistance, please do not hesitate to call.

Sincerely,

Electrical Reliability Services, Inc

A handwritten signature in blue ink, appearing to read "Bob Ross".

Bob Ross
Service Center Manager

Enclosures



Electrical Reliability Services, Inc.
Kansas City Area Office

348 N.W. Capital Drive
Lee's Summit, MO 64086
T (816) 525-7156
F (816) 524-3274

**Electrical Equipment Maintenance
Test Report**

At

**DOCKING STATE OFFICE BLDG
Topeka, KS**

for

Capital Electric
P.O.Box 410079
Kansas City, MO 64141

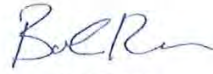
Attention: Mr. Mark Hurshman
Order No: PO#196031, JOB#56763

Reference No. 3126895

Submitted By: David Duncan
Field Engineer

December 6, 2010

Reviewed By:


Bob Ross
Service Center Manager

1 PURPOSE

- 1.1 The equipment and components listed in Section 3.0 of this report have been inspected and tested to help assure their proper and safe operation. Defective or marginal equipment can be identified, repaired, replaced or scheduled for future repairs without costly or unexpected interruptions during normal operating periods.
- 1.2 The test results are particularly valuable when kept for comparison with past and future maintenance test results. This historic database enables one to predict the probability of equipment failure and thus schedule facility production and financial budgets to accommodate preventive maintenance or repair rather than breakdown maintenance.

2 SUMMARY

- 2.1 This project was initiated by Mr. Mark Hurshman with Capital Electric. All testing was performed by Electrical Reliability Services Field Engineers David Duncan and Charles Howell on Saturday, November 27, 2010.
- 2.2 Please refer to Section 5 "Results and Recommendations" for complete details of the testing.

3 EQUIPMENT TESTED AND INSPECTED

- 3.1 **Three (3)** medium voltages disconnect switches, S&C, SM-5, and 400 Amp.
- 3.2 **Seventeen (17)** medium voltages disconnect switches, electrical engineering equipment co, S.O. # 50542, 300 Amp.

4 PROCEDURES

4.1 Medium Voltage Air Switches

4.1.1 Visual and Mechanical Inspection

- .1 Compared equipment nameplate data with drawings and specifications.
- .2 Inspected for physical damage, proper installation, required area clearances, anchorage and grounding. Cleaned interior, insulators, arc chutes and interphase barriers.
- .3 Performed mechanical operator tests in accordance with manufacturer's instructions. Cleaned and lubricated contacts and mechanism as applicable. Confirmed correct application of manufacturer's recommended lubricants.
- .4 Checked contact alignment, wipe and pressure.
- .5 Inspected for correct phase barrier materials and installation.
- .6 Checked fuse linkage and element for proper holder and current rating. Recorded fuse data.
- .7 Verified tightness of accessible bolted electrical connections by calibrated torque-wrench method.
- .8 Verified that fuse sizes and types were in accordance with drawings and power system studies.
- .9 Inspected all indicating and control devices for correct operation.
- .10 Tested all interlocking systems for correct operation and sequencing. Checked key interlock for proper operation and proper key distribution.
- .11 Verified arc interrupter operation.

4.1.2 Electrical Tests

- .1 Performed contact resistance test across each switch blade and fuse link.
- .2 Measured fuse resistance.
- .3 Performed insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute.

5 RESULTS AND RECOMMENDATIONS

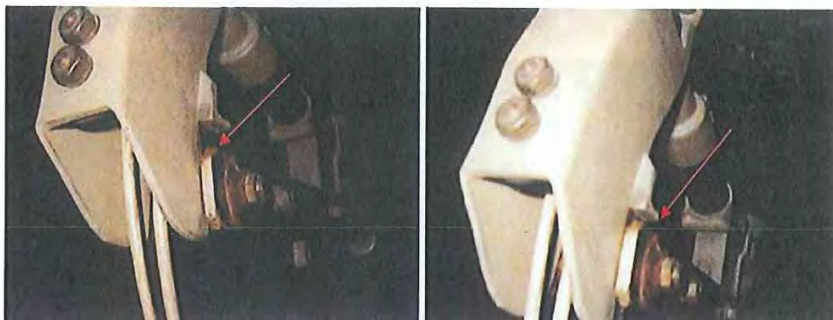
- 5.1 The following is a list of problems discovered during this testing project along with any corrective action that was made by Electrical Reliability Services. Those corrections beyond the scope of the project that require your additional corrective action are in bolded text.

5.1.1 If the equipment tested in Section 3 is not discussed in this section, the results of the tests indicate the equipment to be satisfactory.

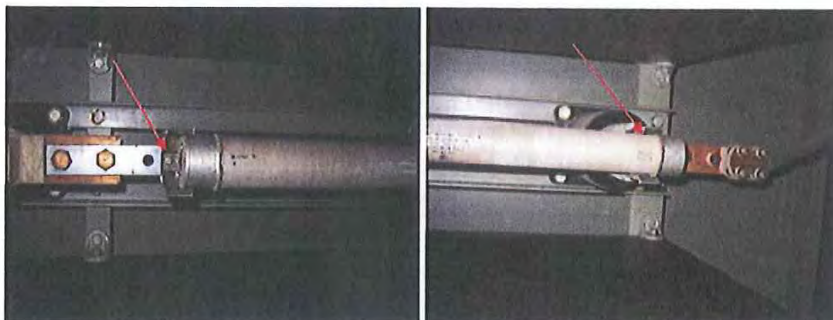
- 5.2 Feeder #10 - A phase contact resistance was found to be higher than the other two phases and was outside of NETA contact resistance tolerances. This could cause contact heating of the other two phases, deterioration, and eventual failure of the switch. This problem was corrected at time of testing by ERS personnel. No further action required at this time.
- 5.3 Feeders 9 & 10 automatic transfer operator could not be tested because of customer restrictions. Because of the age, condition, and unavailability of repair parts the customer did not want the transfer mechanism operated. The customer is aware of the deficiencies with the ATS System and is attempting to have it repaired or replaced.
- **It is recommended that the ATS System should be tested once repairs have been made. Electrical Reliability Services would be pleased offer this service.**
- 5.4 Riser #7 B phase contact resistance was found to be higher than the other two phases and was outside of NETA contact resistance tolerances. This could cause contact heating of the other two phases, deterioration, and eventual failure of the switch. This problem was corrected at time of testing. No further action required at this time.

- 5.5 During the outage for Capital Electric Inc. to perform low voltage retrofits, on down stream equipment, it was discovered that a large percentage of the transformer disconnects were not closing fully. The cause of the problems was found to be the mechanical door interlocks which are bent out of shape. State of Kansas personnel directed Electrical Reliability Services personnel to remove the interlocking mechanism and State of Kansas personnel would install locks and signs to adjust for the safety issues.
- 5.6 During the inspection of Medium Voltage Air Switch LUCS 18, on the (14th) floor it was discovered that the moving contacts were not fully engaging the stationary contact. This could cause contact heating, deterioration, and eventual failure of the switch. Electrical Reliability Services personnel corrected this condition. This same condition was found at the following locations:
- LUCS 17, on the (14th) floor
 - LUCS 16, on the (12th) floor
 - LUCS 15, on the (11th) floor
 - LUCS 14, on the (10th) floor
 - LUCS 9, on the (9th) floor
 - LUCS 10, on the (8th) floor
 - LUCS 11, on the (7th) floor
 - LUCS 12, on the (6th) floor
 - LUCS 13, on the (5th) floor
 - LUCS 5, on the (3rd) floor

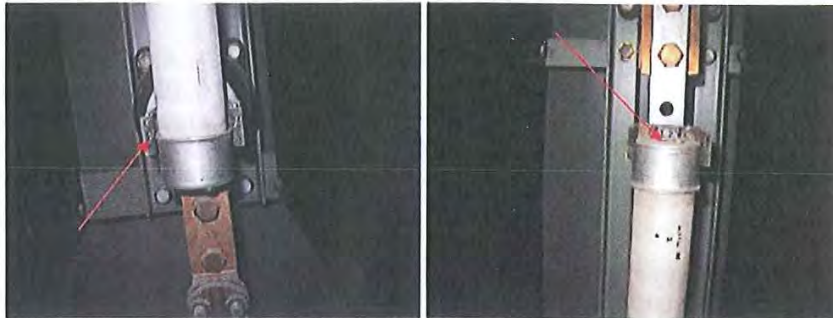
The pictures below are examples of this condition. The left picture is the before adjustment picture and the right picture is after corrections were made.



- It is recommended that all the switches be cleaned and tested. Electrical Reliability Services would be please to provide this service.
- 5.7 LUCS 5, on the (3rd) floor was found with the B phase fuse improperly inserted into the fuse clip. This could cause overheating, premature aging of the fuse and unscheduled outages. Capital Electric Personnel were to correct this problem before restoring service. The left picture is the line side of the fuse and the right picture is load side of the fuse.

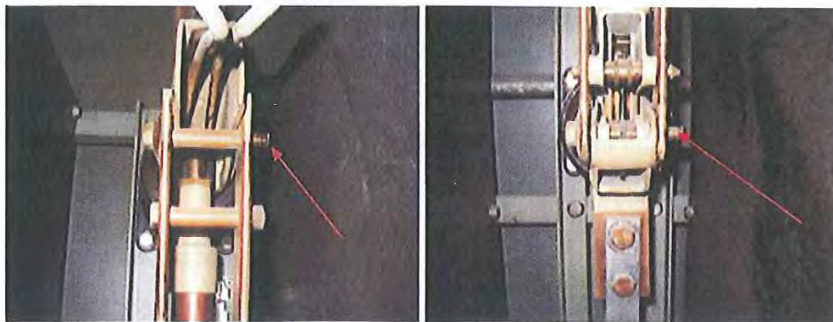


- 5.8 LUCS 5, on the (3rd) floor was found with the C phase fuse improperly inserted into the fuse clip. This could cause overheating, premature aging of the fuse and unscheduled outages. Capital Electric Personnel were to correct this problem before restoring service. The left picture is the load side of the fuse and the right picture is line side of the fuse.



- 5.9 LUCS 3, on the (1st) floor was found with the knife blades fully penetrating the stationary contacts. However the C phase knife switch was found to be missing a nut and cup washer on the line and load side of the switch. This could cause contact heating, deterioration, and eventual failure of the switch. This problem was corrected before restoring utility power by Capital Electric personnel. The left picture is the moving portion of the switch, and the right picture is the elbow or pivot part of the switch. No further mechanical action required at this time.

- It is suggested that a complete cleaning and maintenance test be performed at the next scheduled outage. Electrical Reliability Services would be pleased offer this service.



Ross, Bob [NETPWR/ERS/LEE']

Subject: FW: Docking M.V. switches

Importance: High

-----Original Message-----

From: White, Ben [mailto:bwhite@capitalelectric.com]

Sent: Friday, November 26, 2010 9:32 AM

To: Steele, George [FM]; Flowers, Clifford [FM]

Cc: Werth, George [FM]; Lour, Mike [FM]; Howell, Chuck [NETPWR/ERS/LEE']; Hurshman, Mark

Subject: RE: Docking M.V. switches

Importance: High

Gentlemen this is to document our earlier conversation today in which the door latches were discussed. As directed we will have Emerson Reliability Services remove the door latch mechanism from the throw rod so as to allow complete operation of the switches off the Bus Duct riser only. These components will be placed in the bottom of the cabinets for future needs if it is desired to repair and reattach these at a later date.

In cleaning these switches we noticed the knife blades not fully engaged. During further inspection it was noted that the latch rods have been bent during operation and are obstructing the switches from engaging fully and properly. These latch rods are part of the mechanism that holds the door shut while in the energized state. These will be removed off all these common disconnect switches on the Bus riser so no further issues arise in the event of operating these switches.

It is understood that you will have padlocks in place that only allow Authorized personnel access to these when the switch when they are in the closed position. In addition signage will be placed on all these disconnects to signify this modification and the hazards involved with opening these while energized. I would also suggest signage being added that signifies the proper PPE require to open these switches and the proper CAL requirement for Arc Flash.

Your response to this email will serve as our authorization to perform this work.

Thanks,
Ben White
Capital Electric Construction Company
Service Division
816-215-6691 (cell)

From: Steele, George [FM] [mailto:George.Steele@da.ks.gov]

Sent: Thu 11/25/2010 4:50 PM

To: White, Ben; Hurshman, Mark; Flowers, Clifford [FM]

Cc: Werth, George [FM]; Lour, Mike [FM]

Subject: RE: Docking M.V. switches

We agree with having Emerson look at, repair and modify all switches off the Buss Duct on a Time and Material Basis.

George Steele
900 SW Jackson, Suite 600
Topeka, KS 66612
785-296-4693
Cell 785-215-5709

-----Original Message-----

From: White, Ben [mailto:bwhite@capitalelectric.com]
Sent: Thursday, November 25, 2010 4:17 PM
To: Steele, George [FM]; Hurshman, Mark; Flowers, Clifford [FM]
Subject: Docking M.V. switches

Gentlemen this is to confirm our earlier conversations today about the Switches that are not engaging as they should feeding the transformers on each floor off the Bus Duct run.

We will as discussed remove the safety latch that holds the doors closed while energized. It is understood that the padlock on the door handle will become the safety and labeling will be attached to the doors to identify the voltage hazard. As discussed this is being done so that it can be verified that the knife switches have engaged the switch fully.

Secondly we will have Emerson Reliability Services look at and repair or modify all the switches off the Bus Duct run we have been working on to verify the functionality of all the switches. They will make the necessary adjustments to the two switches in the penthouse.

All this work is on a T&M basis. Please respond to this email as our work authorization.

Thanks,
Ben White
Capital Electric Construction Company
Service Division
816-215-6691 (cell)

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895						
LOCATION: 915 SW HARRISON ST				ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS		FEEDER IDENTIFICATION: RISER NO # 7		TEST EQUIP. ASSET NO: 41-01045/1280		CALIBRATION DATE: 05/26/2010				
NAMEPLATE DATA										
MANUFACTURER: S & C		TYPE: N/A		STYLE/SERIAL NUMBER: CD28082		CURRENT RATING: 400				
						VOLTAGE RATING: 15K				
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4						SYSTEM VOLTAGE: 13.8 KV				
INSPECTION										
CHECK POINT		CONDITION	NOTES	CHECK POINT		CONDITION	NOTES			
PHYSICAL DAMAGE		A		CONTACT ALIGNMENT		A				
CLEANLINESS		C		CONTACT WIPE		A				
MECHANICAL OPERATOR		N/A	(1)	CONTACT PRESSURE		A				
MAIN CONTACTS		A		PHASE BARRIERS		A				
ARC CONTACTS		A		HARDWARE TIGHTNESS		A				
ARC CHUTES		N/A		FUSE HOLDERS		A				
ARC INTERRUPTER SEQUENCE		A		INTERLOCKS		A				
ELECTRICAL TESTS										
				A-PHASE		B-PHASE		C-PHASE		
CONTACT RESISTANCE IN MILLIOHMS				0.373/.112		0.832/.118		.184/139		
FUSE RESISTANCE IN MILLIOHMS				0.410		0.376		0.386		
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS		SWITCH CLOSED						SWITCH OPEN		
		A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
		2.953	3.045	3.099	(4)	(4)	(4)	7040	6150	6200
NOTE										
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED TO TESTIUNG PROCEDCURS										
NOTE 2:) "B" PHASE KNIFE SWITCH HAS HIGHER RESISTANCE THAN OTHER TWO PHASES. ERS CORRECTED WITH AJUSTMENT TO KNIFE SWITCH.										
NOTE 3:) CLOSED INSULATION TEST WERE DONE WITH BUSS RISER ATTACHED.										
NOTE 4:) CANNOT TEST DUE TO METERING EQUIPMNT CONNECTIONS IN PRIMARY CABINET OWNED BY UTILITY COMPANY.										
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE										

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895							
LOCATION: 915 SW HARRISON ST				ENGINEER: CH DD		DATE: 11/26/2010					
SWITCHGEAR DESIGNATION: MAIN ATS		FEEDER IDENTIFICATION: FEEDER # 09		TEST EQUIP. ASSET NO: 41-01045/1280		CALIBRATION DATE: 05/26/2010					
NAMEPLATE DATA											
MANUFACTURER: S & C		TYPE: N/A		STYLE/SERIAL NUMBER: CD28082		CURRENT RATING: 400					
						VOLTAGE RATING: 15K					
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4				SYSTEM VOLTAGE: 13.8 KV							
INSPECTION											
CHECK POINT		CONDITION	NOTES	CHECK POINT		CONDITION	NOTES				
PHYSICAL DAMAGE		A		CONTACT ALIGNMENT		A					
CLEANLINESS		C		CONTACT WIPE		A					
MECHANICAL OPERATOR		N/A	(1)	CONTACT PRESSURE		A					
MAIN CONTACTS		A		PHASE BARRIERS		A					
ARC CONTACTS		A		HARDWARE TIGHTNESS		A					
ARC CHUTES		N/A		FUSE HOLDERS		A					
ARC INTERRUPTER SEQUENCE		A		INTERLOCKS		A					
ELECTRICAL TESTS											
				A-PHASE		B-PHASE					
CONTACT RESISTANCE IN MILLIOHMS				0.135		0.122					
						0.101					
FUSE RESISTANCE IN MILLIOHMS				0.369		0.385					
						0.391					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS		SWITCH CLOSED						SWITCH OPEN			
		A-Gnd	B-Gnd	C-Gnd	A-B		B-C	C-A	A	B	C
		178.5	192.8	177.9	335.2		310.8	470	2779	2983	3181
NOTE											
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED FOR TESTING PROCEDURS											
NOTE 2:) CABLES & ARRESTORS WERE DISCONNECT FOR TESTING PURPOSES.											
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE											

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895						
LOCATION: 915 SW HARRISON ST				ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS		FEEDER IDENTIFICATION: FEEDER # 10		TEST EQUIP. ASSET NO: 41-01045/1280		CALIBRATION DATE: 05/26/2010				
NAMEPLATE DATA										
MANUFACTURER: S & C		TYPE: N/A		STYLE/SERIAL NUMBER: CD28082		CURRENT RATING: 400				
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4						VOLTAGE RATING: 15K				
SYSTEM VOLTAGE: 13.8 KV										
INSPECTION										
CHECK POINT		CONDITION	NOTES	CHECK POINT		CONDITION	NOTES			
PHYSICAL DAMAGE		A		CONTACT ALIGNMENT		A				
CLEANLINESS		C		CONTACT WIPE		A				
MECHANICAL OPERATOR		N/A	(1)	CONTACT PRESSURE		A				
MAIN CONTACTS		A		PHASE BARRIERS		A				
ARC CONTACTS		A		HARDWARE TIGHTNESS		A				
ARC CHUTES		N/A		FUSE HOLDERS		A				
ARC INTERRUPTER SEQUENCE		A		INTERLOCKS		A				
ELECTRICAL TESTS										
CONTACT RESISTANCE IN MILLIOHMS (2)		A-PHASE		B-PHASE		C-PHASE				
		0.584/.144		0.234/.123		0.232/.143				
FUSE RESISTANCE IN MILLIOHMS		0.338		0.339		0.346				
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS		SWITCH CLOSED						SWITCH OPEN		
		A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
		245.9	228.3	178.3	443	275	418	3381	3065	3265
NOTE										
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED FOR TESTING PROCEDURES										
NOTE 2:) "A" PHASE KNIFE SWITCH HAS HIGHER RESISTANCE THAN OTHER TWO PHASES. ERS CORRECTED WITH ADJUSTMENT TO KNIFE SWITCH.										
NOTE 3:) CABLES & ARRESTORS WERE DISCONNECT FOR TESTING PURPOSES.										
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE										



Electrical Reliability Services
Project Status Report / Work Authorization

CLIENT	CAPITAL ELECTRIC	JOB NO.	3126895	
PROJECT	915 SW HARRISON ST.	ENGINEER	CH/DD	DATE 11/26/2010

THIS DOCUMENT IS INTENDED TO PROVIDE PRELIMINARY INFORMATION AS TO THE STATUS OF THIS PROJECT. A FORMAL REPORT WILL BE SUBMITTED AT THE PROJECT COMPLETION.

- ☐ THE FOLLOWING ITEMS REQUIRE REPLACEMENT, REPAIR AND/OR ADJUSTMENT:
- ☐ THE FOLLOWING TESTS AND/OR INSPECTIONS ARE REQUIRED PRIOR TO PROJECT COMPLETION:
- ☒ THE FOLLOWING WORK IS AUTHORIZED:

VISUAL INSPECTION AND REMOVAL OF INTERLOCK ARM PER CUSTOMER REQUEST
(SEE E-MAIL) AS PER BEN WHITE ON FLOORS 1-14
OPEN MAIN SWITCHES IN BASEMENT FOR VISUAL INSPECTION BY CUSTOMER.

LCUS "18" 14TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE- PHOTOS
LCUS "17" 14TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "16" 12 FLOOR- REMOVAL OF INTERLOCK-PHOTOS
LCUS "15" 11TH FOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "14" 10TH FLOOR- REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "9" 9TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "10" 8TH FLOOR-REMOVAL OF INTERLOCK
LCUS "11" 7TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "12" 6TH FLOOR-REMOVAL OF INTERLOCK
LCUS "13" 5TH FLOOR REMOVAL OF INTERLOCK -PHOTOS
LCUS "8" 3TH FLOOR NO REMOVAL REQUIRED, SWITCH RETOR-FITED WITH NEW SW
LCUS "7" 3TH FLOOR REMOVAL OF INTERLOCK
LCUS "6" 3TH FLOOR REMOVAL OF INTERLOCK
LCUS "5" 2TH FLOOR REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
FUSE B&C ARE MISALIGNED IN HOLDER - SEE PHOTOS
LCUS "4" 2TH FLOOR REMOVAL OF INTERLOCK
LCUS "3" 1ST FLOOR REMOVAL OF INTERLOCK - C PHASE OF SWITCH IS MISSING
NUTS AND WASHERS ON PIVOT POINT & TENTION POINT - PHOTOS
LCUS "2" BASEMENT-REMOVAL OF INTERLOCK

CUSTOMER SIGNATURE	AUTHORIZATION NO.
N/A	SEE EMAIL

WHITE COPY - FILE

PINK COPY - CUSTOMER

PAGE 1 OF 1

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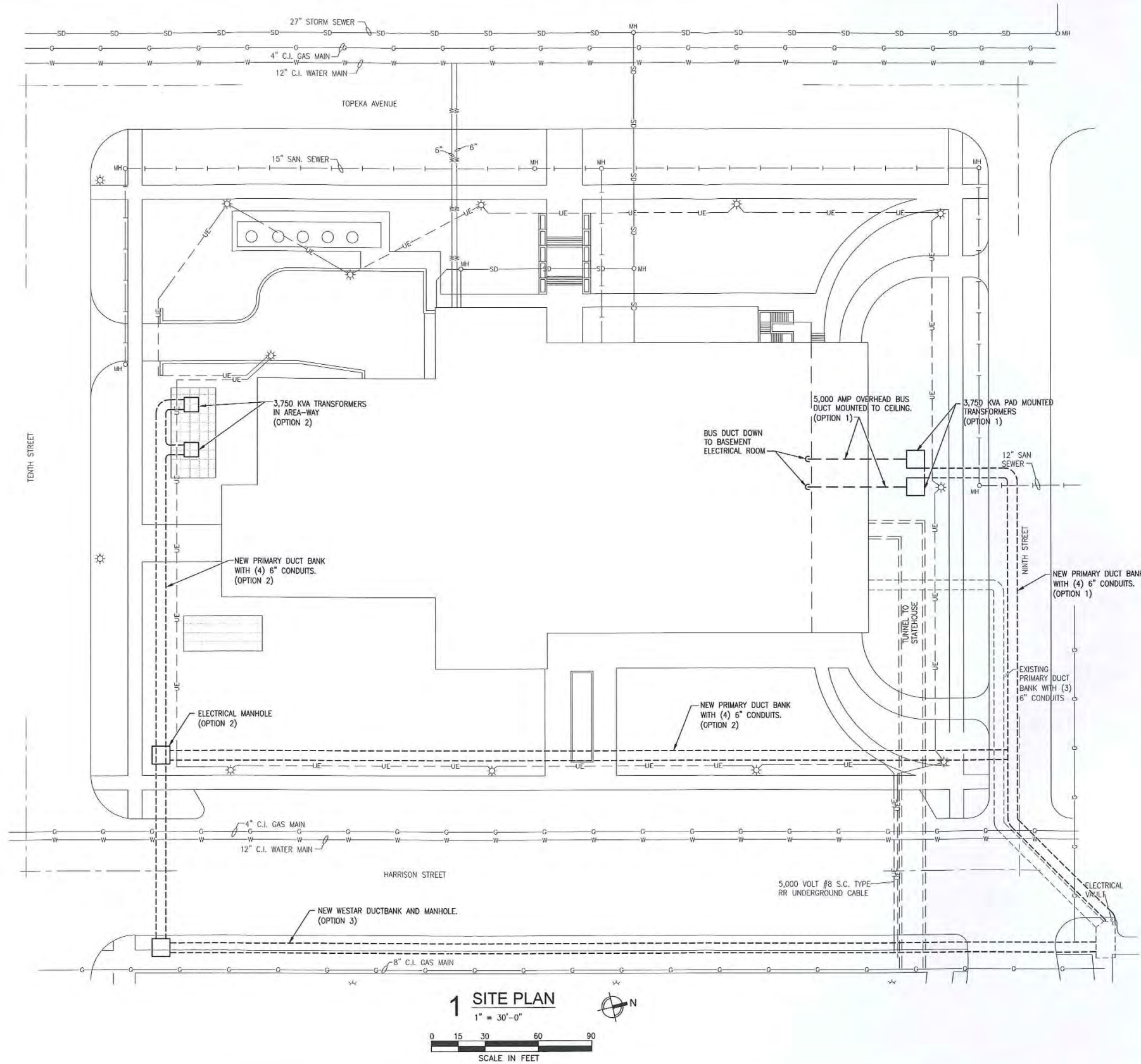
APPENDIX B: WESTAR ENERGY USAGE

Bill Constant: 8800
DOCKING STATE OFFC
915 SW HARRISON ST
TOPEKA KS

METER NUMBER : 2285030 RATE CODE: 345
BILL CONSTANT: 8800 REV CLASS: 3
MANUFACTURER : 28 RELATED : Y
IRREG USE CD : 3 PHASE : 3
MTR LOC : 52 BASEMENT S WALL

S	DATE	DAYS	USE	ACT DEM	PF%	ADJ DEM	BLG DEM
	11/24/10	30	774400		0.25	100	2200 2394
	10/25/10	31	880000		0.25	100	2200 2394
	09/24/10	30	1012000		0.31	100	2728 2728
	08/25/10	29	1100000		0.3	100	2640 2640
	07/27/10	32	1161600		0.3	100	2640 2640
	06/25/10	30	1082400		0.32	100	2816 2816
	05/26/10	29	888800		0.3	100	2640 2693
	04/27/10	29	880000		0.31	100	2728 2728
	03/29/10	31	853600		0.27	100	2376 2693
	02/26/10	29	809600		0.26	100	2288 2693
	01/28/10	30	853600		0.26	100	2288 2693
	12/29/09	35	932800		0.27	100	2376 2693
	11/24/09	32	915200		0.28	100	2464 2693
	10/23/09	29	915200		0.27	100	2376 2693
	09/24/09	30	1073600		0.33	100	2904 2904
	08/25/09	29	1179200		0.33	100	2904 2904
	07/27/09	32	1293600		0.33	100	2904 2904
	06/25/09	29	1135200		0.36	100	3168 3168
	05/27/09	30	1064800		0.31	100	2728 2728
	04/27/09	31	1003200		0.31	100	2728 2728
	03/27/09	29	968000		0.31	100	2728 2728
	02/26/09	29	959200		0.3	100	2640 2640
	01/28/09	30	968000		0.29	100	2552 2552
	12/29/08	35	1064800		0.28	100	2464 2468
	11/24/08	32	1073600		0.29	100	2552 2552
	10/23/08	29	1056000		0.29	100	2552 2552
	09/24/08	30	1152800		0.32	100	2816 2816
	08/25/08	31	1293600		0.33	100	2904 2904
	07/25/08	30	1284800		0.33	100	2904 2904
	06/25/08	29	1170400		0.32	100	2816 2816
	05/27/08	32	1161600		0.32	100	2816 2816
	04/25/08	29	1047200		0.3	100	2640 2768
	03/27/08	29	1020800		0.29	100	2552 2768
	02/27/08	29	976800		0.26	100	2288 2768
	01/29/08	32	1029600		0.28	100	2464 2768

APPENDIX C: SITE PLAN, FLOOR PLANS & ONE-LINE DIAGRAM



REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

LOCHNER
BWR Division
2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

Department of Administration
Division of Facilities Management
Landon State Office Building
900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

EXISTING
SITE PLAN

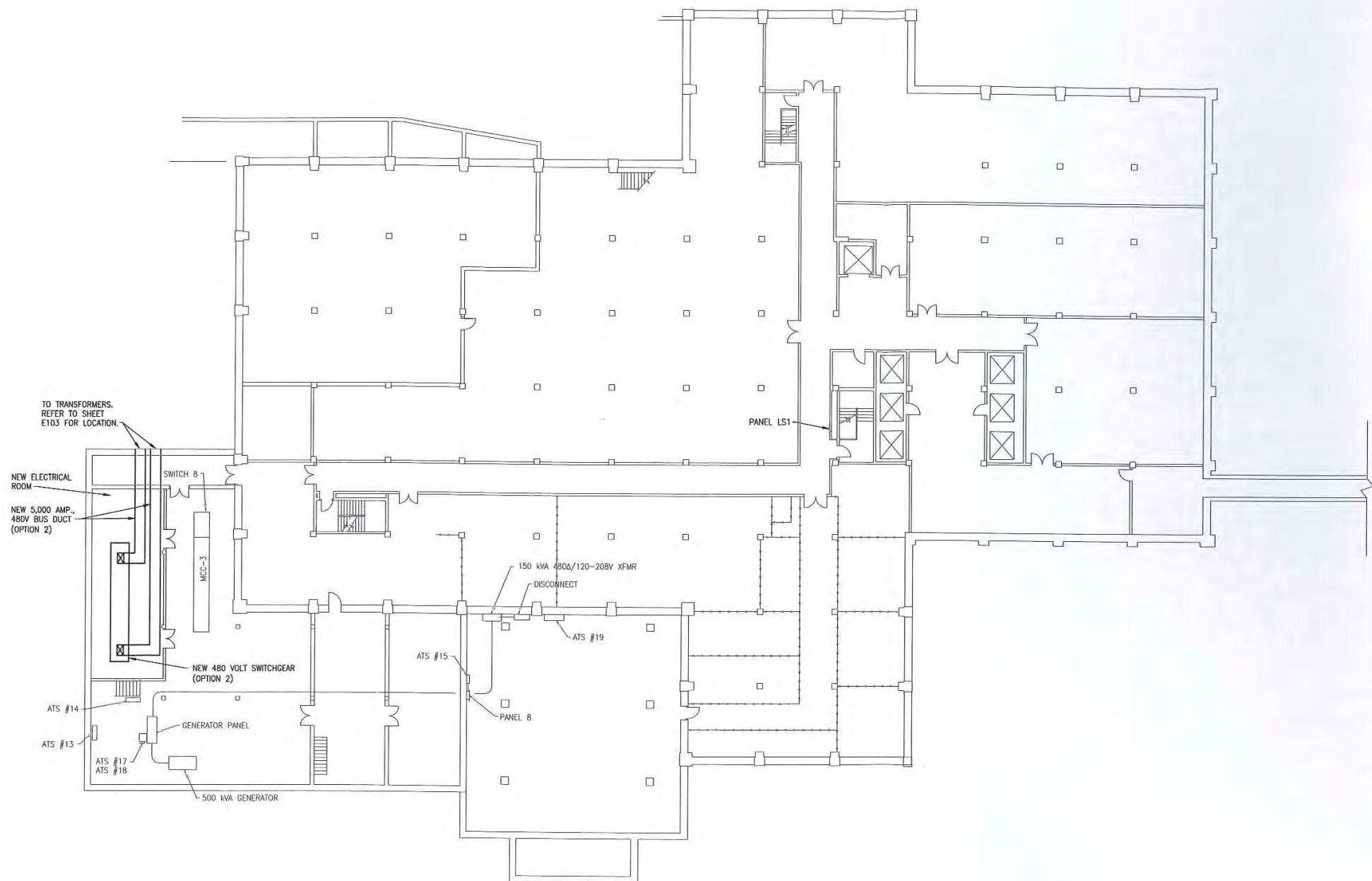
A-XXXXX

E-101

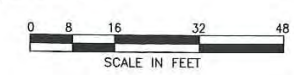
ELECTRICAL
STUDY

1 SITE PLAN
1" = 30'-0"
0 15 30 60 90
SCALE IN FEET





1 SUB-BASEMENT POWER PLAN
1/16" = 1'-0"



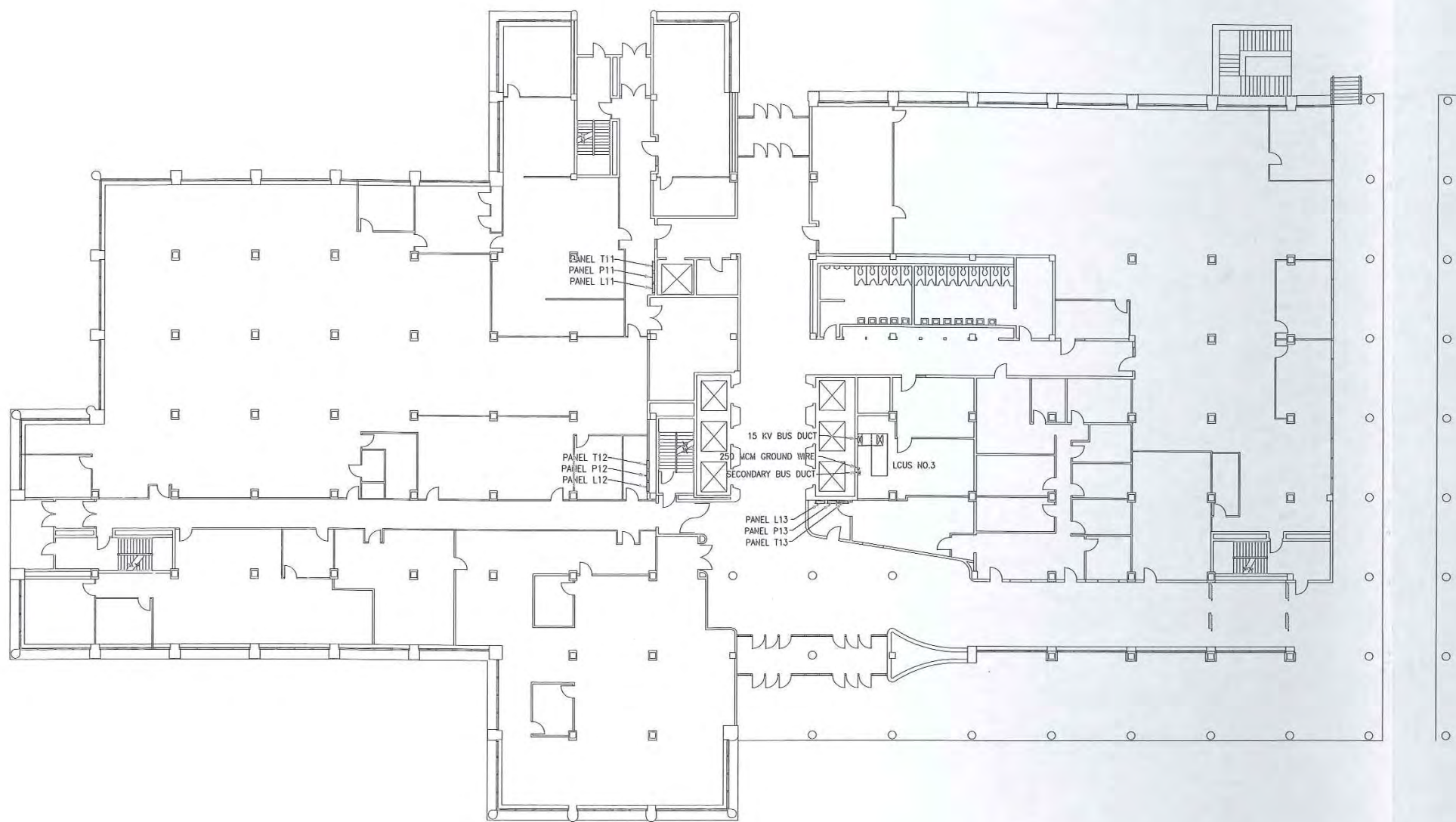
REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

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Department of Administration
Division of Facilities Management
Landon State Office Building
900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

SUB-BASEMENT
POWER PLAN
A-XXXXX
E-102
ELECTRICAL
STUDY



1 FIRST FLOOR POWER PLAN
1/16" = 1'-0"
0 8 16 32 48
SCALE IN FEET



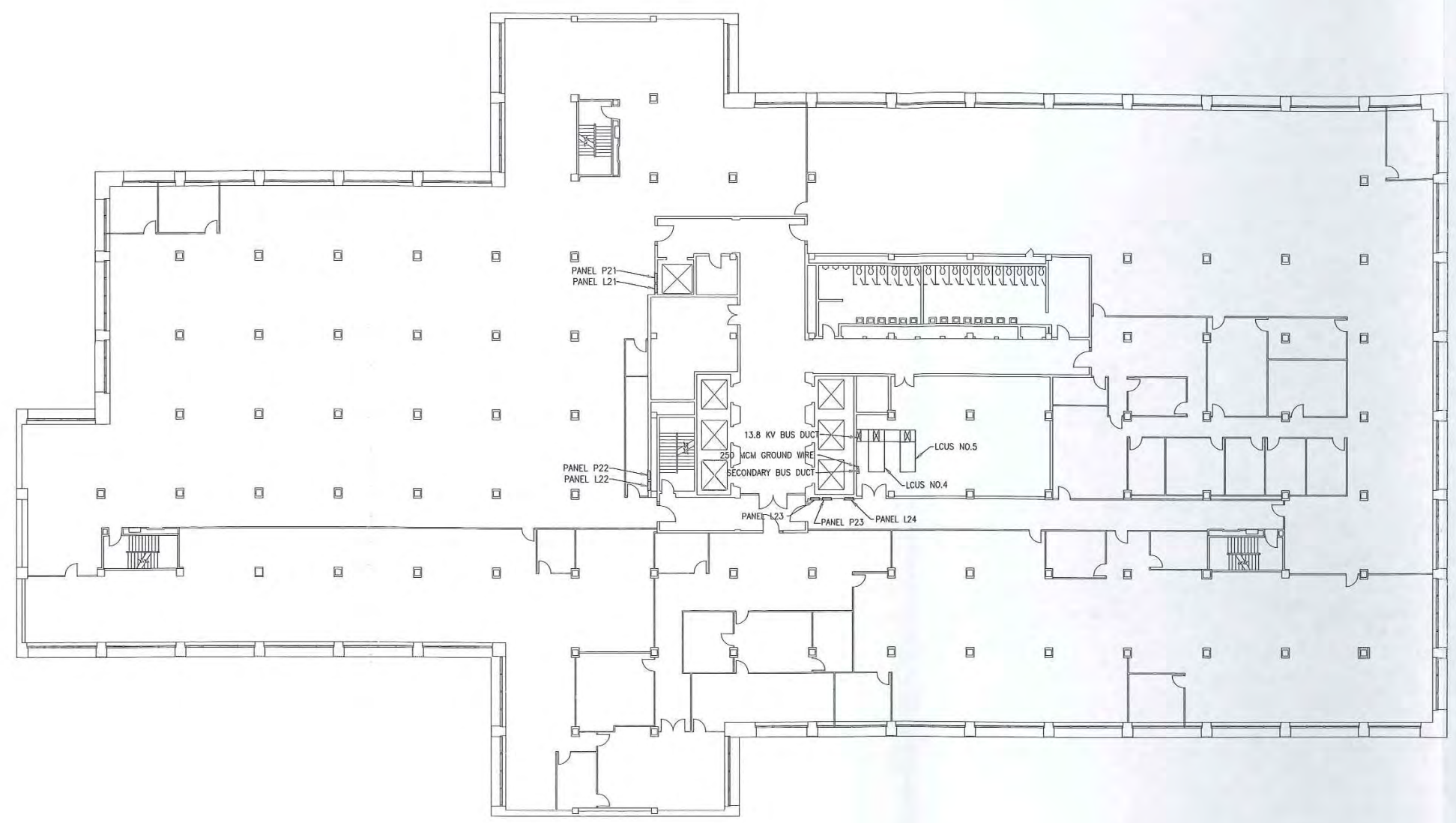
REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

LOCHNER
BWR Division
2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

Department of Administration
Division of Facilities Management
Landon State Office Building
900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

FIRST FLOOR
POWER PLAN
A-XXXXX
E-104
ELECTRICAL
STUDY



1 SECOND FLOOR POWER PLAN
 1/16" = 1'-0"
 0 8 16 32 48
 SCALE IN FEET

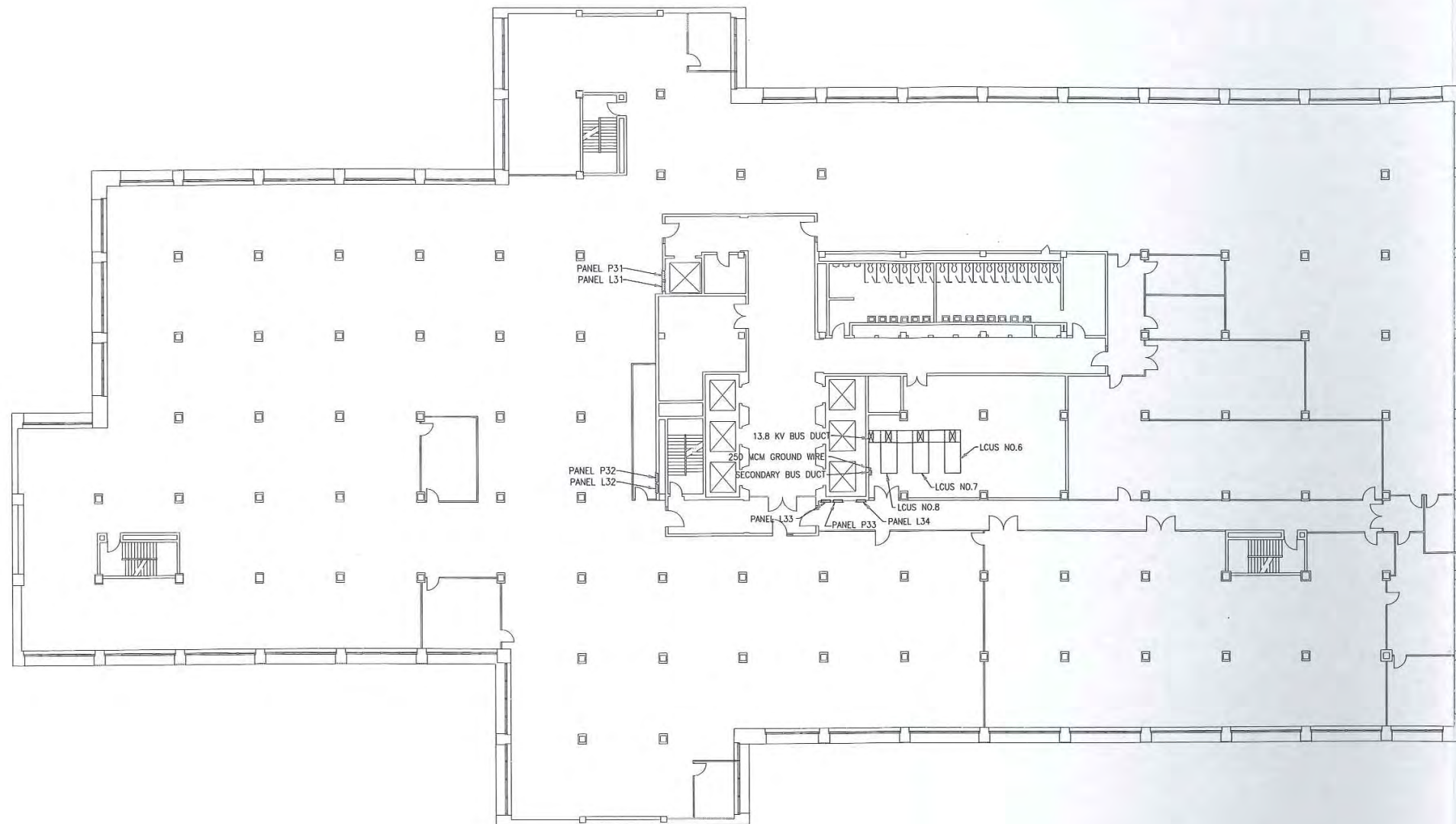
REVIEW SET
 NOT TO BE
 USED FOR
 BIDDING OR
 CONSTRUCTION

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 2335 E. Crawford Street | Salina, Kansas 67401-3713
 P 785.827.3603 | F 785.827.3029

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 Topeka, Kansas 66612-1220
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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
 TOPEKA, KANSAS
 DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

SECOND FLOOR
 POWER PLAN
 A-XXXXX
 E-105
 ELECTRICAL
 STUDY



1 THIRD FLOOR POWER PLAN
1/16" = 1'-0"



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CONSTRUCTION

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Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

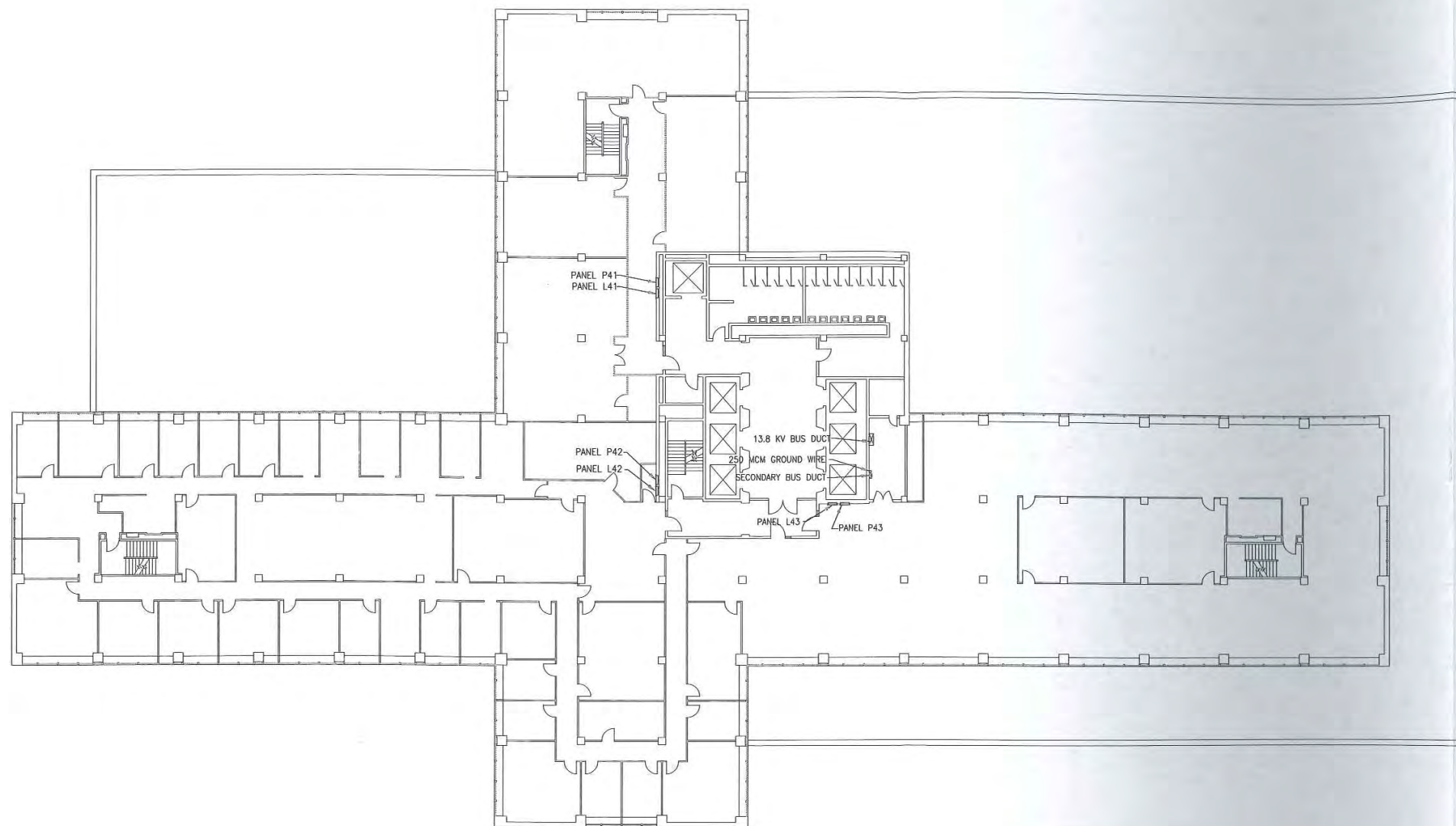
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

THIRD FLOOR
POWER PLAN

A-XXXXX

E-106

ELECTRICAL
STUDY



1 FOURTH FLOOR POWER PLAN
1/16" = 1'-0"



REVIEW SET
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CONSTRUCTION

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Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

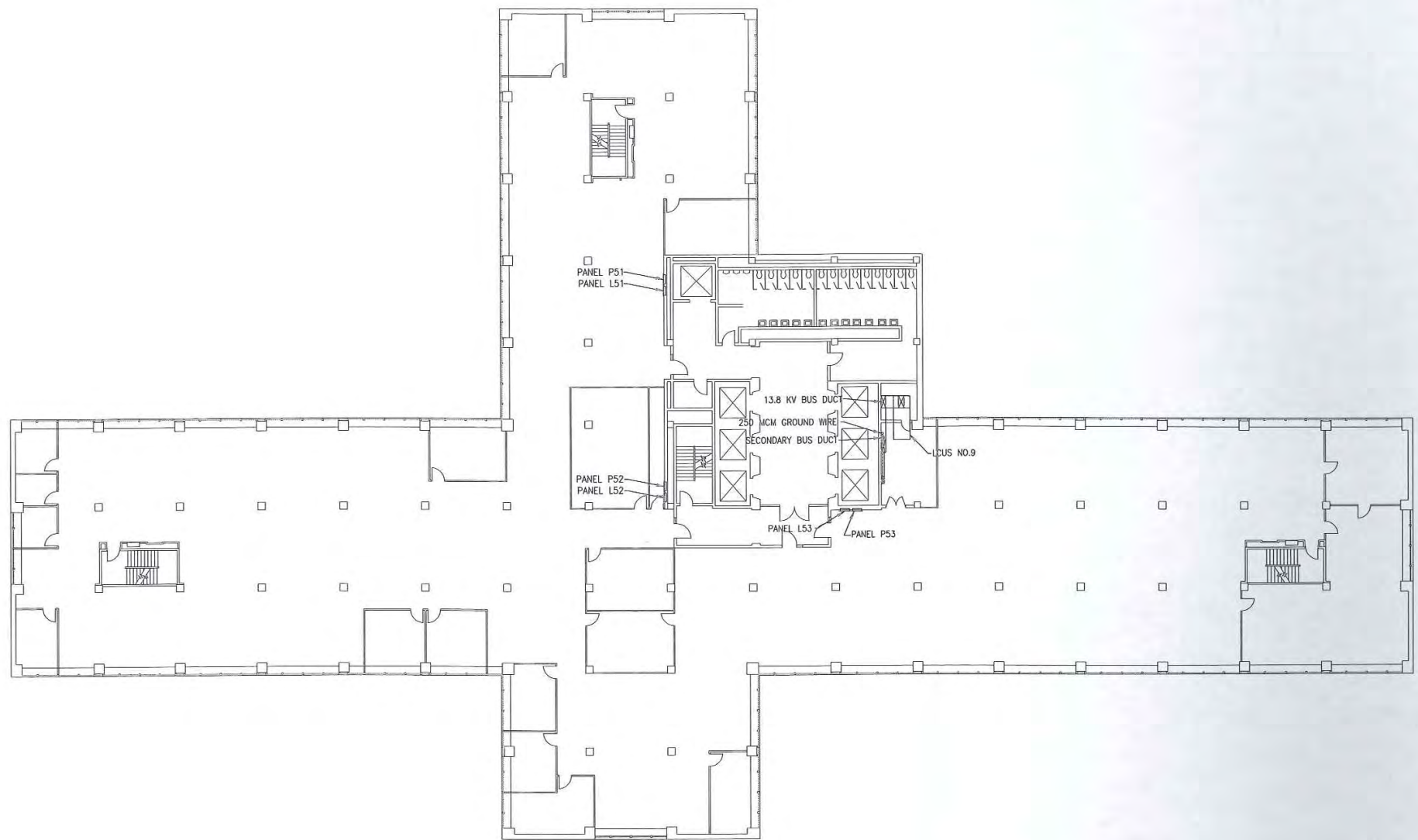
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REGION:

FOURTH FLOOR
POWER PLAN

A-XXXXX

E-107

ELECTRICAL
STUDY



1 FIFTH FLOOR POWER PLAN
 1/16" = 1'-0"



REVIEW SET
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 BIDDING OR
 CONSTRUCTION

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DOCKING STATE OFFICE BUILDING
 ELECTRICAL UPGRADE
 TOPEKA, KANSAS

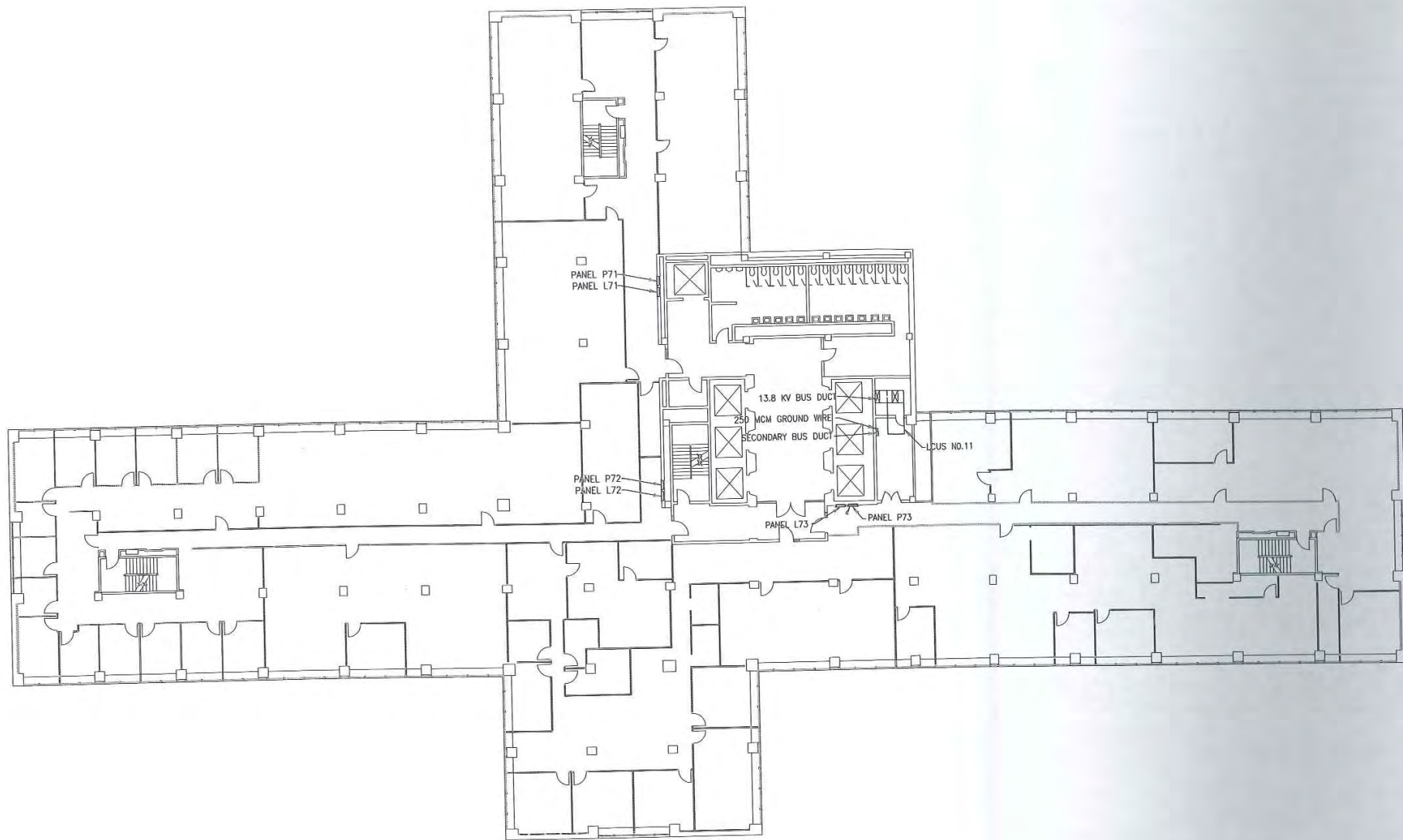
DATE: 1/17/11
 DRAWN BY: CSS
 CHECKED BY: LWS
 REVISION:

FIFTH FLOOR
 POWER PLAN

A-XXXXX

E-108

ELECTRICAL
 STUDY



1 SEVENTH FLOOR POWER PLAN
1/16" = 1'-0"



REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

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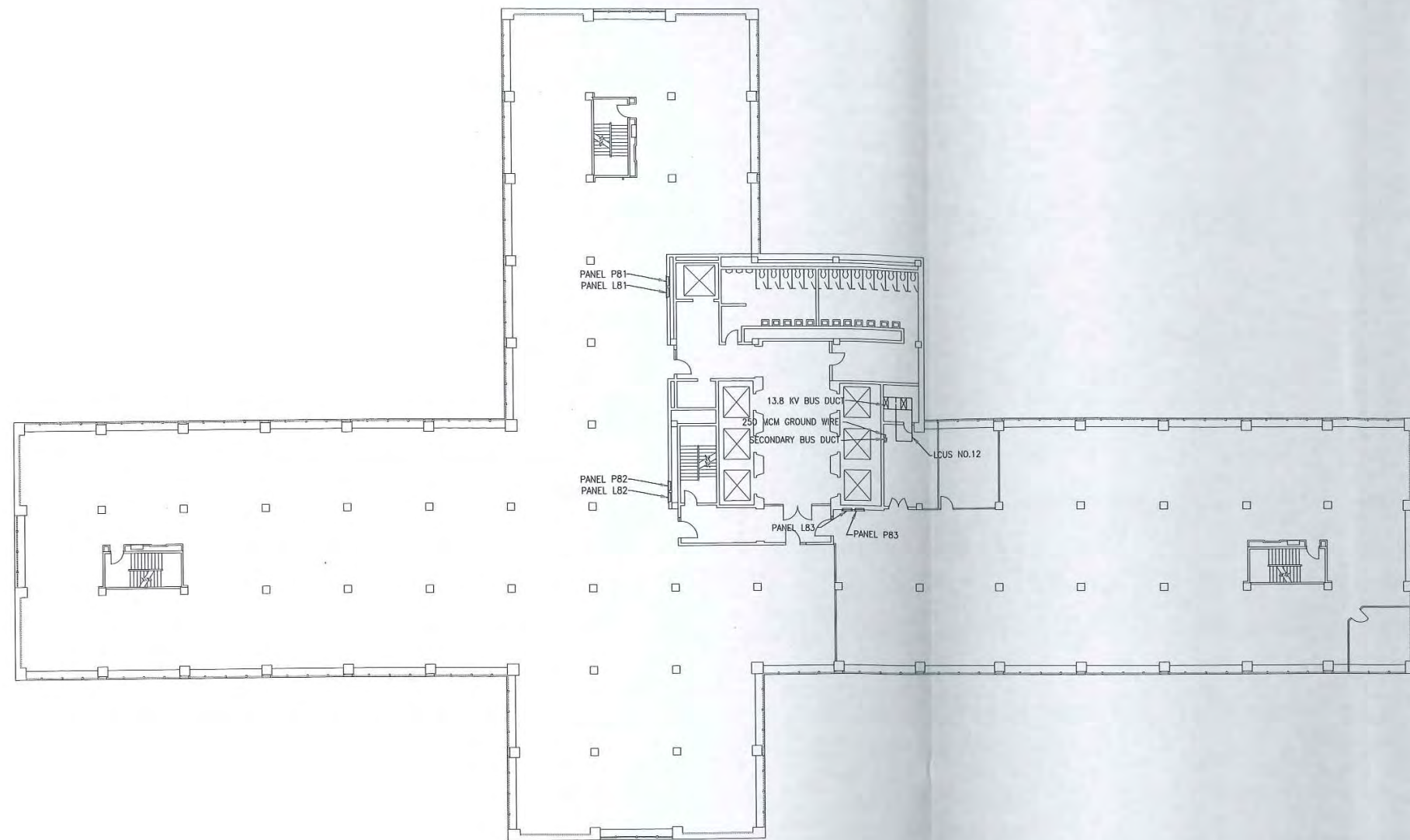
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

SEVENTH FLOOR
POWER PLAN

A-XXXXX

E-110

ELECTRICAL
STUDY



1 EIGHTH FLOOR POWER PLAN
 1/16" = 1'-0"

0 8 16 32 48
 SCALE IN FEET



REVIEW SET
 NOT TO BE
 USED FOR
 BIDDING OR
 CONSTRUCTION

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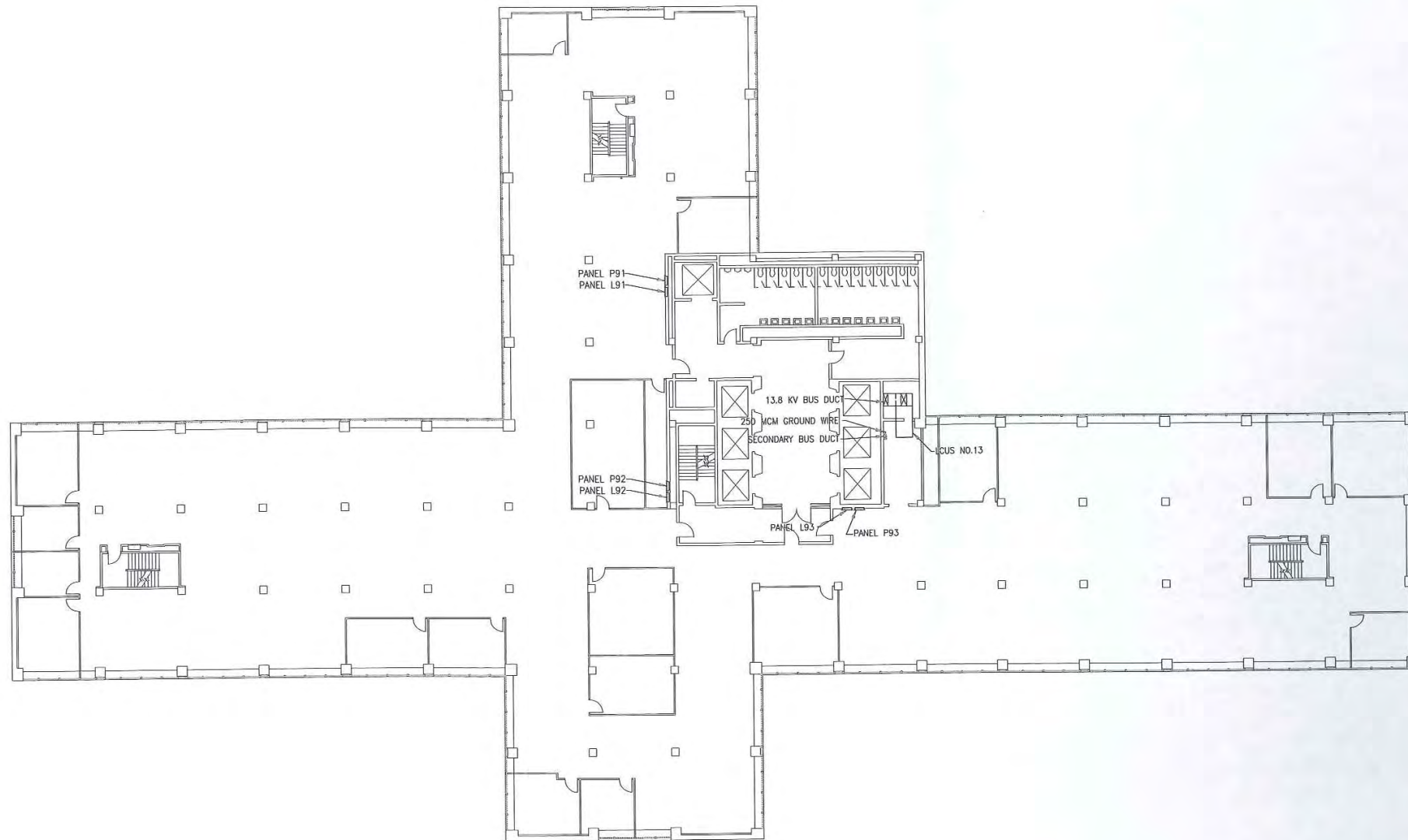
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
 TOPEKA, KANSAS
 DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

EIGHTH FLOOR
 POWER PLAN

A-XXXXX

E-111

ELECTRICAL
 STUDY



1 NINTH FLOOR POWER PLAN
 1/16" = 1'-0"



REVIEW SET
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 CONSTRUCTION

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 Topeka, Kansas 66612-1220
 Telephone 785-236-6899 Fax 785-296-6898

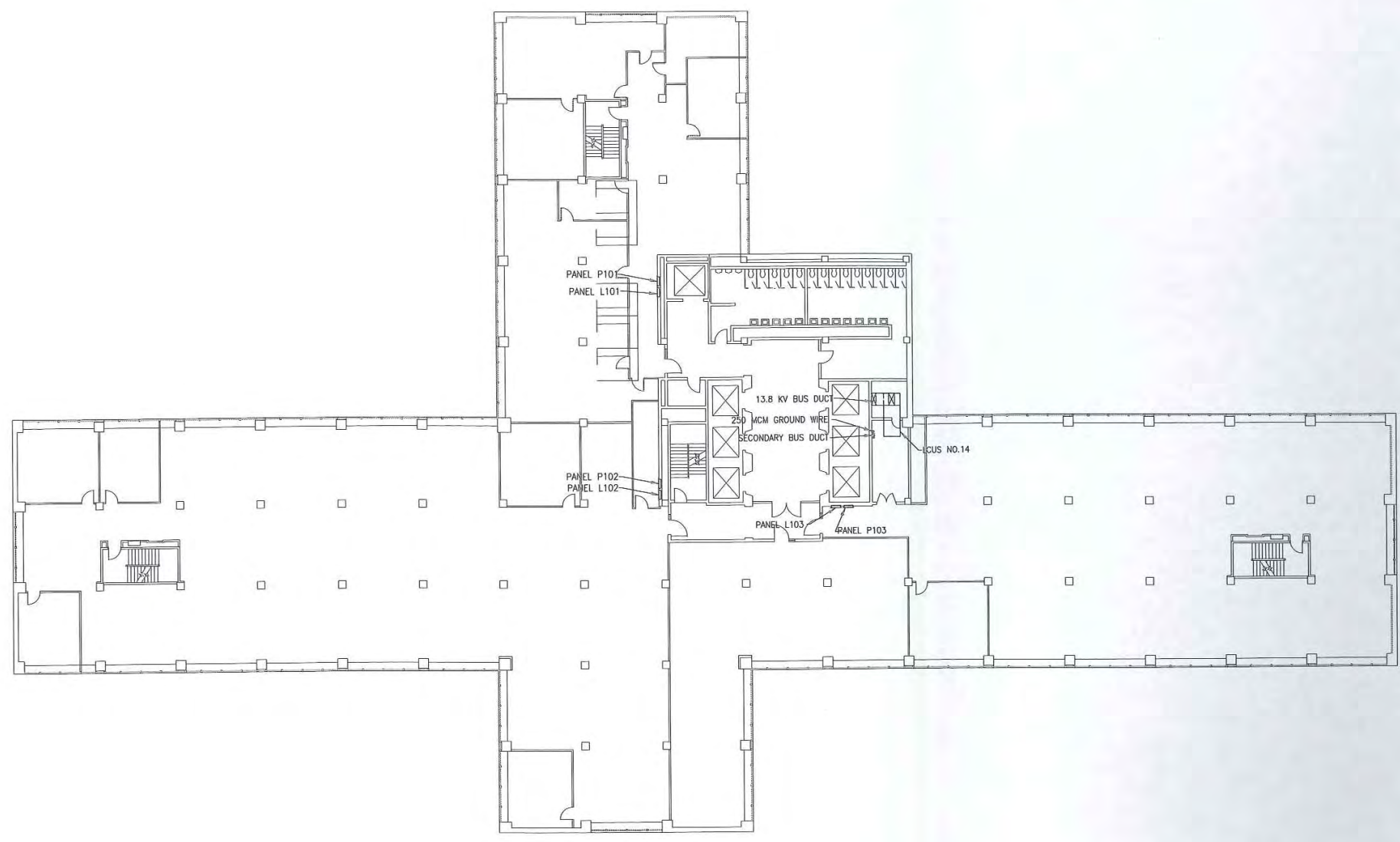
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
 TOPEKA, KANSAS
 DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

NINTH FLOOR
 POWER PLAN

A-XXXXX

E-112

ELECTRICAL
 STUDY



1 TENTH FLOOR POWER PLAN
 1/16" = 1'-0"
 0 8 16 32 48
 SCALE IN FEET



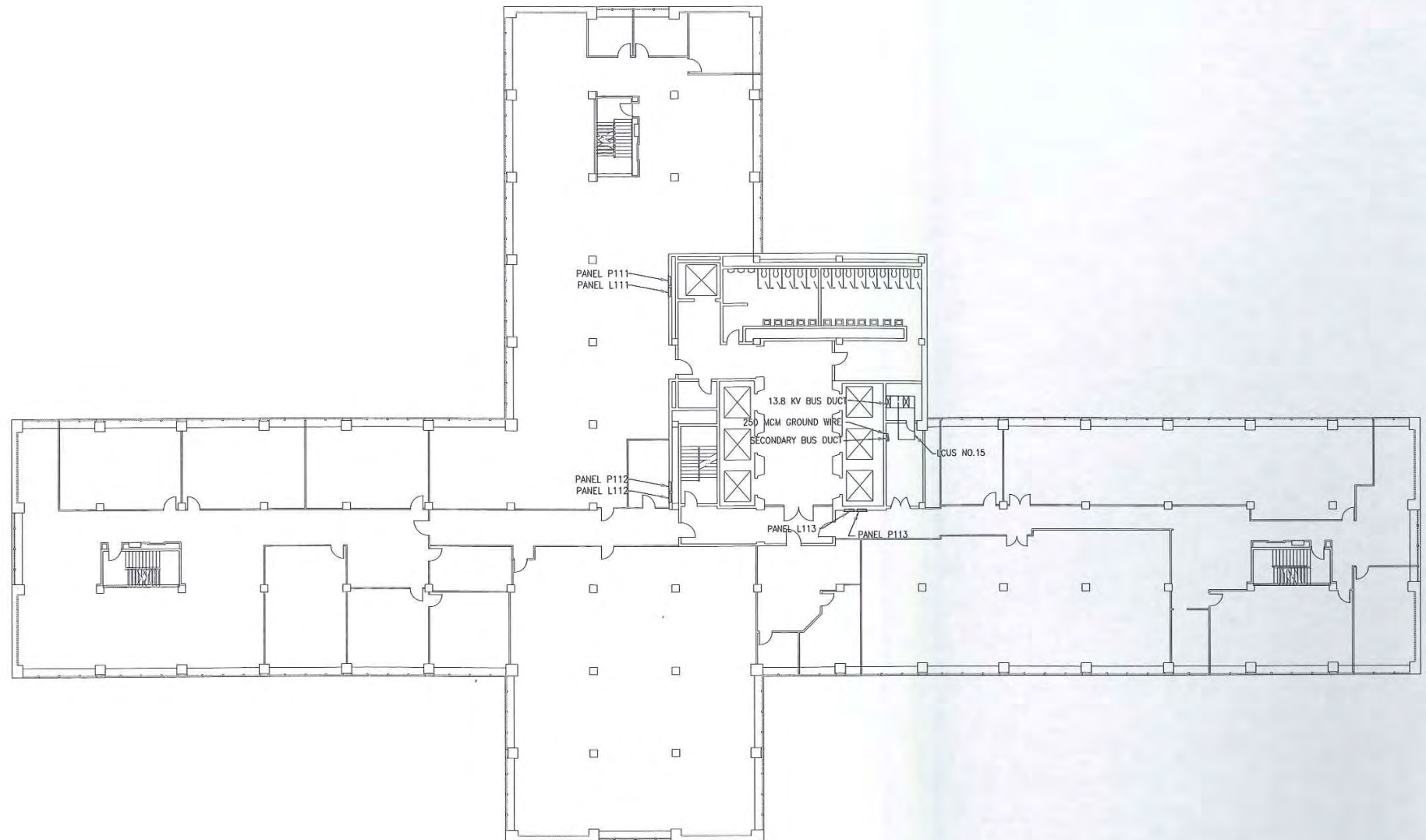
REVIEW SET
 NOT TO BE
 USED FOR
 BIDDING OR
 CONSTRUCTION

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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
 TOPEKA, KANSAS
 DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

TENTH FLOOR
 POWER PLAN
 A-XXXXX
 E-113
 ELECTRICAL
 STUDY



1 ELEVENTH FLOOR POWER PLAN
 1/16" = 1'-0"



REVIEW SET
 NOT TO BE
 USED FOR
 BIDDING OR
 CONSTRUCTION

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Department of Administration
 Division of Facilities Management
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 Topeka, Kansas 66612-1220
 Telephone 785-296-8899 Fax 785-296-8898

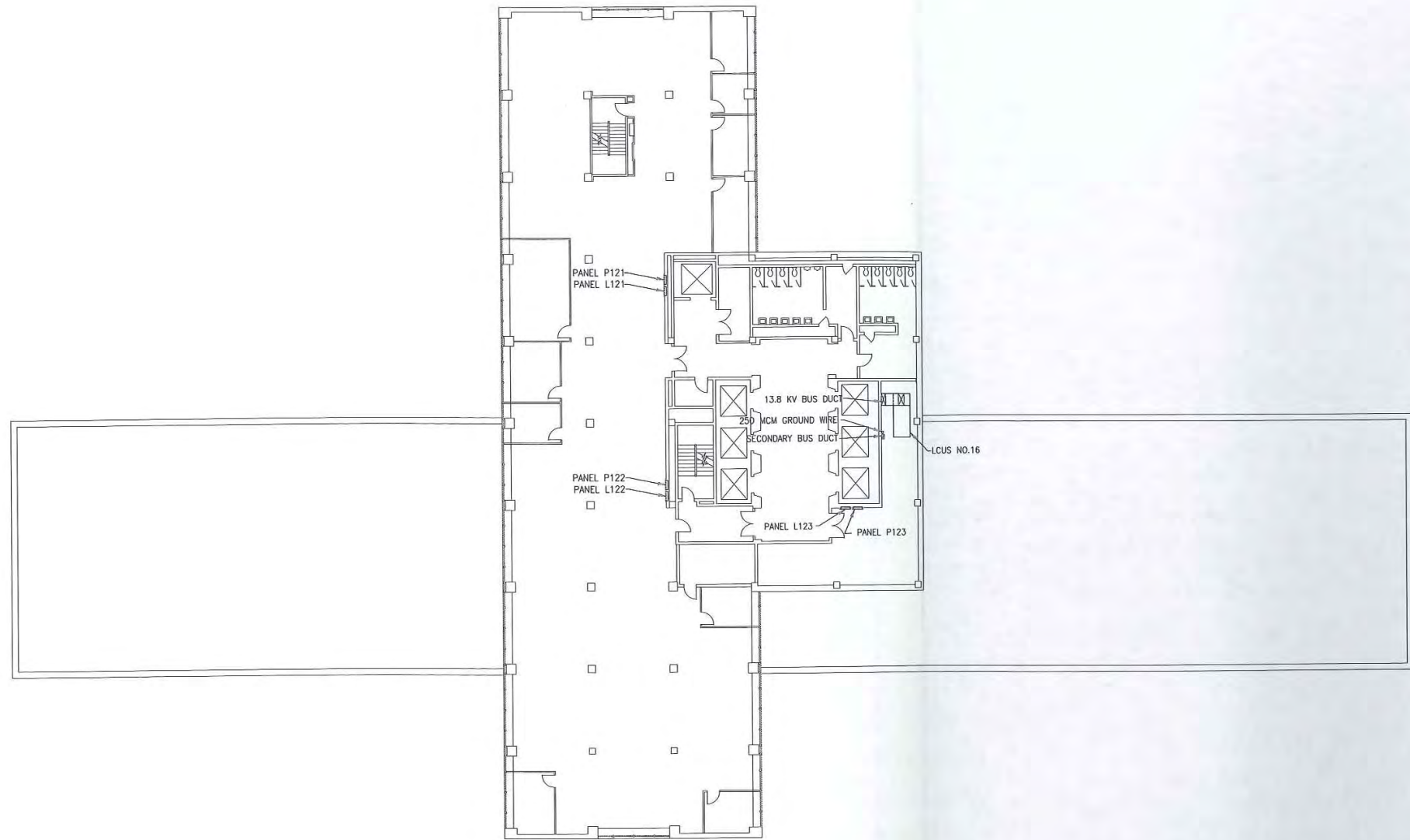
DOCKING STATE OFFICE BUILDING
 ELECTRICAL UPGRADE
 TOPEKA, KANSAS
 DATE: 1/17/11 DOWN BY: CSS CHECKED BY: LWS REVISION:

ELEVENTH FLOOR
 POWER PLAN

A-XXXXX

E-114

ELECTRICAL
 STUDY



1 **TWELFTH FLOOR POWER PLAN**
1/16" = 1'-0"
0 8 16 32 48
SCALE IN FEET



REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

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Department of Administration
Division of Facilities Management
Landon State Office Building
900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

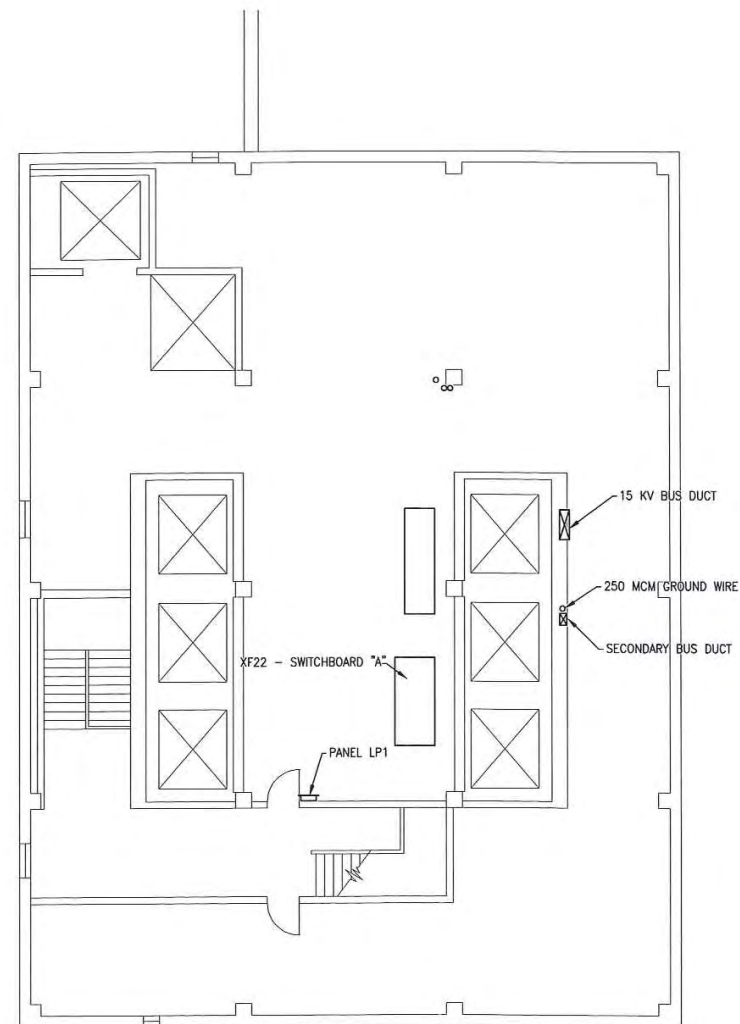
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

TWELFTH FLOOR
POWER PLAN

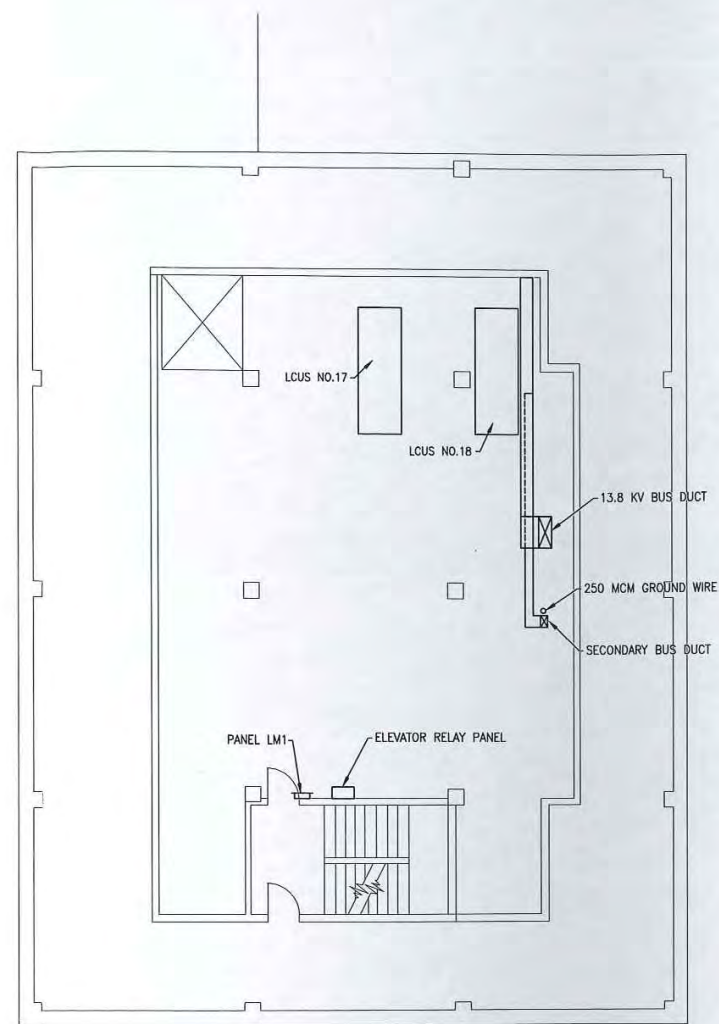
A-XXXXX

E-115

ELECTRICAL
STUDY



1 PENTHOUSE POWER PLAN
1/8" = 1'-0"



2 MACHINERY FLOOR POWER PLAN
1/8" = 1'-0"



REVIEW SET
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USED FOR
BIDDING OR
CONSTRUCTION

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Division of Facilities Management
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Telephone 785-296-8899 Fax 785-296-8898

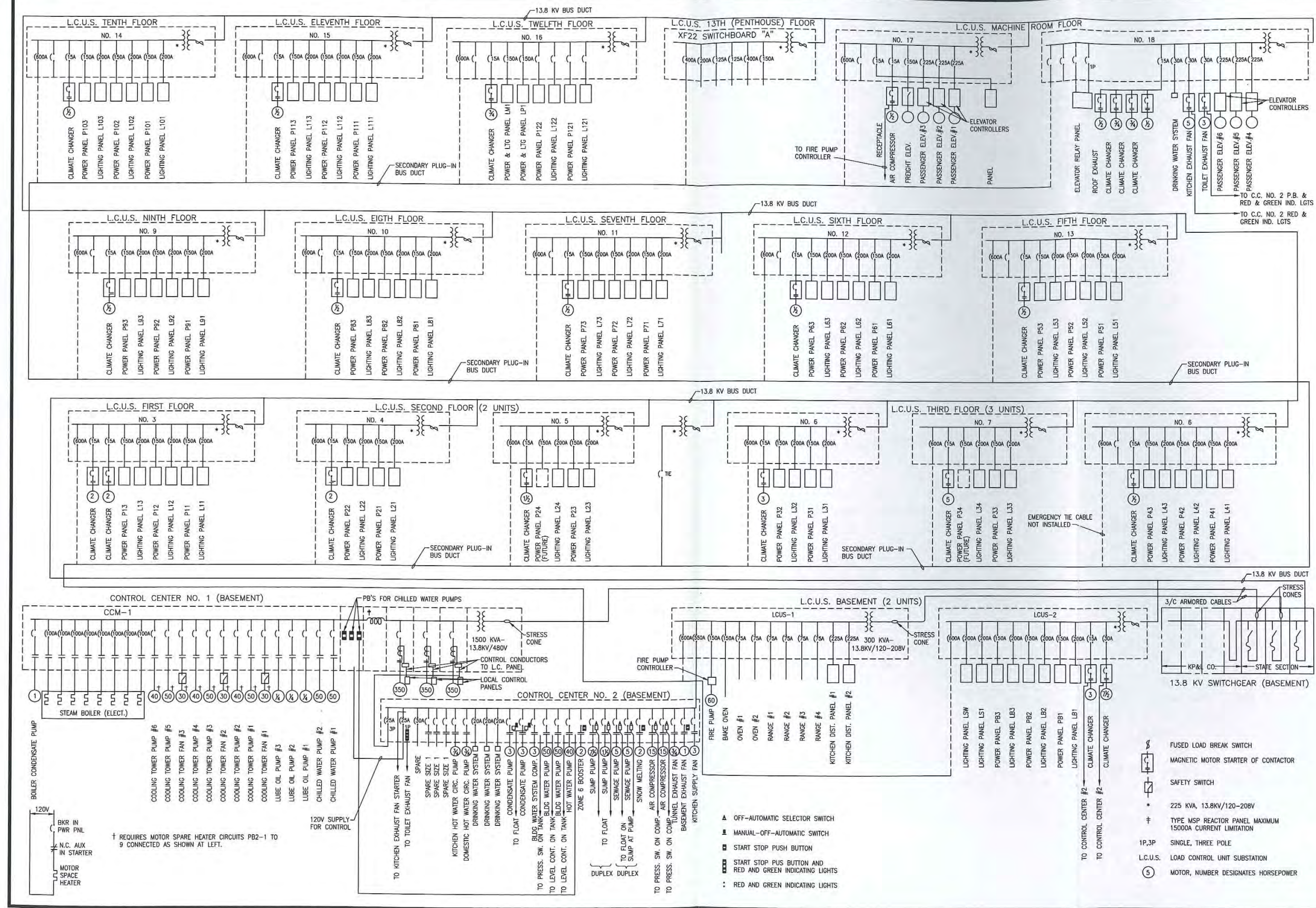
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

PENTHOUSE AND
MACHINERY FLOOR
POWER PLANS

A-XXXXX

E-116

ELECTRICAL
STUDY



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CONSTRUCTION

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Department of Administration
Division of Facilities Management
Landon State Office Building

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

EXISTING
ONE-LINE DIAGRAM

A-XXXXXX

E-601

ELECTRICAL
STUDY

DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISIONS:

APPENDIX D: AMPCALC

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Calculation Method:

Distinct AMPACITY calculated for each position in the system based on user specified conductor temperature.

Summary of Neher-McGrath Calculation Results:

No.	Identifier	System	x Coord	y Coord	Qty-Type	Cable Size	Sys kV	Temp	Amps	Rac	Watts/ft
1		1	0.000	0.000	4-1/c	500 kcmil	0.48	75.00	228.4	27.42	5.719
2		1	7.500	0.000	4-1/c	500 kcmil	0.48	75.00	188.4	27.42	3.893
3		1	15.000	0.000	4-1/c	500 kcmil	0.48	75.00	172.0	27.42	3.243
4		1	22.500	0.000	4-1/c	500 kcmil	0.48	75.00	164.2	27.42	2.956
5		1	30.000	0.000	4-1/c	500 kcmil	0.48	75.00	160.0	27.42	2.809
6		1	37.500	0.000	4-1/c	500 kcmil	0.48	75.00	157.7	27.42	2.726
7		1	45.000	0.000	4-1/c	500 kcmil	0.48	75.00	156.3	27.42	2.678
8		1	52.500	0.000	4-1/c	500 kcmil	0.48	75.00	155.4	27.42	2.648
9	C1	1	60.000	0.000	4-1/c	500 kcmil	0.48	75.00	154.9	27.42	2.630
10		1	67.500	0.000	4-1/c	500 kcmil	0.48	75.00	154.5	27.42	2.619
11		1	75.000	0.000	4-1/c	500 kcmil	0.48	75.00	154.4	27.42	2.615
12		1	82.500	0.000	4-1/c	500 kcmil	0.48	75.00	154.4	27.42	2.615
13		1	90.000	0.000	4-1/c	500 kcmil	0.48	75.00	154.5	27.42	2.619
14		1	97.500	0.000	4-1/c	500 kcmil	0.48	75.00	154.9	27.42	2.630
15		1	105.000	0.000	4-1/c	500 kcmil	0.48	75.00	155.4	27.42	2.648
16	C1	1	112.500	0.000	4-1/c	500 kcmil	0.48	75.00	156.3	27.42	2.678
17		1	120.000	0.000	4-1/c	500 kcmil	0.48	75.00	157.7	27.42	2.726
18		1	127.500	0.000	4-1/c	500 kcmil	0.48	75.00	160.0	27.42	2.809
19		1	135.000	0.000	4-1/c	500 kcmil	0.48	75.00	164.2	27.42	2.956
20		1	142.500	0.000	4-1/c	500 kcmil	0.48	75.00	172.0	27.42	3.243
21		1	150.000	0.000	4-1/c	500 kcmil	0.48	75.00	188.4	27.42	3.893
22		1	157.500	0.000	4-1/c	500 kcmil	0.48	75.00	228.4	27.42	5.719
23		1	0.000	-7.500	4-1/c	500 kcmil	0.48	75.00	207.5	27.42	4.722
24		1	7.500	-7.500	4-1/c	500 kcmil	0.48	75.00	162.8	27.42	2.908
25		1	15.000	-7.500	4-1/c	500 kcmil	0.48	75.00	142.6	27.42	2.230
26		1	22.500	-7.500	4-1/c	500 kcmil	0.48	75.00	132.0	27.42	1.910
27		1	30.000	-7.500	4-1/c	500 kcmil	0.48	75.00	125.7	27.42	1.734
28		1	37.500	-7.500	4-1/c	500 kcmil	0.48	75.00	121.8	27.42	1.626
29		1	45.000	-7.500	4-1/c	500 kcmil	0.48	75.00	119.1	27.42	1.556
30		1	52.500	-7.500	4-1/c	500 kcmil	0.48	75.00	117.3	27.42	1.510
31		1	60.000	-7.500	4-1/c	500 kcmil	0.48	75.00	116.2	27.42	1.480
32		1	67.500	-7.500	4-1/c	500 kcmil	0.48	75.00	115.4	27.42	1.462

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
 Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas
 Program Serial Number: 203400552
 Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Calculation Method:

Distinct AMPACITY calculated for each position in the system based on user specified conductor temperature.

Summary of Neher-McGrath Calculation Results:

No.	Identifier	System	x Coord	y Coord	Qty-Type	Cable Size	Sys kV	Temp	Amps	Rac	Watts/ft
33		1	75.000	-7.500	4-1/c	500 kcmil	0.48	75.00	115.1	27.42	1.453
34		1	82.500	-7.500	4-1/c	500 kcmil	0.48	75.00	115.1	27.42	1.453
35		1	90.000	-7.500	4-1/c	500 kcmil	0.48	75.00	115.4	27.42	1.462
36		1	97.500	-7.500	4-1/c	500 kcmil	0.48	75.00	116.2	27.42	1.480
37		1	105.000	-7.500	4-1/c	500 kcmil	0.48	75.00	117.3	27.42	1.510
38		1	112.500	-7.500	4-1/c	500 kcmil	0.48	75.00	119.1	27.42	1.556
39		1	120.000	-7.500	4-1/c	500 kcmil	0.48	75.00	121.8	27.42	1.626
40		1	127.500	-7.500	4-1/c	500 kcmil	0.48	75.00	125.7	27.42	1.734
41		1	135.000	-7.500	4-1/c	500 kcmil	0.48	75.00	132.0	27.42	1.910
42		1	142.500	-7.500	4-1/c	500 kcmil	0.48	75.00	142.6	27.42	2.230
43		1	150.000	-7.500	4-1/c	500 kcmil	0.48	75.00	162.8	27.42	2.908
44		1	157.500	-7.500	4-1/c	500 kcmil	0.48	75.00	207.5	27.42	4.722

User System Input Data**For System #1 of 1**

Underground system filename	0
Type of underground system	Direct Buried Conduits
Number of cable positions in system	44
Distance from earth's surface to origin (in.)	40.000
Earth thermal resistivity (RHO)	90
Earth temperature (degrees C)	20

Cable Position Input Data:

No.	Identifier	x Coord	# & Type	Cable Library	Cable Size	Shield	Sys kV	Duct Library	1/c Spc	Spec Temp
	System	y Coord	Cond.	Library Volume	Rated kV	Config	Sys Freq	Nom. Size	LF%	Spec Amps

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
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Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Cable Position Input Data:

No.	Identifier System	x Coord y Coord	# & Type Cond.	Cable Library Library Volume	Cable Size Rated kV	Shield Config	Sys kV Sys Freq	Duct Library Nom. Size	1/c Spc LF%	Spec Temp Spec Amps
1	1	0.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
2	1	7.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
3	1	15.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
4	1	22.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
5	1	30.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
6	1	37.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
7	1	45.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
8	1	52.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
9	C1 1	60.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
10	1	67.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
11	1	75.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
12	1	82.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
13	1	90.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
14	1	97.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
15	1	105.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
16	C1 1	112.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
17	1	120.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
18	1	127.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Cable Position Input Data:

No.	Identifier System	x Coord y Coord	# & Type Cond.	Cable Library Library Volume	Cable Size Rated kV	Shield Config	Sys kV Sys Freq	Duct Library Nom. Size	1/c Spc LF%	Spec Temp Spec Amps
19	1	135.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
20	1	142.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
21	1	150.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
22	1	157.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
23	1	0.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
24	1	7.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
25	1	15.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
26	1	22.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
27	1	30.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
28	1	37.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
29	1	45.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
30	1	52.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
31	1	60.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
32	1	67.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
33	1	75.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
34	1	82.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
35	1	90.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
36	1	97.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0

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Filename: 0

Cable Position Input Data:

No.	Identifier System	x Coord y Coord	# & Type Cond.	Cable Library Library Volume	Cable Size Rated kV	Shield Config	Sys kV Sys Freq	Duct Library Nom. Size	1/c Spc LF%	Spec Temp Spec Amps
37	1	105.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
38	1	112.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
39	1	120.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
40	1	127.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
41	1	135.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
42	1	142.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
43	1	150.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
44	1	157.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0

Caution - Specified Temp and Amps are user input setpoints and do not necessarily represent a correct solution.
 Bracketed value is user specified input variable which may be held constant in optional calculation.

Voltage Drop Calculations:

No.	Identifier	Length (ft.)	Amps/Conductor	PF (%)	Ohms/1000 feet/Cond.		Volt Drop (+%) or Rise (-%)	
					Resistance	Reactance		
1		80	228.4	100.000	Lag	0.0274	0.0292	0.181 OK
2		80	188.4	100.000	Lag	0.0274	0.0292	0.149 OK
3		80	172.0	100.000	Lag	0.0274	0.0292	0.136 OK
4		80	164.2	100.000	Lag	0.0274	0.0292	0.130 OK
5		80	160.0	100.000	Lag	0.0274	0.0292	0.127 OK
6		80	157.7	100.000	Lag	0.0274	0.0292	0.125 OK
7		80	156.3	100.000	Lag	0.0274	0.0292	0.124 OK
8		80	155.4	100.000	Lag	0.0274	0.0292	0.123 OK
9	C1	80	154.9	100.000	Lag	0.0274	0.0292	0.123 OK
10		80	154.5	100.000	Lag	0.0274	0.0292	0.122 OK
11		80	154.4	100.000	Lag	0.0274	0.0292	0.122 OK
12		80	154.4	100.000	Lag	0.0274	0.0292	0.122 OK
13		80	154.5	100.000	Lag	0.0274	0.0292	0.122 OK

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Voltage Drop Calculations:

No.	Identifier	Length (ft.)	Amps/Conductor	PF (%)	Ohms/1000 feet/Cond.		Volt Drop (+%) or Rise (-%)	
					Resistance	Reactance		
14		80	154.9	100.000	Lag	0.0274	0.0292	0.123 OK
15		80	155.4	100.000	Lag	0.0274	0.0292	0.123 OK
16	C1	80	156.3	100.000	Lag	0.0274	0.0292	0.124 OK
17		80	157.7	100.000	Lag	0.0274	0.0292	0.125 OK
18		80	160.0	100.000	Lag	0.0274	0.0292	0.127 OK
19		80	164.2	100.000	Lag	0.0274	0.0292	0.130 OK
20		80	172.0	100.000	Lag	0.0274	0.0292	0.136 OK
21		80	188.4	100.000	Lag	0.0274	0.0292	0.149 OK
22		80	228.4	100.000	Lag	0.0274	0.0292	0.181 OK
23		80	207.5	100.000	Lag	0.0274	0.0292	0.164 OK
24		80	162.8	100.000	Lag	0.0274	0.0292	0.129 OK
25		80	142.6	100.000	Lag	0.0274	0.0292	0.113 OK
26		80	132.0	100.000	Lag	0.0274	0.0292	0.105 OK
27		80	125.7	100.000	Lag	0.0274	0.0292	0.100 OK
28		80	121.8	100.000	Lag	0.0274	0.0292	0.096 OK
29		80	119.1	100.000	Lag	0.0274	0.0292	0.094 OK
30		80	117.3	100.000	Lag	0.0274	0.0292	0.093 OK
31		80	116.2	100.000	Lag	0.0274	0.0292	0.092 OK
32		80	115.4	100.000	Lag	0.0274	0.0292	0.091 OK
33		80	115.1	100.000	Lag	0.0274	0.0292	0.091 OK
34		80	115.1	100.000	Lag	0.0274	0.0292	0.091 OK
35		80	115.4	100.000	Lag	0.0274	0.0292	0.091 OK
36		80	116.2	100.000	Lag	0.0274	0.0292	0.092 OK
37		80	117.3	100.000	Lag	0.0274	0.0292	0.093 OK
38		80	119.1	100.000	Lag	0.0274	0.0292	0.094 OK
39		80	121.8	100.000	Lag	0.0274	0.0292	0.096 OK
40		80	125.7	100.000	Lag	0.0274	0.0292	0.100 OK
41		80	132.0	100.000	Lag	0.0274	0.0292	0.105 OK
42		80	142.6	100.000	Lag	0.0274	0.0292	0.113 OK
43		80	162.8	100.000	Lag	0.0274	0.0292	0.129 OK
44		80	207.5	100.000	Lag	0.0274	0.0292	0.164 OK

Load Flow Calculations:

No.	Identifier System	Voltage		Current/Phase		PF (%)	Load Flow Power			kW Loss	
		Mag	Deg	Amps	Deg		kVA	kW	kVAR	kVAR Loss	

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Load Flow Calculations:

No.	Identifier System		Voltage		Current/Phase		PF (%)		Load Flow Power			kW Loss
			Mag	Deg	Amps	Deg			kVA	kW	kVAR	kVAR Loss
1	1	Source-->	480.0	0.00			100.0	Unity	189.9	189.9	0.4	0.343
		Load-->	479.1	-0.11	228.4	-0.11	100.0	Lag	189.5	189.5	0.0	0.365
2	1	Source-->	480.0	0.00			100.0	Unity	156.6	156.6	0.2	0.234
		Load-->	479.3	-0.09	188.4	-0.09	100.0	Lag	156.4	156.4	0.0	0.249
3	1	Source-->	480.0	0.00			100.0	Unity	143.0	143.0	0.2	0.195
		Load-->	479.3	-0.08	172.0	-0.08	100.0	Lag	142.8	142.8	0.0	0.207
4	1	Source-->	480.0	0.00			100.0	Unity	136.5	136.5	0.2	0.177
		Load-->	479.4	-0.08	164.2	-0.08	100.0	Lag	136.3	136.3	0.0	0.189
5	1	Source-->	480.0	0.00			100.0	Unity	133.0	133.0	0.2	0.169
		Load-->	479.4	-0.08	160.0	-0.08	100.0	Lag	132.9	132.9	0.0	0.179
6	1	Source-->	480.0	0.00			100.0	Unity	131.1	131.1	0.2	0.164
		Load-->	479.4	-0.08	157.7	-0.08	100.0	Lag	130.9	130.9	0.0	0.174
7	1	Source-->	480.0	0.00			100.0	Unity	129.9	129.9	0.2	0.161
		Load-->	479.4	-0.08	156.3	-0.08	100.0	Lag	129.7	129.7	0.0	0.171
8	1	Source-->	480.0	0.00			100.0	Unity	129.2	129.2	0.2	0.159
		Load-->	479.4	-0.07	155.4	-0.07	100.0	Lag	129.0	129.0	0.0	0.169
9	C1	Source-->	480.0	0.00			100.0	Unity	128.7	128.7	0.2	0.158
		Load-->	479.4	-0.07	154.9	-0.07	100.0	Lag	128.6	128.6	0.0	0.168
10	1	Source-->	480.0	0.00			100.0	Unity	128.5	128.5	0.2	0.157
		Load-->	479.4	-0.07	154.5	-0.07	100.0	Lag	128.3	128.3	0.0	0.167
11	1	Source-->	480.0	0.00			100.0	Unity	128.4	128.4	0.2	0.157
		Load-->	479.4	-0.07	154.4	-0.07	100.0	Lag	128.2	128.2	0.0	0.167
12	1	Source-->	480.0	0.00			100.0	Unity	128.4	128.4	0.2	0.157
		Load-->	479.4	-0.07	154.4	-0.07	100.0	Lag	128.2	128.2	0.0	0.167
13	1	Source-->	480.0	0.00			100.0	Unity	128.5	128.5	0.2	0.157
		Load-->	479.4	-0.07	154.5	-0.07	100.0	Lag	128.3	128.3	0.0	0.167
14	1	Source-->	480.0	0.00			100.0	Unity	128.7	128.7	0.2	0.158
		Load-->	479.4	-0.07	154.9	-0.07	100.0	Lag	128.6	128.6	0.0	0.168
15	1	Source-->	480.0	0.00			100.0	Unity	129.2	129.2	0.2	0.159
		Load-->	479.4	-0.07	155.4	-0.07	100.0	Lag	129.0	129.0	0.0	0.169
16	C1	Source-->	480.0	0.00			100.0	Unity	129.9	129.9	0.2	0.161
		Load-->	479.4	-0.08	156.3	-0.08	100.0	Lag	129.7	129.7	0.0	0.171
17	1	Source-->	480.0	0.00			100.0	Unity	131.1	131.1	0.2	0.164
		Load-->	479.4	-0.08	157.7	-0.08	100.0	Lag	130.9	130.9	0.0	0.174
18	1	Source-->	480.0	0.00			100.0	Unity	133.0	133.0	0.2	0.169
		Load-->	479.4	-0.08	160.0	-0.08	100.0	Lag	132.9	132.9	0.0	0.179

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Load Flow Calculations:

No.	Identifier System		Voltage		Current/Phase		PF (%)	Load Flow Power			kW Loss	
			Mag	Deg	Amps	Deg		kVA	kW	KVAR	kVAR Loss	
19	1	Source-->	480.0	0.00			100.0	Unity	136.5	136.5	0.2	0.177
		Load-->	479.4	-0.08	164.2	-0.08	100.0	Lag	136.3	136.3	0.0	0.189
20	1	Source-->	480.0	0.00			100.0	Unity	143.0	143.0	0.2	0.195
		Load-->	479.3	-0.08	172.0	-0.08	100.0	Lag	142.8	142.8	0.0	0.207
21	1	Source-->	480.0	0.00			100.0	Unity	156.6	156.6	0.2	0.234
		Load-->	479.3	-0.09	188.4	-0.09	100.0	Lag	156.4	156.4	0.0	0.249
22	1	Source-->	480.0	0.00			100.0	Unity	189.9	189.9	0.4	0.343
		Load-->	479.1	-0.11	228.4	-0.11	100.0	Lag	189.5	189.5	0.0	0.365
23	1	Source-->	480.0	0.00			100.0	Unity	172.5	172.5	0.3	0.283
		Load-->	479.2	-0.10	207.5	-0.10	100.0	Lag	172.2	172.2	0.0	0.301
24	1	Source-->	480.0	0.00			100.0	Unity	135.4	135.4	0.2	0.174
		Load-->	479.4	-0.08	162.8	-0.08	100.0	Lag	135.2	135.2	0.0	0.186
25	1	Source-->	480.0	0.00			100.0	Unity	118.5	118.5	0.1	0.134
		Load-->	479.5	-0.07	142.6	-0.07	100.0	Lag	118.4	118.4	0.0	0.142
26	1	Source-->	480.0	0.00			100.0	Unity	109.7	109.7	0.1	0.115
		Load-->	479.5	-0.06	132.0	-0.06	100.0	Lag	109.6	109.6	0.0	0.122
27	1	Source-->	480.0	0.00			100.0	Unity	104.5	104.5	0.1	0.104
		Load-->	479.5	-0.06	125.7	-0.06	100.0	Lag	104.4	104.4	0.0	0.111
28	1	Source-->	480.0	0.00			100.0	Unity	101.2	101.2	0.1	0.098
		Load-->	479.5	-0.06	121.8	-0.06	100.0	Lag	101.1	101.1	0.0	0.104
29	1	Source-->	480.0	0.00			100.0	Unity	99.0	99.0	0.1	0.093
		Load-->	479.5	-0.06	119.1	-0.06	100.0	Lag	98.9	98.9	0.0	0.099
30	1	Source-->	480.0	0.00			100.0	Unity	97.6	97.6	0.1	0.091
		Load-->	479.6	-0.06	117.3	-0.06	100.0	Lag	97.5	97.5	0.0	0.096
31	1	Source-->	480.0	0.00			100.0	Unity	96.6	96.6	0.1	0.089
		Load-->	479.6	-0.06	116.2	-0.06	100.0	Lag	96.5	96.5	0.0	0.094
32	1	Source-->	480.0	0.00			100.0	Unity	96.0	96.0	0.1	0.088
		Load-->	479.6	-0.06	115.4	-0.06	100.0	Lag	95.9	95.9	0.0	0.093
33	1	Source-->	480.0	0.00			100.0	Unity	95.7	95.7	0.1	0.087
		Load-->	479.6	-0.06	115.1	-0.06	100.0	Lag	95.6	95.6	0.0	0.093
34	1	Source-->	480.0	0.00			100.0	Unity	95.7	95.7	0.1	0.087
		Load-->	479.6	-0.06	115.1	-0.06	100.0	Lag	95.6	95.6	0.0	0.093
35	1	Source-->	480.0	0.00			100.0	Unity	96.0	96.0	0.1	0.088
		Load-->	479.6	-0.06	115.4	-0.06	100.0	Lag	95.9	95.9	0.0	0.093
36	1	Source-->	480.0	0.00			100.0	Unity	96.6	96.6	0.1	0.089
		Load-->	479.6	-0.06	116.2	-0.06	100.0	Lag	96.5	96.5	0.0	0.094

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Filename: 0

Load Flow Calculations:

No.	Identifier System		Voltage		Current/Phase		PF (%)		Load Flow Power			kW Loss
			Mag	Deg	Amps	Deg			kVA	kW	kVAR	kVAR Loss
37	1	Source-->	480.0	0.00			100.0	Unity	97.6	97.6	0.1	0.091
		Load-->	479.6	-0.06	117.3	-0.06	100.0	Lag	97.5	97.5	0.0	0.096
38	1	Source-->	480.0	0.00			100.0	Unity	99.0	99.0	0.1	0.093
		Load-->	479.5	-0.06	119.1	-0.06	100.0	Lag	98.9	98.9	0.0	0.099
39	1	Source-->	480.0	0.00			100.0	Unity	101.2	101.2	0.1	0.098
		Load-->	479.5	-0.06	121.8	-0.06	100.0	Lag	101.1	101.1	0.0	0.104
40	1	Source-->	480.0	0.00			100.0	Unity	104.5	104.5	0.1	0.104
		Load-->	479.5	-0.06	125.7	-0.06	100.0	Lag	104.4	104.4	0.0	0.111
41	1	Source-->	480.0	0.00			100.0	Unity	109.7	109.7	0.1	0.115
		Load-->	479.5	-0.06	132.0	-0.06	100.0	Lag	109.6	109.6	0.0	0.122
42	1	Source-->	480.0	0.00			100.0	Unity	118.5	118.5	0.1	0.134
		Load-->	479.5	-0.07	142.6	-0.07	100.0	Lag	118.4	118.4	0.0	0.142
43	1	Source-->	480.0	0.00			100.0	Unity	135.4	135.4	0.2	0.174
		Load-->	479.4	-0.08	162.8	-0.08	100.0	Lag	135.2	135.2	0.0	0.186
44	1	Source-->	480.0	0.00			100.0	Unity	172.5	172.5	0.3	0.283
		Load-->	479.2	-0.10	207.5	-0.10	100.0	Lag	172.2	172.2	0.0	0.301

Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
1	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
2	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
3	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
4	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
5	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
6	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
7	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
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Program Serial Number: 203400552
Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
8	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
9	C1 1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
10	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
11	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
12	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
13	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
14	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
15	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
16	C1 1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
17	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
18	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
19	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
20	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
21	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
22	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
23	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
24	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
25	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
26	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
27	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
28	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
29	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
30	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
31	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
32	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
33	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
34	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
35	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
36	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
37	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
38	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
39	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
40	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
41	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
42	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
43	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
44	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

Cable Library Volume Data:

No.	Identifier System	Cable Library Lib Volume	Type kV	Temp Shield?	SIC SIC exp	DF DF exp	Ins RHO Jac RHO	CU res AL res	ks kp	3/c configuration
1	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
2	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
3	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
4	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
5	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
6	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
7	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
8	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
9	C1 1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
10	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
11	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
12	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
13	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
14	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Cable Library Volume Data:

No.	Identifier System	Cable Library Lib Volume	Type kV	Temp Shield?	SIC SIC exp	DF DF exp	Ins RHO Jac RHO	CU res AL res	ks kp	3/c configuration
15	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
16	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
17	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
18	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
19	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
20	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
21	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
22	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
23	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
24	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
25	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
26	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
27	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
28	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
29	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
30	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
31	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
32	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations										
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Program Serial Number: 203400552										
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Filename: 0

Cable Library Volume Data:

No.	Identifier System	Cable Library Lib Volume	Type kV	Temp Shield?	SIC SIC exp	DF DF exp	Ins RHO Jac RHO	CU res AL res	ks kp	3/c configuration
33	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
34	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
35	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
36	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
37	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
38	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
39	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
40	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
41	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
42	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
43	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
44	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F AL lay F	Shield Th. Shield Dia.	Shield Rdc Calc Yse?
							kmil	Diameter			
1	1	500 kmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
2	1	500 kmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
3	1	500 kmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552
Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F AL lay F	Shield Th. Shield Dia.	Shield Rdc Calc Yse?
							kcmil	Diameter			
4	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
5	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
6	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
7	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
8	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
9	C1----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
10	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
11	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
12	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
13	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
14	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
15	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
16	C1----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
17	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
18	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
19	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
20	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
21	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
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Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F	Shield Th.	Shield Rdc
							kcmil	Diameter	AL lay F	Shield Dia.	Calc Yse?
22	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
23	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
24	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
25	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
26	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
27	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
28	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
29	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
30	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
31	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
32	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
33	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
34	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
35	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
36	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
37	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
38	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-
39	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	-	-

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
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Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F	Shield Th.	Shield Rdc
							kcmil	Diameter	AL lay F	Shield Dia.	Calc Yse?
40	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
41	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
42	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
43	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
44	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -

Duct Library Data

No.	Identifier	System	Duct Library	Duct					Covering	
				Type	RHO	Nominal Size	ID	Thickness	RHO	Thickness
1		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
2		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
3		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
4		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
5		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
6		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
7		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
8		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
9	C1	1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
10		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
11		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
12		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
13		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
14		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
15		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
16	C1	1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
17		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
18		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
19		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
20		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
21		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000

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Duct Library Data

No.	Identifier	System	Duct Library	Duct					Covering	
				Type	RHO	Nominal Size	ID	Thickness	RHO	Thickness
22		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
23		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
24		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
25		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
26		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
27		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
28		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
29		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
30		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
31		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
32		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
33		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
34		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
35		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
36		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
37		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
38		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
39		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
40		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
41		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
42		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
43		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
44		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000

CALCULATION RESULTS - Table 1 of 3

No.	Identifier	System	Temp	Amps	# Cond.	Loss Fac.	Watts/ft	Rac	Rdc	Wd	Dtd
1		1	75.000	228.4	4	1.000	5.719	27.419	25.800	0.0000	0.000
2		1	75.000	188.4	4	1.000	3.893	27.419	25.800	0.0000	0.000
3		1	75.000	172.0	4	1.000	3.243	27.419	25.800	0.0000	0.000
4		1	75.000	164.2	4	1.000	2.956	27.419	25.800	0.0000	0.000
5		1	75.000	160.0	4	1.000	2.809	27.419	25.800	0.0000	0.000
6		1	75.000	157.7	4	1.000	2.726	27.419	25.800	0.0000	0.000
7		1	75.000	156.3	4	1.000	2.678	27.419	25.800	0.0000	0.000
8		1	75.000	155.4	4	1.000	2.648	27.419	25.800	0.0000	0.000
9	C1	1	75.000	154.9	4	1.000	2.630	27.419	25.800	0.0000	0.000

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CALCULATION RESULTS - Table 1 of 3

No.	Identifier	System	Temp	Amps	# Cond.	Loss Fac.	Watts/ft	Rac	Rdc	Wd	Dtd
10		1	75.000	154.5	4	1.000	2.619	27.419	25.800	0.0000	0.000
11		1	75.000	154.4	4	1.000	2.615	27.419	25.800	0.0000	0.000
12		1	75.000	154.4	4	1.000	2.615	27.419	25.800	0.0000	0.000
13		1	75.000	154.5	4	1.000	2.619	27.419	25.800	0.0000	0.000
14		1	75.000	154.9	4	1.000	2.630	27.419	25.800	0.0000	0.000
15		1	75.000	155.4	4	1.000	2.648	27.419	25.800	0.0000	0.000
16	C1	1	75.000	156.3	4	1.000	2.678	27.419	25.800	0.0000	0.000
17		1	75.000	157.7	4	1.000	2.726	27.419	25.800	0.0000	0.000
18		1	75.000	160.0	4	1.000	2.809	27.419	25.800	0.0000	0.000
19		1	75.000	164.2	4	1.000	2.956	27.419	25.800	0.0000	0.000
20		1	75.000	172.0	4	1.000	3.243	27.419	25.800	0.0000	0.000
21		1	75.000	188.4	4	1.000	3.893	27.419	25.800	0.0000	0.000
22		1	75.000	228.4	4	1.000	5.719	27.419	25.800	0.0000	0.000
23		1	75.000	207.5	4	1.000	4.722	27.419	25.800	0.0000	0.000
24		1	75.000	162.8	4	1.000	2.908	27.419	25.800	0.0000	0.000
25		1	75.000	142.6	4	1.000	2.230	27.419	25.800	0.0000	0.000
26		1	75.000	132.0	4	1.000	1.910	27.419	25.800	0.0000	0.000
27		1	75.000	125.7	4	1.000	1.734	27.419	25.800	0.0000	0.000
28		1	75.000	121.8	4	1.000	1.626	27.419	25.800	0.0000	0.000
29		1	75.000	119.1	4	1.000	1.556	27.419	25.800	0.0000	0.000
30		1	75.000	117.3	4	1.000	1.510	27.419	25.800	0.0000	0.000
31		1	75.000	116.2	4	1.000	1.480	27.419	25.800	0.0000	0.000
32		1	75.000	115.4	4	1.000	1.462	27.419	25.800	0.0000	0.000
33		1	75.000	115.1	4	1.000	1.453	27.419	25.800	0.0000	0.000
34		1	75.000	115.1	4	1.000	1.453	27.419	25.800	0.0000	0.000
35		1	75.000	115.4	4	1.000	1.462	27.419	25.800	0.0000	0.000
36		1	75.000	116.2	4	1.000	1.480	27.419	25.800	0.0000	0.000
37		1	75.000	117.3	4	1.000	1.510	27.419	25.800	0.0000	0.000
38		1	75.000	119.1	4	1.000	1.556	27.419	25.800	0.0000	0.000
39		1	75.000	121.8	4	1.000	1.626	27.419	25.800	0.0000	0.000
40		1	75.000	125.7	4	1.000	1.734	27.419	25.800	0.0000	0.000
41		1	75.000	132.0	4	1.000	1.910	27.419	25.800	0.0000	0.000
42		1	75.000	142.6	4	1.000	2.230	27.419	25.800	0.0000	0.000
43		1	75.000	162.8	4	1.000	2.908	27.419	25.800	0.0000	0.000
44		1	75.000	207.5	4	1.000	4.722	27.419	25.800	0.0000	0.000

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CALCULATION RESULTS - Table 2 of 3

No.	Identifier	System	Yp	Qp	Spacing	GF1	GF2	Ri	Rj	Rsd	Rcap	Rd
1		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
2		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
3		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
4		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
5		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
6		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
7		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
8		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
9	C1	1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
10		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
11		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
12		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
13		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
14		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
15		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
16	C1	1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
17		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
18		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
19		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
20		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
21		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
22		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
23		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
24		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
25		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
26		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
27		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
28		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
29		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
30		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
31		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
32		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
33		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
34		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
35		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
36		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206

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CALCULATION RESULTS - Table 2 of 3

No.	Identifier	System	Yp	Qp	Spacing	GF1	GF2	Ri	Rj	Rsd	Rcap	Rd
37		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
38		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
39		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
40		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
41		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
42		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
43		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
44		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206

CALCULATION RESULTS - Table 3 of 3

No.	Identifier	System	Yc	Ycs	Ycp	Shld X	Ys	Ysc	Yse	Qs
1		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
2		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
3		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
4		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
5		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
6		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
7		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
8		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
9	C1	1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
10		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
11		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
12		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
13		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
14		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
15		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
16	C1	1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
17		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
18		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
19		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
20		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
21		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
22		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
23		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
24		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000

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CALCULATION RESULTS - Table 3 of 3

No.	Identifier	System	Yc	Ycs	Ycp	Shld X	Ys	Ysc	Yse	Qs
25		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
26		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
27		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
28		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
29		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
30		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
31		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
32		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
33		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
34		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
35		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
36		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
37		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
38		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
39		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
40		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
41		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
42		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
43		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
44		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000

Variable Definitions and Units:

Variable Label	Description	Units
# Cond	Number of conductors (not cables) at position	
1/c OD	For 3/c Cable, outside diameter of 1/c portion	
1/c Spacing	Equivalent phase spacing for 1/c cables at different positions	Inches
3/c Configuration	Type of 3/c cable, round or sector	Inches
Actual Fill %	Actual conduit fill	%
AL lay F	Lay factor for aluminum conductor	
AL Res	Aluminum electrical resistivity	
Allowable Fill %	Allowable conduit fill according to limits set by user or NEC defaults	
Amps	Calculated or specified current on a per conductor basis	%
Cable Lib	Cable data library descriptor	Amperes
Cable OD	Cable overall outside diameter	
Cable Size	Cable size designation	Inches
Cable Type	Cable type, 1/c or 3/c	
Concrete thermal resistivity (RHO)	Concrete thermal resistivity	
Cond.	Conductor Material, Copper or Aluminum	Deg C-cm/watt
Conductor Diameter	Conductor diameter	Inches

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Variable Definitions and Units:

Variable Label	Description	Units
Config	Cable configuration, non-applicable, equilateral, cradled or mixed	
CU lay F	Lay factor for copper conductor	
CU Res	Copper electrical resistivity	Cir mils ohms/ft
Current Mag	Magnitude of current used in load flow calculations	Amps
Current Deg	Phase angle of current used in load flow calculations	Degrees
Dissipation Factor	Insulation dissipation factor, (DF), overall DF = DF x e ^(DF Exp x Temp)	
Dissipation Factor Exponent	Insulation dissipation factor exponent, overall DF = DF x e ^(DF Exp x Temp)	
Distance from earth's surface to origin	Vertical distance from earth's surface to origin of coordinate system	Inches
Dist. top of ductbank to earth's surface	Vertical distance from top of ductbank concrete envelope to earth's surface	Inches
Dtd	Increment of conductor temperature rise due to dielectric losses	Deg C
Duct ID	Duct Inner diameter	Inches
Duct Library	Duct data library descriptor	
Duct RHO	Duct material thermal resistivity	Deg C-cm/watt
Duct Thickness	Duct wall thickness	Inches
Duct Type	Whether duct material is Non-magnetic, Steel or Iron	
Ductbank Geometric Factor	Calculated ductbank geometric factor	
Ductbank Height	Height of ductbank concrete envelope	Inches
Ductbank Width	Width of ductbank concrete envelope	Inches
dx	Fictitious diameter at which the effect of loss factor commences	Inches
Earth temperature	Earth ambient temperature	Deg C
Earth thermal resistivity (RHO)	Earth thermal resistivity	Deg C-cm/watt
GF1	Geometric factor for 3/c cable applying to insulation resistance	
GF2	Geometric factor for 3/c cable applying to dielectric loss	
Grd OD	Overall outer diameter of ground cables at position	Inches
Grd Qty	Quantity of ground cables at position (needed only for conduit fill calculations)	
Grd Size	Size of ground cables at position	
Grd Type	Whether ground cables are Insulated or bare	
Identifier	Cable position identifier assigned by user	
Ins RHO	Thermal resistivity of insulation	Deg C-cm/watt
Insulation Thickness	Cable insulation thickness	Inches
IpF	Insulation power factor, overall IpF = IpF x e ^(IpF Exp x Temp)	
IpF Exp	Insulation power factor exponent, overall IpF = IpF x e ^(IpF Exp x Temp)	
Jac RHO	Cable jacket thermal resistivity	Deg C-cm/watt
Jacket Thickness	Cable jacket thickness	Inches
Jam Ratio	Ratio of duct ID to cable OD, to be OK for 3 cables must be < 2.8 or > 3.2	
kcmil	Conductor area	Thou. circ mils
kp	Conductor proximity effect factor	
ks	Conductor skin effect factor	
kV	Rated cable line-to-line kilovolts	kilovolts
kVA	Circuit three phase load flow kilovoltamperes for all cables at position	kVA
kVAR	Circuit three phase load flow kilovars for all cables at position	kVAR
kVAR Loss	Total Circuit three phase kilovars losses for all cables at position	kVAR
kW	Circuit three phase load flow kilowatt for all cables at position	kW
kW Loss	Total Circuit three phase kilowatt losses for all cables at position	kW
Length	Circuit length, (one-way distance for dc as well as ac)	Feet
LF%	Load factor	%
Lib Volume	Cable Library data volume tag	
LOG10(Fd)	Log (base 10) of distance product factor	
Loss Fac	Loss factor	
Neut OD	Overall outer diameter of neutral cables at position	Inches

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

Filename: 0

Variable Definitions and Units:

Variable Label	Description	Units
Neut Qty	Quantity of neutral cables at position (needed only for conduit fill calculations)	
Neut Size	Size of neutral cables at position	
No.	Cable position number not including inactive positions	
Nom. Size	Nominal duct size	
Number of cable positions in system	Number of active cable positions in system calculation	Inches
PF %	Load Power Factor, (for voltage drop calcs)	%
Ph OD	Overall outer diameter of phase cables at position	Inches
Ph Qty	Quantity of phase cables at position	
Ph Size	Size of phase cables at position	
Qp	Loss ratio = Losses in (Conductor + Shield + Duct) / Conductor	
Qs	Loss ratio = Losses in (Conductor + Shield) / Conductor	
Qty-Type	Quantity and type (1/c or 3/c) of cables at position	
Rac	Conductor ac resistance at conductor specified or rated temperature	microhms/foot
Rated kV	Cable line-to-line kilovolt rating	kilovolts
Rcap	Overall thermal resistance between conductor & ambient	Thermal ohm-ft
Rd	Duct thermal resistance	Thermal ohm-ft
Rdc	Conductor dc resistance at conductor specified or rated temperature	microhms/foot
Reactance	Conductor ac reactance used for voltage drop calcs	ohms/1000 feet
Rep	Thermal resistance at interface zone between cable or conduit surface & ambient air	Thermal ohm-ft
Resistance	Conductor ac resistance used for voltage drop calcs	ohms/1000 feet
Ri	Insulation thermal resistance	Thermal ohm-ft
Rj	Cable Jacket thermal resistance	Thermal ohm-ft
Rsd	Thermal resistance between cable exterior and duct interior	Thermal ohm-ft
Shield	Cable shielded? Yes or No	
Shield	Shield grounding, No shield, Shield w/1 end grd or Shield w/2 end grd	
Shield Dia	Shield mean diameter	Inches
Shield Rdc	Shield dc resistance	microhms/foot
Shield Th	Shield thickness	Inches
Shld X	Mutual reactance conductor to shield	Microhms/foot
SIC	Insulation Specific Inductive capacitance (SIC), $SIC = SIC \times e^{(SIC \exp \times Temp)}$	
SIC Exp	Insulation SIC exponent, overall $SIC = SIC \times e^{(SIC \exp \times Temp)}$	
Size	Cable size designation	
Spacing	Spacing between conductors in the same phase group	Inches
Specified Amps	Specified conductor current	Amperes
Specified Temp	Specified conductor temperature	Deg C
Sys Freq	Applied power frequency in cable	Hertz
Sys kV	Applied cable line-to-line kilovolts	kilovolts
System	Number of system (assigned in order entered)	
Temp	Calculated or specified total conductor temperature	Deg C
Thermal Factor	Factor specifying relative heating at each cable position	
Type of underground system	Type of underground system, ductbank or direct buried	
Underground system filename	Path and *.ugs filename where underground system data stored	
Voltage Mag	Source or load voltage magnitude in load flow calcs	Volts
Voltage Deg	Source or load voltage phase angle in load flow calcs	Degrees
Volt Drop (+%) or Rise (-%)	Voltage drop or rise across circuit length, $= 100 \times (V_{source} - V_{load}) / V_{source}$	%
Watts/ft	Total cable watts loss per foot	Watts/foot
Wd	Cable dielectric loss	Watts/foot
x Coord	Position x coordinate	Inches
y Coord	Position y coordinate	Inches
Yc	Increment of Rac/Rdc ratio due to conductor effects = $Y_{cs} + Y_{cp}$	

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations
 Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas

Program Serial Number: 203400552

Single user license for Bucher, Willis & Ratliff, Kansas City, MO

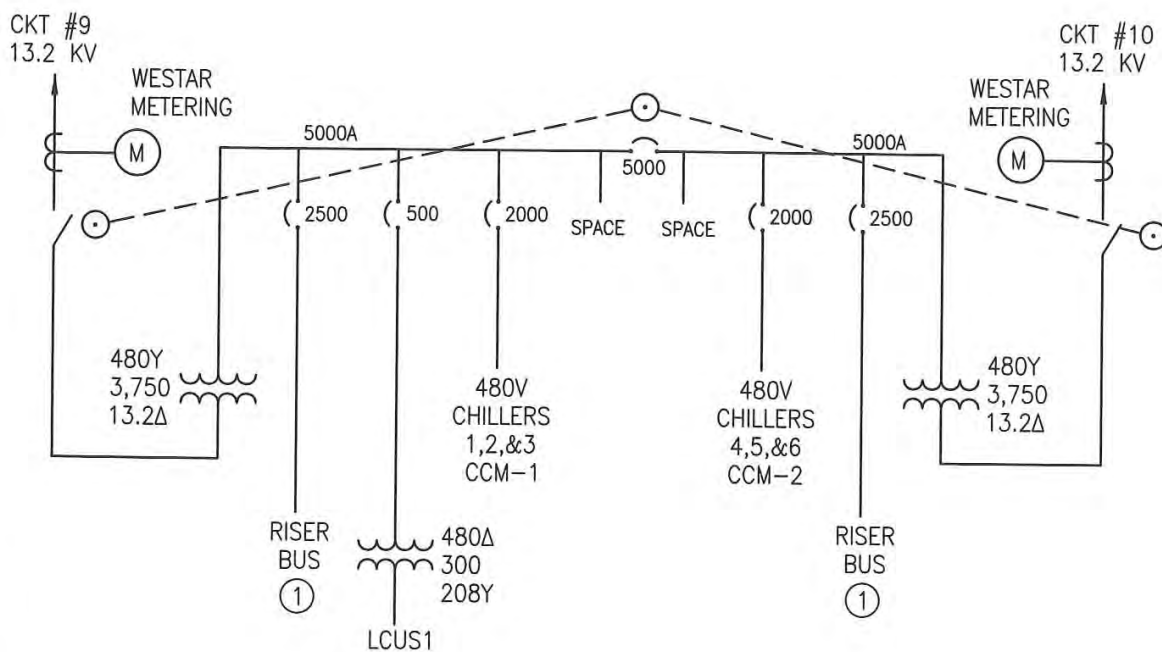
Filename: 0

Variable Definitions and Units:

Variable Label	Description	Units
Ycp	Increment of Rac/Rdc ratio due to conductor proximity effect	
Ycs	Increment of Rac/Rdc ratio due to conductor skin effect	
Yp	Increment of Rac/Rdc ratio due to pipe or conduit losses	
Ys	Increment of Rac/Rdc ratio due to total shield losses = Ysc + Yse	
Ysc	Increment of Rac/Rdc ratio due to circulating currents in shield	
Yse	Increment of Rac/Rdc ratio due to eddy currents in the shield	

APPENDIX E: ONE-LINE/RISER DIAGRAMS

Drawing Name: K:\2010-0343-KDFM-DockingElectrical\01ACAD\DWG\PROPONELINE.dwg Jan 18, 2011 - 8:07am



① RISER UP BLDG TO FEED 300 KVA XFMR, 480Δ-208Y POWER STATIONS.

PROPOSED LINE-UP (MAIN-TIE-MAIN)

NO SCALE

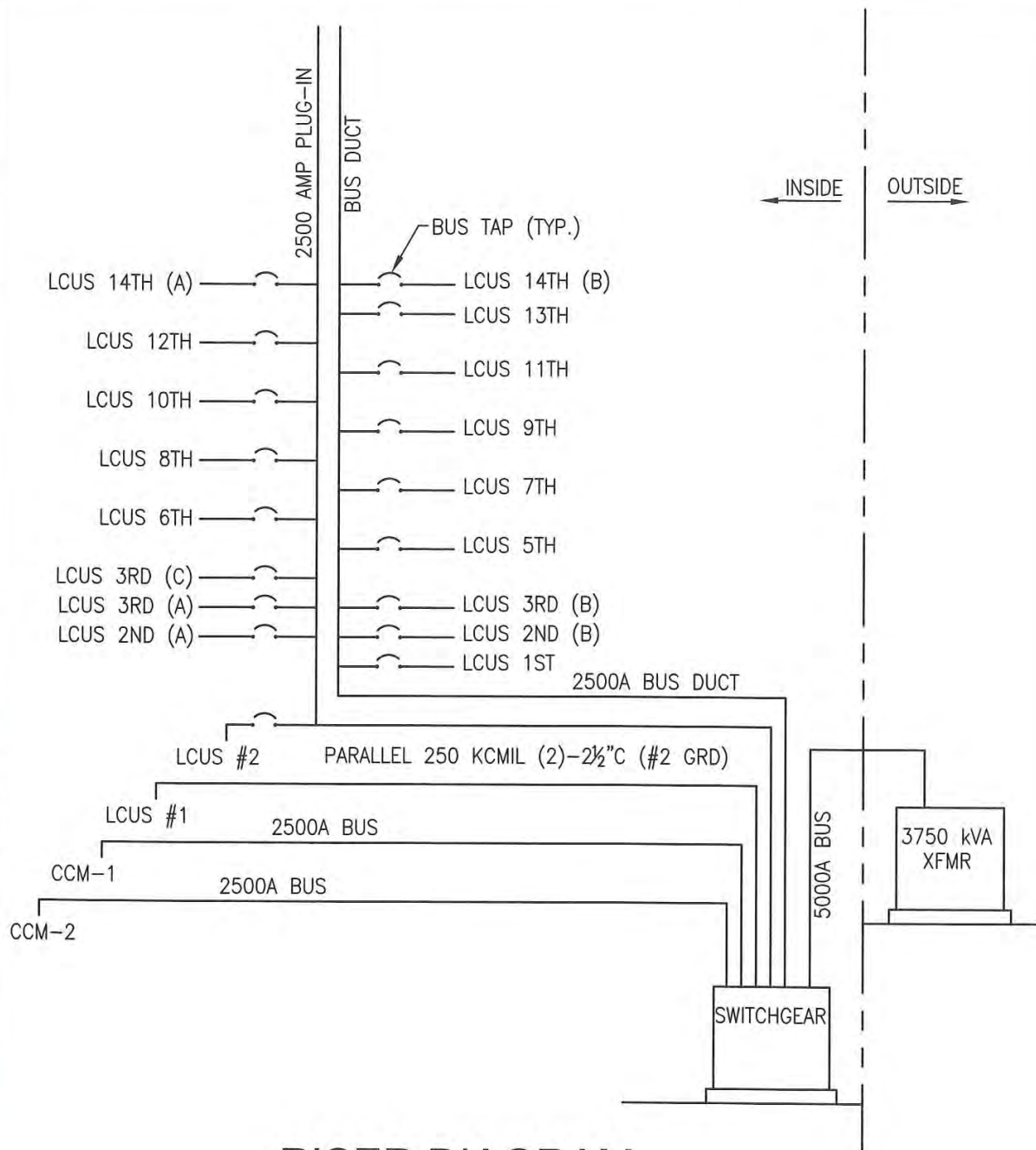
LOCHNER

BWR Division

2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

Drawing Name: K:\2010-0343-KDFM-DockingElectrical\01\ACAD\DWG\RISER-OPTIONS.dwg Jan 18, 2011 - 8:11am



RISER DIAGRAM

NO SCALE

OPTION 1

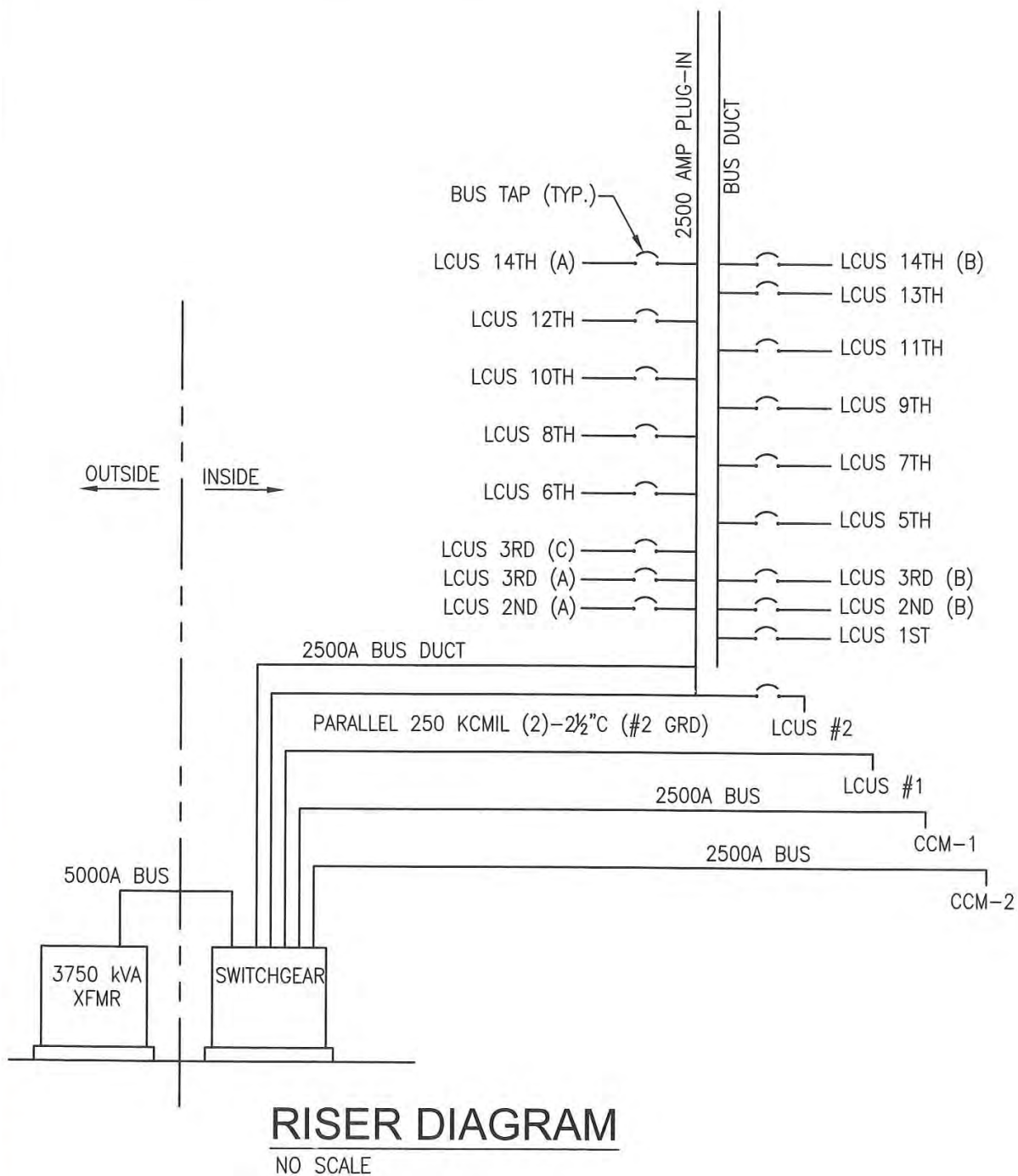
LOCHNER

BWR Division

2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

Drawing Name: K:\2010-0343-KDFM-DockingElectrical\01VACAD\DWG\RISER-OPTIONS.dwg Jan 18, 2011 - 8:13am



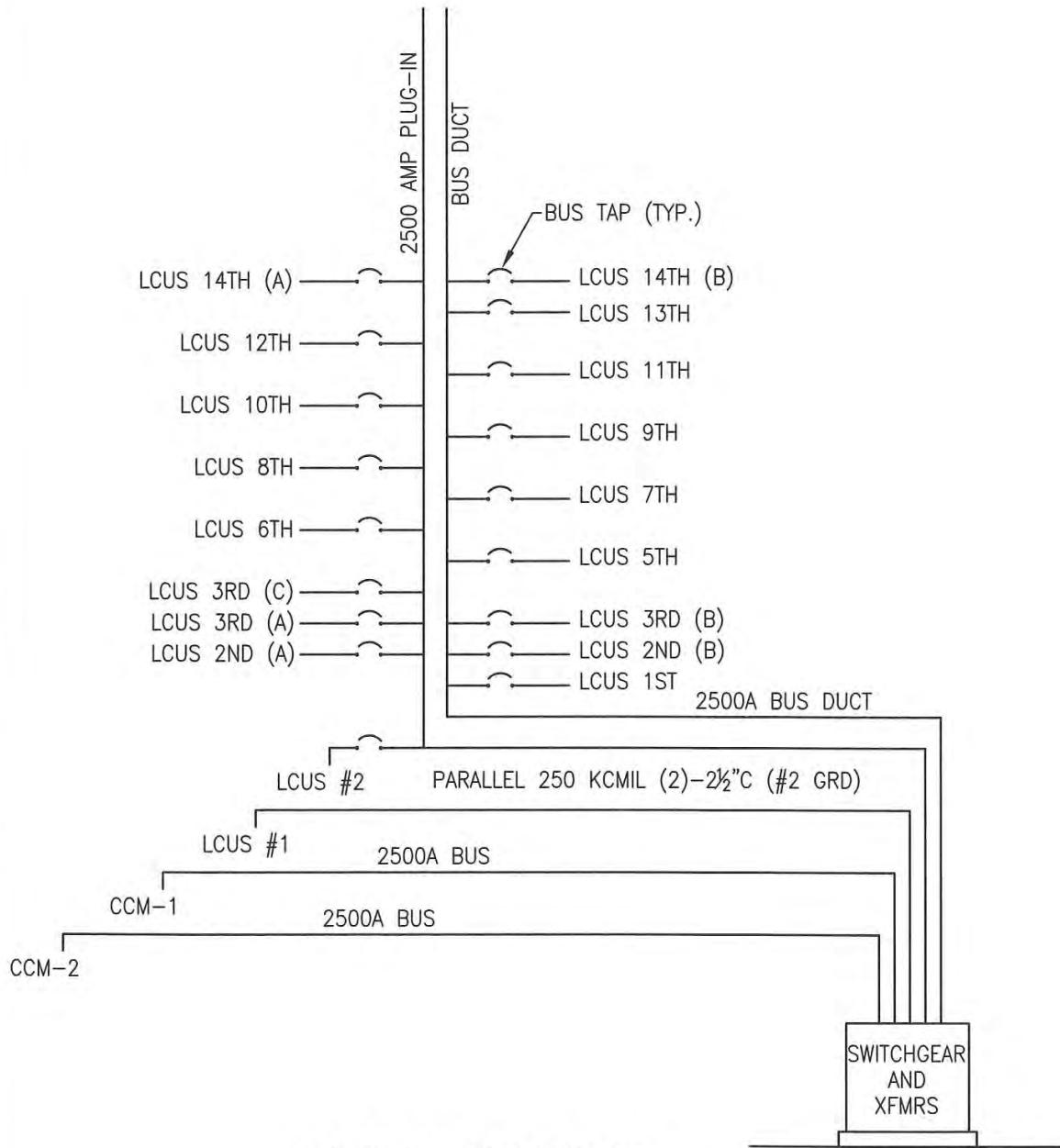
OPTION 2

LOCHNER
BWR Division

2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

Drawing Name: K:\2010-0343-KDFM-DockingElectrical\01ACAD\DWG\RISER-OPTIONS.dwg Jan 18, 2011 - 8:03am



RISER DIAGRAM

NO SCALE

OPTION 4

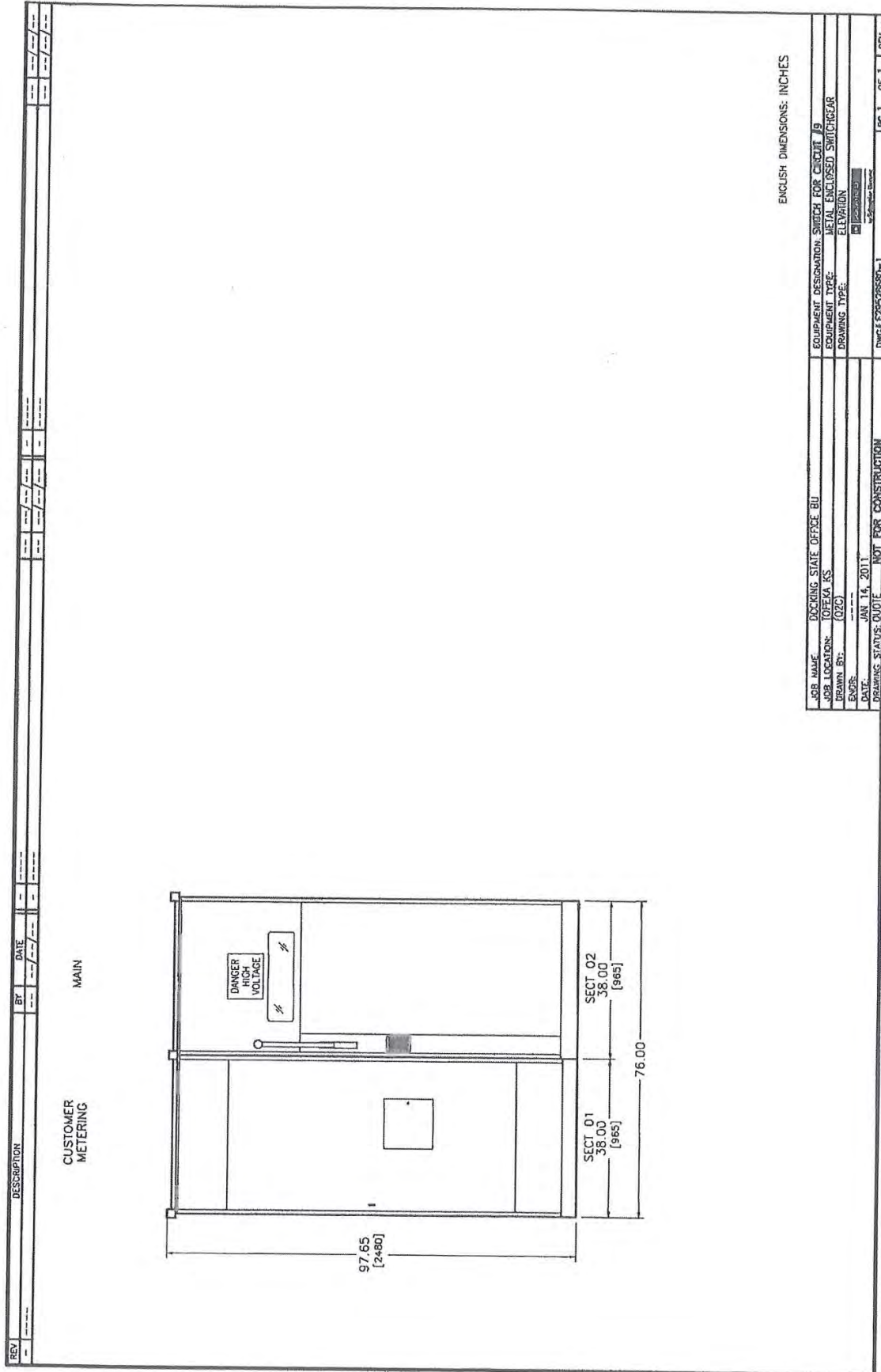
LOCHNER

BWR Division

2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

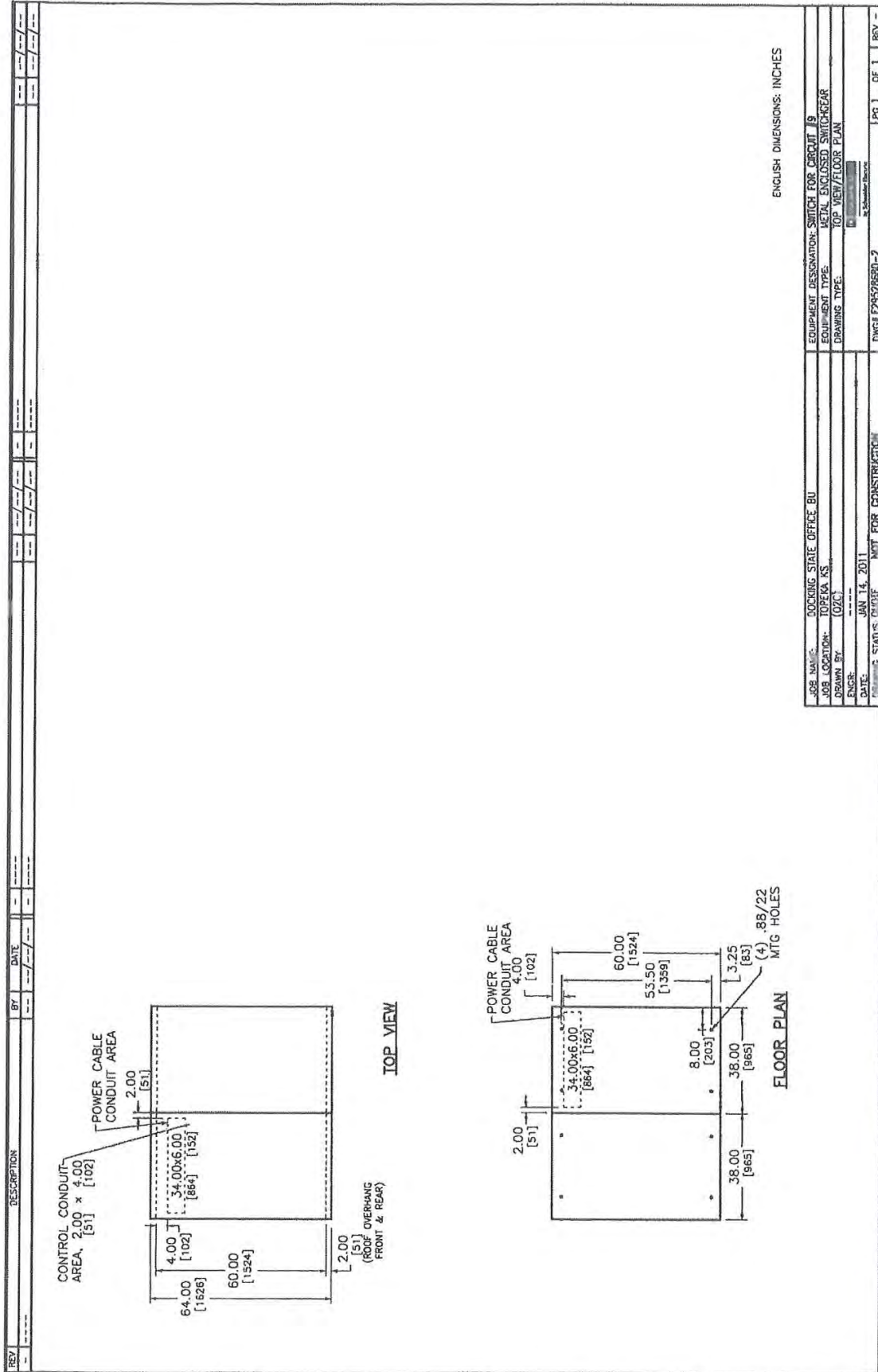
DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

APPENDIX F: OPTION 1 - TRANSFORMER AND SWITCHGEAR SHOP DRAWINGS



ENGLISH DIMENSIONS: INCHES

JOB NAME: DOCKING STATE OFFICE BU	EQUIPMENT DESIGNATION: SWITCH FOR CIRCUIT #8	EQUIPMENT TYPE: METAL ENCLOSED SWITCHGEAR
JOB LOCATION: TOPEKA KS	EQUIPMENT TYPE: METAL ENCLOSED SWITCHGEAR	EQUIPMENT TYPE: METAL ENCLOSED SWITCHGEAR
DRAWN BY: (02C)	ELEVATION	ELEVATION
DATE: JAN 14, 2011	NOT FOR CONSTRUCTION	NOT FOR CONSTRUCTION
DRAWING STATUS: 01/01E		Doc# J55526580-1
		PG 1 OF 1



REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

GENERAL NOTES:

PRODUCT DESCRIPTION AND RATINGS:

13200 VOLTS, 3 PHASE, 3 WIRE WYE SOLIDLY GROUND
 15.0 KW MAXIMUM VOLTAGE RATING
 95 KW BIL 60 HERTZ FREQUENCY
 1.5 KVA - 120 VAC CONTROL POWER

BUS SYSTEM DATA:

600A COPPER, SILVER PLATED MAIN BUS
 EPOXY BUS SUPPORTS
 SILVER PLATED COPPER GROUND BUS
 40 KA Asym (25 KA Sym) MAIN BUS BRACING

ENCLOSURE DATA:

TYPE 3R OUTDOOR NON-WALKIN CONSTRUCTION
 CATEGORY "B" ENCLOSURE
 ANSI #61 FINISH
 FRONT TYPE 3R REMOVED FOR CLARITY
 FRONT AND REAR ACCESS IS AVAILABLE
 PADLOCK PROVISIONS

TOP CABLE ENTRY: ENTRY THRU TOP TO BE PUNCHED DURING INSTALLATION
 IN GENERAL AREA SHOWN ON TOP VIEW, IF APPLICABLE. RECOMMENDED POWER CABLE
 ENTRY AREA, 6" X 34" (152 X 864) AS SHOWN ON TOP VIEW.
BOTTOM CABLE ENTRY: BOTTOMS ARE OPEN. RECOMMENDED POWER CABLE ENTRY AREA,
 6" X 34" (152 X 864) AS SHOWN ON FLOOR PLAN.

HANDLING:

SWITCHGEAR SECTIONS ARE FURNISHED WITH LIFTING ANGLES AND ARE SHIPPED ON SKIDS.
 ROLLERS OR FORKLIFT SHALL ONLY BE USED WITH SKID IN PLACE.
 APPROXIMATE WEIGHT: 2372 LBS 1078 KG
 SHIPPING SPILT 1 WEIGHT: 2372 LBS 1078 KG

CODE STANDARDS:

THIS EQUIPMENT BEARS THE UL LISTING MARK FOR THE UNITED STATES.

PRODUCT INFORMATION:

CONTROL WIRING:

#14 AWG, TYPE SIS CONTROL WIRING, UNLESS OTHERWISE SPECIFIED
 #12 AWG, TYPE SIS HEATER CONTROL WIRING

WIRE LABELING:

WIRES SHALL BE LABELED WITH DESTINATION MARKING (ORIGIN-DESTINATION).

TERMINATIONS:

LOW VOLTAGE WIRE TERMINATIONS (WHERE REQUIRED) SHALL BE
 UNINSULATED RING TYPE LUGS (STYLE 25009-XXXXX). TERMINAL

**BLOCKS ARE SQUARE D COMPRESSION SOLDERLESS BOX LUG (TYPE 9080GR6).
 FUSE BLOCK (9080GR6).**

INSTRUCTION BULLETIN:

OPTIONS/ACCESSORIES:

LIST OF MISC. ACCESSORIES:

STRIP HEATERS

LIST OF MISC. STRUCTURE OPTIONS:

LIST OF MISC. GENERAL OPTIONS:

JOB NAME:	DOCKING STAGE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT 19
JOB LOCATION:	TOPPERA KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	(026)	DRAWING TYPE:	GENERAL NOTES
DATE:	JAN 14, 2011	BY:	026/026
DRAWN BY STATUS:	DATE NOT FOR CONSTRUCTION	DATE:	026/026/026-3
REV	OF	REV	OF

REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

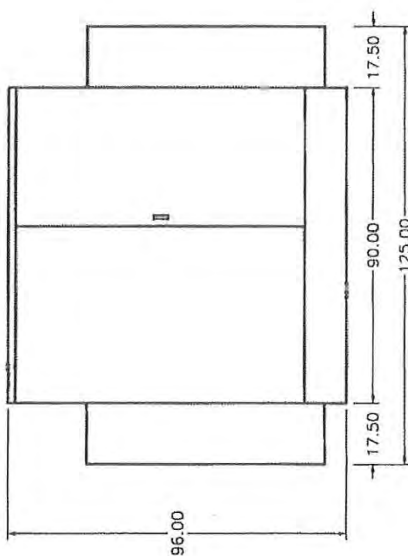
GENERAL NOTES

PRODUCT DESCRIPTION AND RATINGS

POWER SYSTEM DATA:
3750 KVA 13200 PRIMARY 480Y/277 SECONDARY
3 PHASE 60 HZ CLASS ONAN

ENCLOSURE DATA:
GENERAL PURPOSE - OUTDOOR ENCLOSURE
FINISH MUNSELL #7.05Y-3.29/1.5

ESTIMATED SHIPPING WEIGHTS:
TOTAL 17600 LB / 7990 KG



FRONT ELEVATION

ENGLISH DIMENSIONS: INCHES

PRODUCT INFORMATION

TRANSFORMER RATING

3750 KVA
13200 V
95 HV BASIC IMPULSE LEVEL (KV):
DELTA PRIMARY VOLTAGE CONNECTION:
480Y/277 SECONDARY VOLTAGE
30 LV BASIC IMPULSE LEVEL (KV):
WYE SECONDARY VOLTAGE CONNECTION:
COPPER PRIMARY CONDUCTOR:
2-2.5% SECONDARY CONDUCTOR:
TAPS: FCAN 2-2.5% FCBN
IMPEDANCE: 5.75 NOMINAL +/- 1.5%
TEMPERATURE RISE: 65 DEGREES C
INSULATION TYPE: MINERAL OIL
GALLONS: 500.0
64 DB SOUND LEVEL:
STANDARD DESIGN EFFICIENCY:

JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATION:	TRANS. for Crawl 19
JOB LOCATION:	TOPKRA	EQUIPMENT TYPE:	LIQUID FILLED TRANSFORMER
DRAWN BY:	(GDC)	DRAWING TYPE:	ELEVATION
DATE:	JANUARY 14, 2011	DATE:	01/14/2011
DRAWING STATUS:	QUOTE	DATE FOR CONSTRUCTION:	01/14/2011
A		PG 1 OF 2	REV 00

DESCRIPTION		BY	DATE	REV	
MAIN					
CUSTOMER METERING					

97.65
[2480]

DANGER
HIGH
VOLTAGE

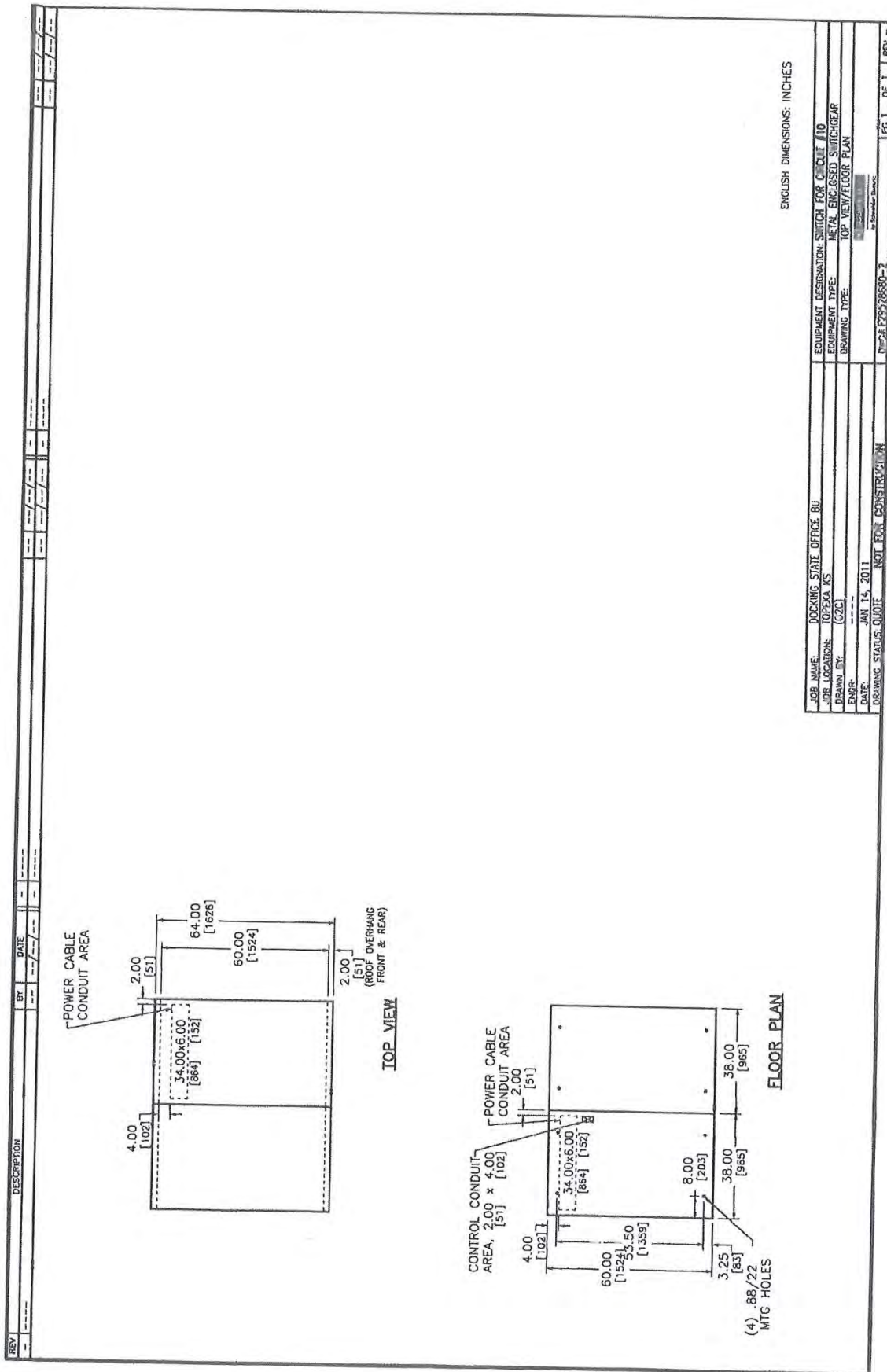
SECT 01
38.00
[965]

SECT 02
38.00
[965]

76.00

ENGLISH DIMENSIONS: INCHES

JOB NAME:	DODGING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT 110
JOB LOCATION:	TOPPER KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	(820)	DRAWING TYPE:	ELEVATION
DATE:	JAN 14, 2011		
DRAWING STATUS:	NOTE NOT FOR CONSTRUCTION	DWG#	F2652-500-1
		PC	1 OF 1 REV -



REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

GENERAL NOTES:

PRODUCT DESCRIPTION AND RATINGS:

13200 VOLTS, 3 PHASE, 3 WIRE WYE SOLIDLY GROUND
 15.0 KV MAXIMUM VOLTAGE RATING
 95 KV BIL, 60 HERTZ FREQUENCY
 1.5 MVA - 120 VAC CONTROL POWER

BUS SYSTEM DATA:

600A COPPER, SILVER PLATED MAIN BUS
 EPOXY BUS SUPPORTS
 SILVER PLATED COPPER GROUND BUS
 40 VA Asym (25 VA Sym) MAIN BUS BRACING

ENCLOSURE DATA:

TYPE JR OUTDOOR NON-WALKIN CONSTRUCTION
 CATEGORY "B" ENCLOSURE
 ANSI #61 FINISH
 FRONT TYPE JR REMOVED FOR CLARITY
 FRONT AND REAR ACCESS IS AVAILABLE

PAIDLOCK PROVISIONS

TOP CABLE ENTRY: ENTRY THRU TOP TO BE PUNCHED DURING INSTALLATION
 IN GENERAL AREA SHOWN ON TOP VIEW, IF APPLICABLE. RECOMMENDED POWER CABLE
 ENTRY AREA, 6" X 34" (152 X 864) AS SHOWN ON TOP VIEW.

BOTTOM CABLE ENTRY: BOTTOMS ARE OPEN. RECOMMENDED POWER CABLE ENTRY AREA,
 6" X 34" (152 X 864) AS SHOWN ON FLOOR PLAN.

HANDLING:

SWITCHGEAR SECTIONS ARE FURNISHED WITH LIFTING ANGLES AND ARE SHIPPED ON SKIDS.
 ROLLERS OR FORKLIFT SHALL ONLY BE USED WITH SKID IN PLACE.
 APPROXIMATE WEIGHT: 2372 LBS 1078 KG
 SHIPPING SPLIT 1 WEIGHT: 2372 LBS 1078 KG

CODE STANDARDS:

THIS EQUIPMENT BEARS THE UL LISTING MARK FOR THE UNITED STATES.

PRODUCT INFORMATION:

CONTROL WIRING:

#14 AWG, TYPE SIS CONTROL WIRING, UNLESS OTHERWISE SPECIFIED
 #12 AWG, TYPE SIS HEATER CONTROL WIRING

WIRE LABELING:

WIRES SHALL BE LABELED WITH DESTINATION MARKING (ORIGIN-DESTINATION).

TERMINATIONS:

LOW VOLTAGE WIRE TERMINATIONS (WHERE REQUIRED) SHALL BE
 UNINSULATED RING TYPE LUGS (STYLE 25009-KXXXX). TERMINAL

BLOCKS ARE SQUARE D COMPRESSION SOLDERLESS BOX LUG (TYPE 9080GR6),
 FUSE BLOCK (9080GF6).

INSTRUCTION BULLETIN:

OPTIONS/ACCESSORIES:

LIST OF MISC. ACCESSORIES:

STRIP HEATERS

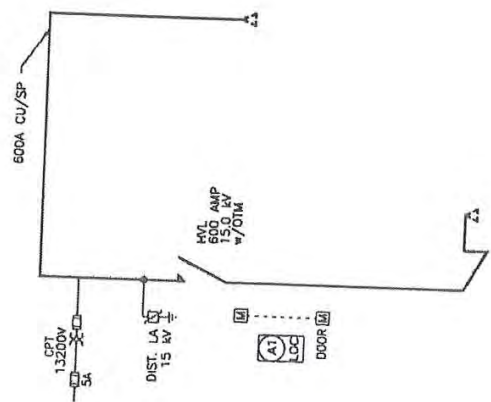
LIST OF MISC. STRUCTURE OPTIONS:

LIST OF MISC. GENERAL OPTIONS:

JOB NAME:	DOCKING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT 110
JOB LOCATION:	TO: PCA KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	020	DRAWING TYPE:	GENERAL NOTES
DATE:	JAN 14, 2011	BY:	020
DRAWING STATUS:	QUOTE	NOT FOR CONSTRUCTION	0206 F25578501-3
PC 1	OF 1	REV	-

REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE
1	MAIN SECTION UL/C-UL LABEL																		
2	CUSTOMER METERING SECTION UL/C-UL LABEL																		

LUC PROVISIONS ONLY
SUITABLE FOR TWO
500 KCMIL CABLE(S) /PH
TOP INCOMING



LUC PROVISIONS ONLY
SUITABLE FOR TWO
500 KCMIL CABLE(S) /PH
BOTTOM OUTGOING



JOB NAME:	DOCKING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT 110
JOB LOCATION:	10-22A N5	EQUIPMENT TYPE:	NET/ENCLOSED SWITCHGEAR
DESIGN BY:	Q2C	DRAWING TYPE:	ONE LINE
DATE:	JAN 14, 2011		
DRAWING STATUS:	DATE FOR CONSTRUCTION	DWG NO:	02952880-1
		PG	1 OF 1 REV -

[illegible]

GENERAL NOTES

PRODUCT DESCRIPTION AND RATINGS

POWER SYSTEM DATA:
3750 KVA 13200 PRIMARY 480Y/277 SECONDARY
3 PHASE 60 Hz CLASS ONAN

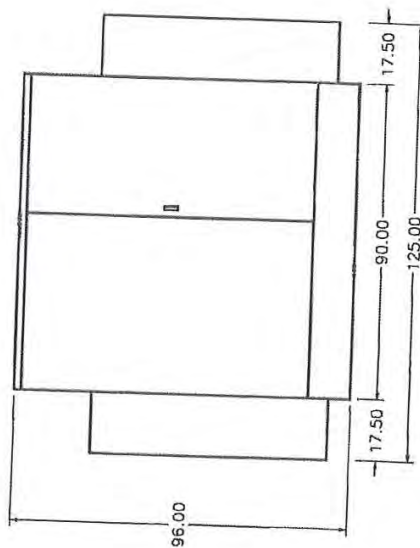
ENCLOSURE DATA:
GENERAL PURPOSE -- OUTDOOR ENCLOSURE
FINISH MUNSELL #7.0GY-3.29/1.5

ESTIMATED SHIPPING WEIGHTS:
TOTAL

PRODUCT INFORMATION

TRANSFORMER RATING

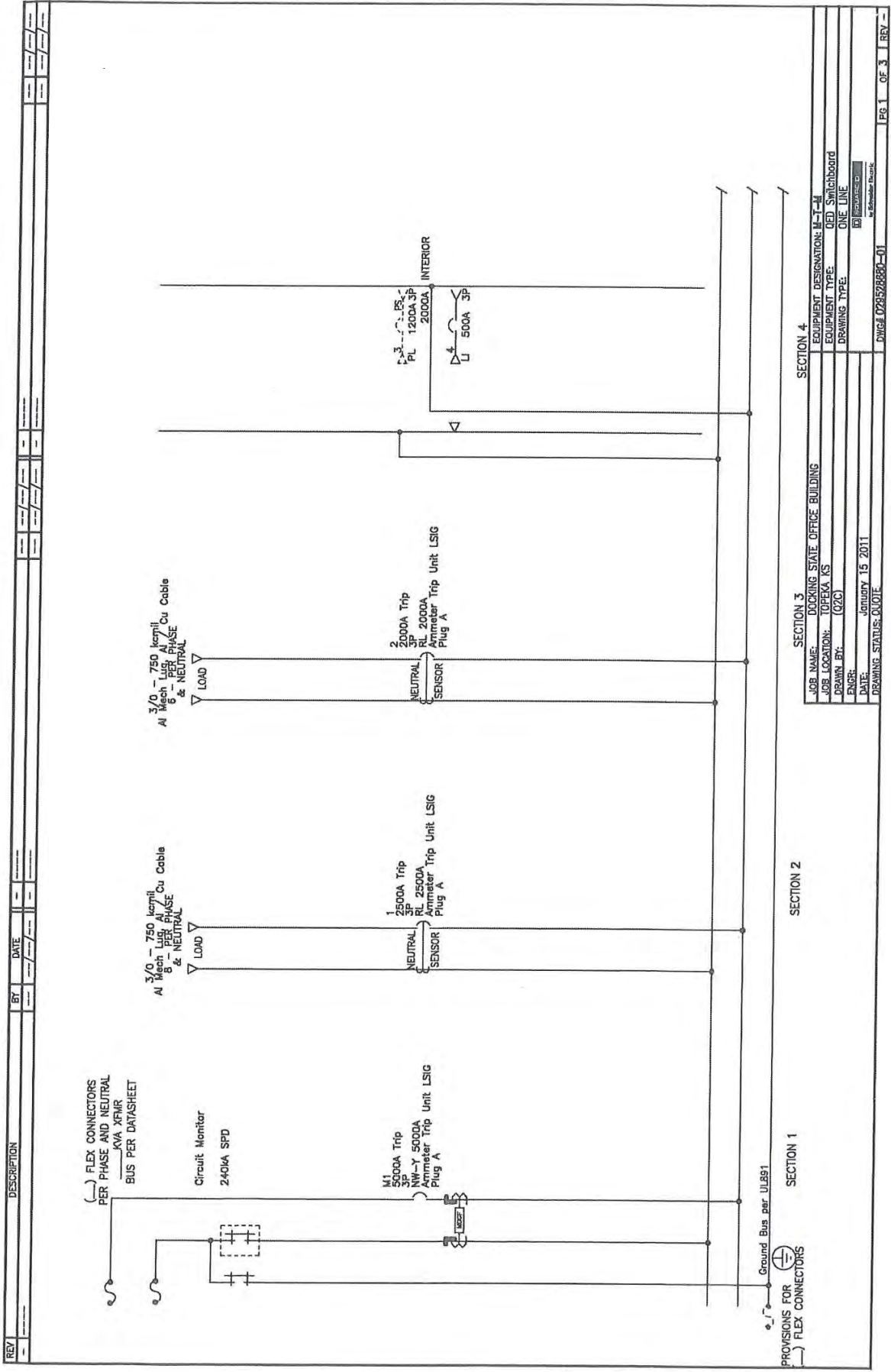
KVA:	3750
PRIMARY VOLTAGE:	13200
HV BASIC IMPULSE LEVEL (KV):	55
PRIMARY VOLTAGE CONNECTION:	DELTA
SECONDARY VOLTAGE:	560V/277
LV BASIC IMPULSE LEVEL (KV):	30
SECONDARY VOLTAGE CONNECTION:	WYE
PRIMARY CONDUCTOR:	COPPER
SECONDARY CONDUCTOR:	COPPER
TAPS:	2-2.5% FCAN
TEMPERATURE:	2-2.5% FCBN
TEMPERATURE RISE:	5.75 NOMINAL +/- 1.5%
FLUID TYPE:	65 DEGREES C
COILS:	MINERAL OIL
COILS/PHASE:	500.0
SOUND LEVEL:	64 DB
DESIGN EFFICIENCY:	STANDARD

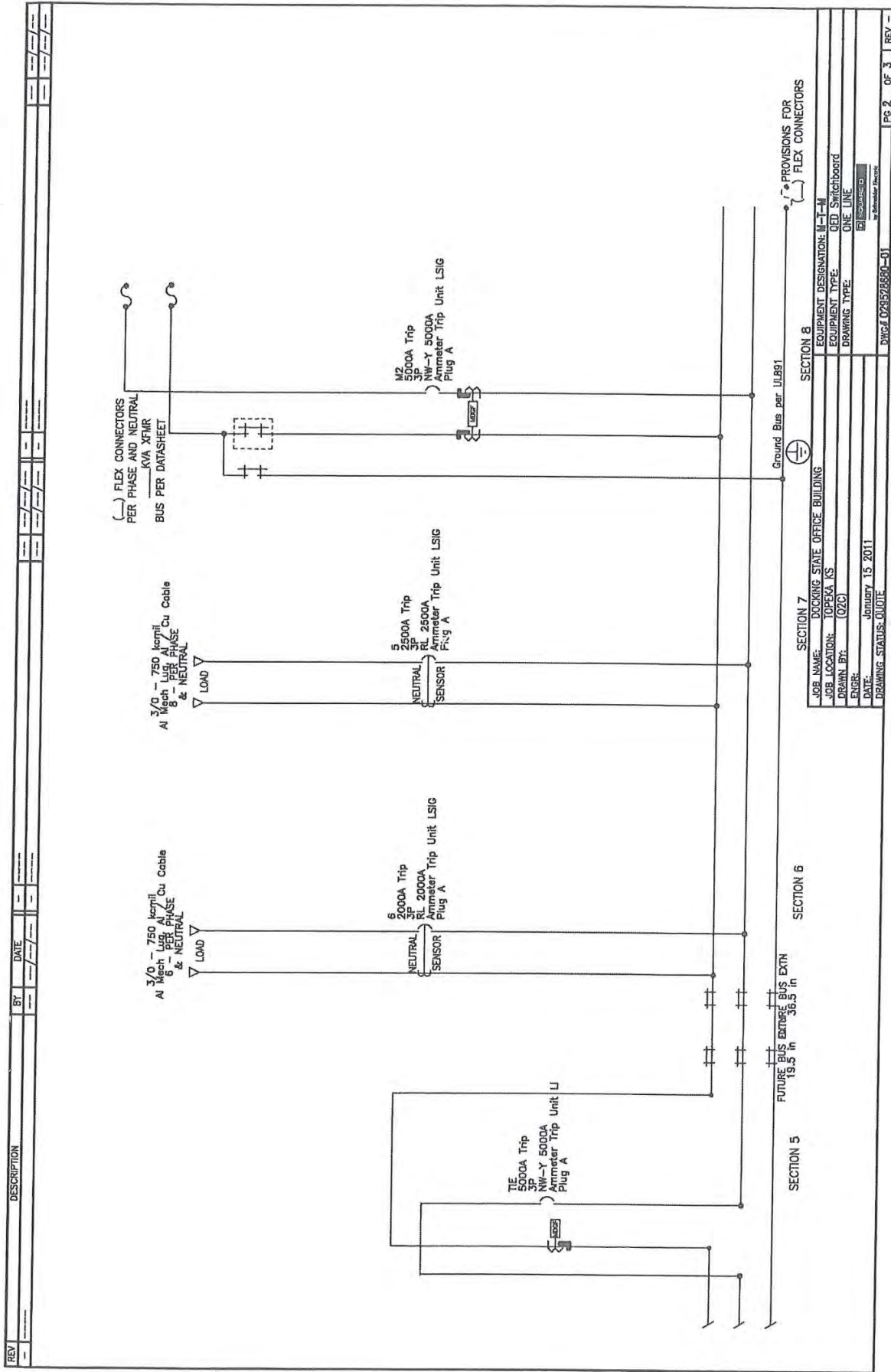


FRONT ELEVATION

ENGLISH DIMENSIONS: INCHES

JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATION:	TRANS. TO CRAN.	110
JOB LOCATION:	TOPEKA	EQUIPMENT TYPE:	LIQUID FILLED TRANSFORMER	
DRAWN BY:	OZEK	DRAWING TYPE:	ELEVATION	
ENGR:		DATE:	JANUARY 14, 2011	
ISSUED:		DATE:		
PENDING STATUS:	OJOIE	NOT FOR CONSTRUCTION		
			DWG# P749-580	PC 1 OF 2 REV 00





REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE
1				1			
2				2			
3				3			
4				4			
5				5			
6				6			
7				7			
8				8			

POWER STYLE QED-2 SWITCHBOARD

SECT	CKT	GMD	NO	NO	HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	N/P	LUG INFORMATION				ACCESSORIES
												QTY	PHASE	WIRE RANGE	QTY	
1	1	—	—	—	—	Incoming Connection	—	—	—	—	—	—	—	—	—	CM Circuit Monitor COM Communications GF Ground Fault MCH Spring Charging Motor MX1 Shunt Trip MX2 Shunt Trip Second OFB 8 Form C Breaker Aux Contacts PLA Padlock Attachment—Fixed PLC PLC Autotransfer Scheme SDE1 Over Current Trip Switch SPD Surge Protection Device UC2 Modified Differential Ground Fault XF Closing Coil
1	1	—	—	—	—	Circuit Monitor	—	—	—	—	—	—	—	—	—	
1	1	—	—	—	—	240KA SPD	—	—	—	—	—	—	—	—	—	
1	1	M1	—	—	—	NW 5000A Plug A	5000A	A—LSIG	3P	—	—	—	—	—	—	
2	1	—	—	—	—	RL 2500A Plug A	2500A	A—LSIG	3P	No	—	500 — 750 kcmil	—	—	—	
3	2	—	—	—	—	RL 2000A Plug A	2000A	A—LSIG	3P	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA	
4	3	9 in	—	—	—	PL (PS)	(1200A)	—	3P	No	6	3/0 — 750 kcmil	6	3/0 — 750 kcmil	GF,COM,PLA	
4	4	7.5 in	—	—	—	U	500A	—	3P	No	4	3/0 — 500 kcmil	4	250 — 600 kcmil	GF,COM,PLA	
5	TIE	—	—	—	—	NW 5000A Plug A	5000A	A—LJ	3P	No	2	4/0 — 500kcmil	2	250 — 600 kcmil	PLA	
6	6	—	—	—	—	RL2000A Plug A 100%	2000A	A—LSIG	3P	No	—	—	—	—	—	
7	5	—	—	—	—	RL2500A Plug A 100%	2500A	A—LSIG	3P	No	6	3/0 — 750 kcmil	6	3/0 — 750 kcmil	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA	
8	—	—	—	—	—	Incoming Connection	—	—	—	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	GF,COM,PLA	
8	M2	—	—	—	—	NW 5000A Plug A	5000A	A—LSIG	3P	—	—	—	—	—	—	
										No	—	500 — 750 kcmil	—	500 — 750 kcmil	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA	

LEGEND	
CM	Circuit Monitor
COM	Communications
GF	Ground Fault
MCH	Spring Charging Motor
MX1	Shunt Trip
MX2	Shunt Trip Second
OFB	8 Form C Breaker Aux Contacts
PLA	Podlock Attachment-Fixed
PLC	PLC Autotransfer Scheme
SDE1	Over Current Trip Switch
SPD	Surge Protection Device
UC2	Modified Differential Ground Fault
XF	Closing Coil

JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATION:	M-T-M
JOB LOCATION:	TOPEKA KS	EQUIPMENT TYPE:	QED Switchboard
DRAWN BY:	(QZC)	DRAWING TYPE:	SCHEDULE
ENGR:			
DATE:	January 15 2011		
DRAWING STATUS:	QUOTE		
		PWG# 028526880-01	PG 3 OF 3 REV -

APPENDIX G: OPTION 2 - TRANSFORMER AND SWITCHGEAR SHOP DRAWINGS

REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

GENERAL NOTES:

PRODUCT DESCRIPTION AND RATINGS:

13200 VOLTS, 3 PHASE, 3 WIRE WYE SOLIDLY GROUND
 15.0 KV MAXIMUM VOLTAGE RATING
 95 KV BIL, 60 HERTZ FREQUENCY
 1.5 MVA - 120 VAC CONTROL POWER

BUS SYSTEM DATA:

600A COPPER, SILVER PLATED MAIN BUS
 EPOXY BUS SUPPORTS
 SILVER PLATED COPPER GROUND BUS
 40 KA Asym (25 KA Sym) MAIN BUS BRACING

ENCLOSURE DATA:

TYPE 3R OUTDOOR NON-WALKIN CONSTRUCTION
 CATEGORY "B" ENCLOSURE
 ANSI #61 FINISH
 FRONT TYPE 3R REMOVED FOR CLARITY
 FRONT AND REAR ACCESS IS AVAILABLE
 PADLOCK PROVISIONS

TOP CABLE ENTRY: ENTRY THRU TOP TO BE PUNCHED DURING INSTALLATION
 IN GENERAL AREA SHOWN ON TOP VIEW, IF APPLICABLE. RECOMMENDED POWER CABLE
 ENTRY AREA, 6" X 34" (152 X 864) AS SHOWN ON TOP VIEW.

HANDLING:

SWITCHGEAR SECTIONS ARE FURNISHED WITH LIFTING ANGLES AND ARE SHIPPED ON SKIDS.
 ROLLERS OR FORKLIFT SHALL ONLY BE USED WITH SKID IN PLACE.
 APPROXIMATE WEIGHT: 2372 LBS 1078 KG
 SHIPPING SPLIT 1 WEIGHT: 2372 LBS 1078 KG

CODE STANDARDS:

THIS EQUIPMENT BEARS THE UL LISTING MARK FOR THE UNITED STATES.

PRODUCT INFORMATION:

CONTROL WIRING:

#14 AWG, TYPE SIS CONTROL WIRING, UNLESS OTHERWISE SPECIFIED
 #12 AWG, TYPE SIS HEATER CONTROL WIRING

WIRE LABELING:

WIRES SHALL BE LABELED WITH DESTINATION MARKING (ORIGIN-DESTINATION).

TERMINATIONS:

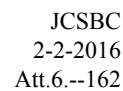
LOW VOLTAGE WIRE TERMINATIONS (WHERE REQUIRED) SHALL BE
 UNINSULATED RING TYPE LUGS (STYLE 25009-XXXXX). TERMINAL
 BLOCKS ARE SQUARE D COMPRESSION SOLDERLESS BOX LUC (TYPE 9080GR6).
 FUSE BLOCK (9080GFE).

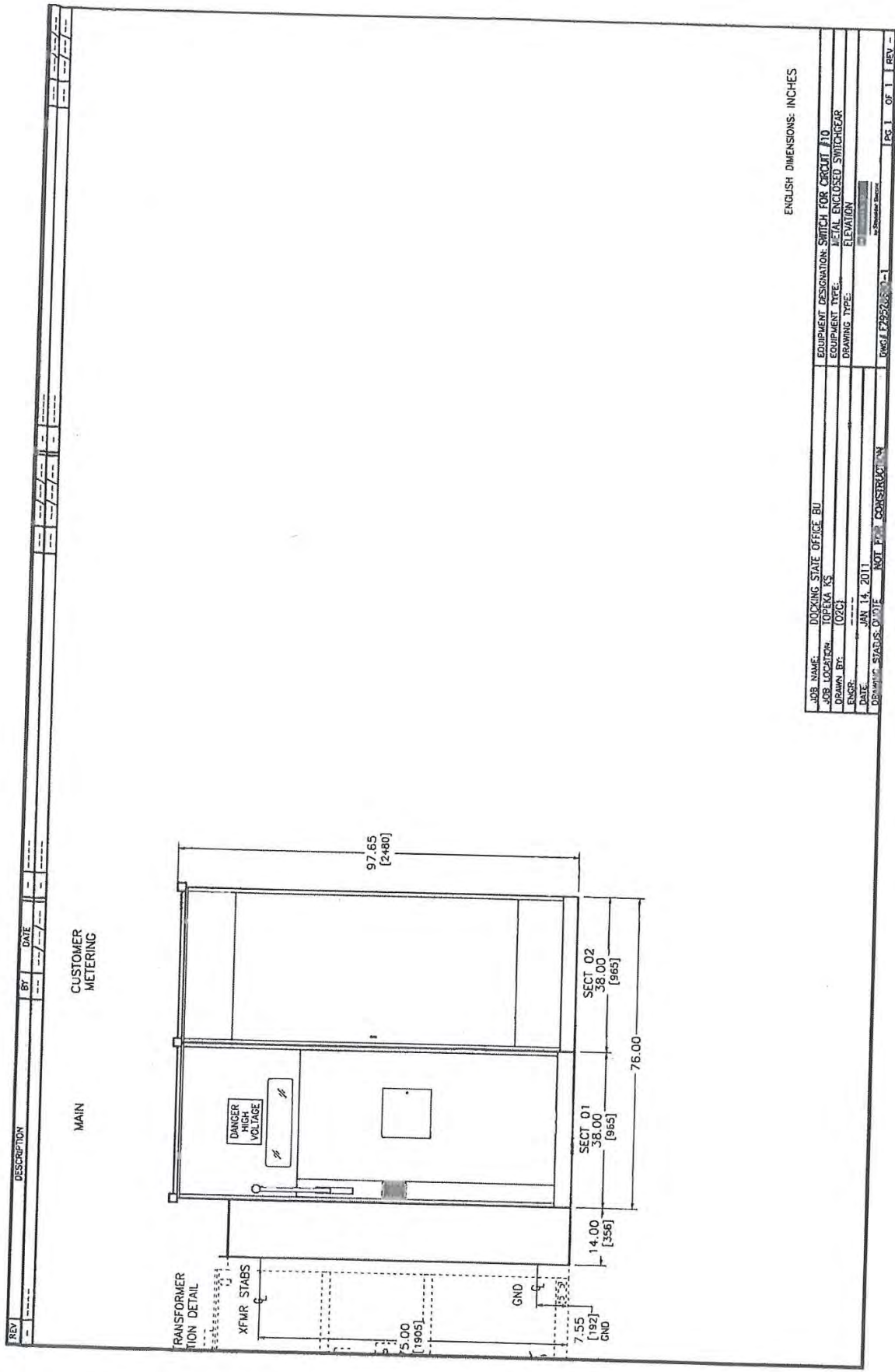
INSTRUCTION BULLETIN

OPTIONS/ACCESSORIES:

LIST OF MISC. ACCESSORIES:
 STRIP HEATERS
 LIST OF MISC. STRUCTURE OPTIONS:
 LIST OF MISC. GENERAL OPTIONS:

JOB NAME:	DOCKING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT 8
JOB LOCATION:	TOPEKA KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	(OZC)	DRAWING TYPE:	GENERAL NOTES
ENGR:		DATE:	JAN 14, 2011
DRAWING STATUS:	QUOTE	DWG#	200305500-3
NOT FOR CONSTRUCTION		PG	1 OF 1





ENGLISH DIMENSIONS: INCHES

JOB NAME:	DOCKING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT #10
JOB LOCATION:	TOPEKA KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	OCG	DRAWING TYPE:	ELEVATION
DATE:	JAN 14, 2011		
DESIGNED BY:	STATUS: DRAFT	NOT FOR CONSTRUCTION	
			DATE: 07/25/2011
			BY: [Signature]
			PG. 1 OF 1 REV. -

TOP VIEW

FLOOR PLAN

8.00 [203] 38.00 [965] 3.25 [83] (4) .88/22 MTG HOLES

15.00 [381]

9.50 [241] TYP

24.50 [622]

20.50 [521]

4.00 [102]

2.00 [51]

64.00 [1626]

60.00 [1524]

34.00x6.00 [864] [152]

GROUND

THROAT

H3

H2

H1

15.00 [381]

9.50 [241] TYP

POWER CABLE CONDUIT AREA

2.00 [51] (ROOF OVERHANG FRONT & REAR)

ENGLISH DIMENSIONS: INCHES

JOB NO.: LOCKING STATE OFFICE BU

JOB LOCATION: TOPPERA KS

DRAWN BY: (320)

ENGR: (320)

DATE: JAN 14, 2011

EQUIPMENT DESIGNATION: SWITCH FE C-CIRCUIT 110

EQUIPMENT TYPE: METAL ENCLOSED SWITCHGEAR

DRAWING TYPE: TOP VIEW/FLOOR PLAN

REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

GENERAL NOTES:

PRODUCT DESCRIPTION AND RATINGS:

13200 VOLTS, 3 PHASE, 3 WIRE WYE SOLIDLY GROUNDED
15.0 kV MAXIMUM VOLTAGE RATING
95 kV BIL 60 HERTZ FREQUENCY
1.5 kVA - 120 VAC CONTROL POWER

BUS SYSTEM DATA:

600A COPPER, SILVER PLATED MAIN BUS
EPOXY BUS SUPPORTS
SILVER PLATED COPPER GROUND BUS
40 kA Asym (25 kA Sym) MAIN BUS BRACING

ENCLOSURE DATA:

TYPE 3R OUTDOOR NON-WALKIN CONSTRUCTION
CATEGORY "B" ENCLOSURE
ANSI #61 FINISH
FRONT TYPE 3R REMOVED FOR CLARITY
FRONT AND REAR ACCESS IS AVAILABLE

PADLOCK PROVISIONS:

TOP CABLE ENTRY: ENTRY THRU TOP TO BE PUNCHED DURING INSTALLATION
IN GENERAL AREA SHOWN ON TOP VIEW, IF APPLICABLE. RECOMMENDED POWER CABLE
ENTRY AREA, 6" x 34" (152 x 864) AS SHOWN ON TOP VIEW.

HANDLING:

SWITCHGEAR SECTIONS ARE FURNISHED WITH LIFTING ANGLES AND ARE SHIPPED ON SKIDS.
ROLLERS OR FORKLIFT SHALL ONLY BE USED WITH SKID IN PLACE.
APPROXIMATE WEIGHT: 2372 LBS 1078 KG
SHIPPING SPLIT 1 WEIGHT: 2372 LBS 1078 KG

CODE STANDARDS:

THIS EQUIPMENT BEARS THE UL LISTING MARK FOR THE UNITED STATES.

PRODUCT INFORMATION:

CONTROL WIRING:

#14 AWG, TYPE SIS CONTROL WIRING, UNLESS OTHERWISE SPECIFIED
#12 AWG, TYPE SIS HEATER CONTROL WIRING

WIRE LABELING:

WIRES SHALL BE LABELED WITH DESTINATION MARKING (ORIGIN-DESTINATION).

TERMINATIONS:

LOW VOLTAGE WIRE TERMINATIONS (WHERE REQUIRED) SHALL BE
UNINSULATED RING TYPE LUGS (STYLE 25009-XXXXX). TERMINAL
BLOCKS ARE SQUARE D COMPRESSION SOLDERLESS BOX LUG (TYPE 9080GR6).
FUSE BLOCK (9080GFE).

INSTRUCTION BULLETIN:

OPTIONS/ACCESSORIES:

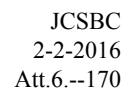
LIST OF MISC. ACCESSORIES:

STRIP HEATERS

LIST OF MISC. STRUCTURE OPTIONS:

LIST OF MISC. GENERAL OPTIONS:

JOB NAME: DOCKING STATE OFFICE - BU	EQUIPMENT DESIGNATION: SWITCH FOR CREDIT #10
JOB LOCATION: TOPEKA KS	EQUIPMENT TYPE: METAL ENCLOSED SWITCHGEAR
DRAWN BY: (02C)	DRAWING TYPE: GENERAL NOTES
ENGR: ---	BY: RESERVE
DATE: JAN 14, 2011	PROJECT: 179976380-3
DRAWING STATUS: QUOTE	NOT FOR CONSTRUCTION
	PG 1 OF 1 REV -



REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE
1				2			
3				4			
5				6			
7				8			
9				10			
11				12			
13				14			
15				16			
17				18			
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89				90			
91				92			
93				94			
95				96			
97				98			
99				100			

POWER STYLE QED-2 SWITCHBOARD

SECT NO	CKT NO	GMD HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	N/P	LUG INFORMATION			ACCESSORIES	LEGEND	
									QTY	PHASE	WIRE RANGE		QTY	NEUT. WIRE RANGE
1	1	—	Incoming Connection	—	—	—	—	—	—	—	—	—	—	CM
1	1	—	Circuit Monitor	—	—	—	—	—	—	—	—	—	—	CM
1	1	—	240kA SPD	—	—	—	—	—	—	—	—	—	—	SPD
1	M1	—	NW 5000A Plug A	5000A	A-LSIG	3P	—	No	—	500 — 750 kcmil	—	500 — 750 kcmil	—	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA
2	1	—	RL 2500A Plug A	2500A	A-LSIG	3P	—	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	—	GF,COM,PLA
3	2	—	RL 2000A Plug A	2000A	A-LSIG	3P	—	No	6	3/0 — 750 kcmil	6	3/0 — 750 kcmil	—	GF,COM,PLA
4	3	9 in	PL (PS)	(1200A)	—	3P	—	No	4	3/0 — 500 kcmil	4	250 — 600 kcmil	—	—
4	4	7.5 in	LI	500A	—	3P	—	No	2	4/0 — 500kcmil	2	250 — 600 kcmil	—	PLA
5	TIE	—	NW 5000A Plug A	5000A	A-LI	3P	—	No	—	—	—	—	—	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA
6	6	—	RL2000A Plug A 100%	2000A	A-LSIG	3P	—	No	6	3/0 — 750 kcmil	6	3/0 — 750 kcmil	—	GF,COM,PLA
7	5	—	RL2500A Plug A 100%	2500A	A-LSIG	3P	—	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	—	GF,COM,PLA
8	—	—	Incoming Connection	—	—	—	—	—	—	—	—	—	—	—
8	M2	—	NW 5000A Plug A	5000A	A-LSIG	3P	—	No	—	500 — 750 kcmil	—	500 — 750 kcmil	—	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA
														Clasing Coil

JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATOR:	W-1-M
JOB LOCATION:	TOPEKA KS	EQUIPMENT TYPE:	QED Switchboard
DRAWN BY:	(QZC)	DRAWING TYPE:	SCHEDULE
ENGR:		DATE:	January 15, 2011
DRAWING STATUS:	QUOTE	DWG#	024506880-01
		Pg	3 OF 3
		REV	—

APPENDIX H: ENGINEER'S OPINION OF PROBABLE PROJECT COSTS

STATEMENT OF PROBABLE CONSTRUCTION COSTS				DATE PREPARED 2-2-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase		
LOCATION Docking State Office Building							
ARCHITECT ENGINEER Lochner/BWR Division							
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY		

SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Option 1							
Ductbank Construction	1	LS	50000	\$50,000	0	\$0	\$50,000
Manhole	1	LS	7500	\$7,500	7500	\$7,500	\$15,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Pad	2	EA	800	\$1,600	200	\$400	\$2,000
Ceiling Modifications	1	LS	40000	\$40,000		\$0	\$40,000
5,000 Amp Copper Bus	90	LF	1500	\$135,000	300	\$27,000	\$162,000
Bus Supports	4	EA	600	\$2,400	600	\$2,400	\$4,800
Wall Penetration	2	EA	750	\$1,500	400	\$800	\$2,300
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	330	LF	70	\$23,100	70	\$23,100	\$46,200
2,500 Amp Copper Bus	1300	LF	630	\$819,000	150	\$195,000	\$1,014,000
2,500 Amp Elbow	19	EA	2550	\$48,450	500	\$9,500	\$57,950
600 Amp Plug-in Unit	18	EA	3825	\$68,850	900	\$16,200	\$85,050
Fire Stop Floor	26	EA	750	\$19,500	225	\$5,850	\$25,350
300 kVA, 480V-208Y Dry Type	19	EA	25000	\$475,000	3500	\$66,500	\$541,500
Modify MCC 1	1	LS	5000	\$5,000	5000	\$5,000	\$10,000
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	3000	\$57,000	\$114,000
Westar Charges	1	LS	100000	\$100,000	0	\$0	\$100,000
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000
Room Modifications	1	LS	50000	\$50,000	0	\$0	\$50,000
Subtotal							\$3,360,350
25% O'head & Profit							\$840,088
Subtotal							\$4,200,438
30% Contingency							\$1,260,131
TOTAL							\$5,460,569

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS				DATE PREPARED 2-2-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase		
LOCATION Docking State Office Building							
ARCHITECT ENGINEER Lochner/BWR Division							
DRAWING NO. / SECTION: ELECTRICAL							
ESTIMATOR LWS					CHECKED BY		

SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Option 2							
Ductbank Construction	1	LS	300000	\$300,000	0	\$0	\$300,000
Manhole	2	LS	7500	\$15,000	7500	\$15,000	\$30,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Pad	2	EA	800	\$1,600	200	\$400	\$2,000
5,000 Amp Copper Bus	200	LF	1500	\$300,000	300	\$60,000	\$360,000
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200
Wall Penetration	2	EA	750	\$1,500	400	\$800	\$2,300
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	270	LF	70	\$18,900	70	\$18,900	\$37,800
2,500 Amp Copper Bus	1200	LF	630	\$756,000	150	\$180,000	\$936,000
2,500 Amp Elbow	20	EA	2550	\$51,000	500	\$10,000	\$61,000
600 Amp Plug-in Unit	18	EA	3825	\$68,850	900	\$16,200	\$85,050
Fire Stop Floor	26	EA	750	\$19,500	225	\$5,850	\$25,350
300 kVA, 480V-208Y Dry Type	19	EA	25000	\$475,000	3500	\$66,500	\$541,500
Modify MCC 1	1	LS	5000	\$5,000	5000	\$5,000	\$10,000
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	1750	\$33,250	\$90,250
Westar Charges	1	LS	200000	\$200,000	0	\$0	\$200,000
Room Addition	1	LS	60000	\$60,000	0	\$0	\$60,000
Load Switchover (After Hours)	19	EA	5000	\$95,000	0	\$0	\$95,000
Subtotal							\$3,788,650
25% O'head & Profit							\$947,163
Subtotal							\$4,735,813
30% Contingency							\$1,420,744
TOTAL							\$6,156,556

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS				DATE PREPARED 2-2-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase		
LOCATION Docking State Office Building							
ARCHITECT ENGINEER Lochner/BWR Division							
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY		

SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Option 3							
Ductbank Construction	1	LS	175000	\$175,000	0	\$0	\$175,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Pad	2	EA	200	\$400	200	\$400	\$800
5,000 Amp Copper Bus	220	LF	1500	\$330,000	300	\$66,000	\$396,000
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200
Wall Penetration	2	EA	750	\$1,500	390	\$780	\$2,280
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	270	LF	70	\$18,900	70	\$18,900	\$37,800
2,500 Amp Copper Bus	1200	LF	630	\$756,000	150	\$180,000	\$936,000
2,500 Amp Elbow	20	EA	2550	\$51,000	500	\$10,000	\$61,000
600 Amp Plug-in Unit	18	EA	3825	\$68,850	900	\$16,200	\$85,050
Fire Stop Floor	26	EA	750	\$19,500	225	\$5,850	\$25,350
300 kVA, 480V-208Y Dry Type	19	EA	24900	\$473,100	3500	\$66,500	\$539,600
Modify MCC 1	1	LS	5000	\$5,000	5000	\$5,000	\$10,000
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	3000	\$57,000	\$114,000
Westar Charges	1	LS	800000	\$800,000	0	\$0	\$800,000
Room Addition	1	LS	60000	\$60,000	0	\$0	\$60,000
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000
Subtotal							\$4,290,280
25% O'head & Profit							\$1,072,570
Subtotal							\$5,362,850
30% Contingency							\$1,608,855
TOTAL							\$6,971,705

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS					DATE PREPARED 2-2-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase			
LOCATION Docking State Office Building								
ARCHITECT ENGINEER Lochner/BWR Division								
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY			
SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Option 4								
Ductbank Construction	1	LS	75000	\$75,000	0	\$0	\$75,000	
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	20000	\$40,000	\$40,000	
Ceiling Modifications	1	LS	40000	\$40,000		\$0	\$40,000	
Floor Shoring	1	LS	350000	\$350,000	0	\$0	\$350,000	
Hallway Modifications	1	LS	150000	\$150,000	0	\$0	\$150,000	
Wall Penetration	2	EA	750	\$1,500	300	\$600	\$2,100	
5,000 Amp double-ended Swgr.	1	LS	800000	\$800,000	15000	\$15,000	\$815,000	
LCUS No. 1 Feed	330	LF	70	\$23,100	70	\$23,100	\$46,200	
2,500 Amp Copper Bus	1300	LF	630	\$819,000	150	\$195,000	\$1,014,000	
2,500 Amp Elbow	19	EA	2550	\$48,450	500	\$9,500	\$57,950	
600 Amp Plug-in Unit	18	EA	3825	\$68,850	900	\$16,200	\$85,050	
Fire Stop Floor	26	EA	750	\$19,500	225	\$5,850	\$25,350	
300 kVA, 480V-208Y Dry Type	19	EA	25000	\$475,000	3500	\$66,500	\$541,500	
Modify MCC 1	1	LS	5000	\$5,000	5000	\$5,000	\$10,000	
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000	
Rerouting of existing Circuits	19	LS	3000	\$57,000	1750	\$33,250	\$90,250	
Westar Charges	1	LS	100000	\$100,000	0	\$0	\$100,000	
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000	
Room Modifications	1	LS	65000	\$65,000	0	\$0	\$65,000	
Subtotal							\$3,773,400	
25% O'head & Profit							\$943,350	
Subtotal							\$4,716,750	
30% Contingency							\$1,415,025	
TOTAL							\$6,131,775	

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS					DATE PREPARED 2-2-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase			
LOCATION Docking State Office Building								
ARCHITECT ENGINEER Lochner/BWR Division								
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS			CHECKED BY		

SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Option 5							
Ductbank Construction	1	LS	40000	\$40,000		\$0	\$40,000
Manhole	1	LS	7500	\$7,500	7500	\$7,500	\$15,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Vault	1	LS	70000	\$70,000	20000	\$20,000	\$90,000
Ceiling Modifications	1	LS	40000	\$40,000		\$0	\$40,000
5,000 Amp Copper Bus	60	LF	1500	\$90,000	300	\$18,000	\$108,000
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200
Wall Penetration	1	EA	800	\$800	350	\$350	\$1,150
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	330	LF	70	\$23,100	70	\$23,100	\$46,200
2,500 Amp Copper Bus	1300	LF	630	\$819,000	150	\$195,000	\$1,014,000
2,500 Amp Elbow	19	EA	2550	\$48,450	500	\$9,500	\$57,950
600 Amp Plug-in Unit	18	EA	3825	\$68,850	900	\$16,200	\$85,050
Fire Stop Floor	26	EA	750	\$19,500	225	\$5,850	\$25,350
300 kVA, 480V-208Y Dry Type	19	EA	25000	\$475,000	3500	\$66,500	\$541,500
Modify MCC 1	1	LS	5000	\$5,000	5000	\$5,000	\$10,000
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	3000	\$57,000	\$114,000
Westar Charges	1	LS	100000	\$100,000	0	\$0	\$100,000
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000
Room Modifications	1	LS	50000	\$50,000	0	\$0	\$50,000
Subtotal							\$3,385,600
25% O'head & Profit							\$846,400
Subtotal							\$4,232,000
30% Contingency							\$1,269,600
TOTAL							\$5,501,600

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS				DATE PREPARED 2-2-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase		
LOCATION Docking State Office Building							
ARCHITECT ENGINEER Lochner/BWR Division							
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY		
SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Option 6							
Ductbank Construction	1	LS	250000	\$250,000	0	\$0	\$250,000
Manhole	2	LS	7500	\$15,000	7500	\$15,000	\$30,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Pad	2	EA	800	\$1,600	200	\$400	\$2,000
5,000 Amp Copper Bus	160	LF	1500	\$240,000	300	\$48,000	\$288,000
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200
Wall Penetration	2	EA	750	\$1,500	400	\$800	\$2,300
Floor Supports	1	LS	50000	\$50,000		\$0	\$50,000
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	270	LF	70	\$18,900	70	\$18,900	\$37,800
2,500 Amp Copper Bus	1200	LF	630	\$756,000	150	\$180,000	\$936,000
2,500 Amp Elbow	20	EA	2550	\$51,000	500	\$10,000	\$61,000
600 Amp Plug-in Unit	18	EA	3825	\$68,850	900	\$16,200	\$85,050
Fire Stop Floor	26	EA	750	\$19,500	225	\$5,850	\$25,350
300 kVA, 480V-208Y Dry Type	19	EA	25000	\$475,000	3500	\$66,500	\$541,500
Modify MCC 1	1	LS	5000	\$5,000	5000	\$5,000	\$10,000
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	3000	\$57,000	\$114,000
Westar Charges	1	LS	200000	\$200,000	0	\$0	\$200,000
Room Addition	1	LS	60000	\$60,000	0	\$0	\$60,000
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000
Subtotal							\$3,740,400
25% O'head & Profit							\$935,100
Subtotal							\$4,675,500
30% Contingency							\$1,402,650
TOTAL							\$6,078,150

Form BWR 2008

* Material Price Included with Switchboard

Docking State Office Building Electrical Equipment Assessment

February 28, 2003

General

Introduction

The Docking State Office Building was built in 1957. The majority of the existing electrical equipment is original to the building. Due to the age of this equipment, concern has been expressed regarding its reliability and safety. A recent fire in a motor control center in the basement was attributed to faulty electrical equipment. Due to these concerns the Division of Facilities Management resolved to have an Electrical Equipment Condition Analysis performed on all of the major electrical distribution equipment in the building.

The Electrical Equipment Condition Analysis is to be performed in two phases. Phase One is an Equipment Condition Assessment. This phase is broken down further into two distinct parts. The first part is to include a visual inspection and assessment of the equipment. Nameplate data is to be recorded and photos taken of each item. Notes are to be recorded regarding the equipment's physical appearance, alignment, any corrosion, and any code violations that are observed. The availability of spare parts for each piece of equipment is also to be verified.

The second part of the Equipment Condition Assessment involves preparing specifications for mechanical, infrared and hypot testing of the equipment. Cost estimates for the testing are also to be prepared. **This report summarizes the findings of the Equipment Condition Assessment.**

Phase Two of the Electrical Equipment Condition Analysis will involve preparing a Master Plan for making repairs or replacement of the equipment assessed in Phase One. The Master Plan will include an analysis of the testing results, a prioritized list of equipment to be repaired or replaced, equipment replacement options, construction costs, logistics involved in replacing the equipment such as office space allocation, and a construction schedule. The final scope of Phase Two will not be determined until Phase One is completed

Objectives

The objectives of the project were to:

1. Evaluate code compliance of the existing equipment and it's installation.
2. Determine the availability of spare parts for the equipment.
3. Assess the equipment's overall condition.

Equipment

The equipment to be included in the assessment was limited to that with a primary electrical voltage of 208V and above. This assessment was also limited to equipment that was accessible and visible. The items to be inspected included:

- Transformers
- Switchgear
- Switchboards
- Bus Ducts
- Motor Control Centers
- Automatic Transfer Switches
- Disconnects
- Emergency Generators

Equipment Inspection

A visual inspection of the electrical equipment in the Docking State Office Building was conducted. Notes and observations regarding each piece of equipment were recorded on survey data sheets. A separate survey data sheet was utilized for each piece of equipment. The survey data sheets and photographs are organized in this report by building floor location. A summary of these observations is provided below.

Transformers

Transformer #CCM-1 is a Allis Chalmers 1500KVA, 13200-480/277V. Its date of manufacture is unknown but the transformer was rewound approximately 1980 or 22 years ago. It was recently megged and checked by KCP&L and the condition was acceptable.

Transformer #TRN-0001 is a Westinghouse 1500KVA, 12470, 480/277V. Its date of manufacture is 1968. It's shows typical wear for a transformer of this age. It is installed temporarily on wooden platforms.

Transformer #TRN-0009 is a Westinghouse 1500KVA, 13800, 480/277V. Its date of manufacture is 1969. It's shows typical wear for a transformer of this age.

There is a 300KVA, 13200/208V transformer on every floor with the exception of the 2nd, 3rd, 4th and 14th floors. The 2nd floor has three transformers, including the backup transformer listed below. The 3rd floor has three transformers and the 4th floor has none. The 4th floor transformer is located on the 3rd floor due to roof entry to other portions of the building. The 14th floor has two transformers. All transformers, although in Allis Chalmers enclosures, were replaced approximately 20 years ago; the exception is the fourteenth floor, on which neither has been replaced.

There is a 300KVA 13200/208V backup transformer on the 2nd floor that serves the building's 208V bus duct. It can be mechanically connected on any given floor. This is a newer unit than the rest, approx. 20 years old, and has been used very little.

Switchgear

The 13200V switchgear is an S & C model. There are 6 sections. Date of manufacture is unknown. There is typical wear for the age, but corrosion is minimal.

Disconnects

There is a 13.8KV disconnect on every transformer package. They are original Allis Chalmers disconnects supplied with the package transformer units. They are all 15 amp disconnects with the exception of the backup unit on the 2nd floor which is rated at 50 amps. We were only able to open the enclosure of one of these units. There was minimal deterioration and very little corrosion observed for a unit of this age.

Switchboards

There is a 208V switchboard on every transformer package. They are original Allis Chalmers switchboards supplied with the package transformer units, with the exception of the backup unit on the 2nd floor. They all have main breakers but are not labeled as to size. We observed numerous panels missing and several panels were cut out and modified to accept newer style breakers.

Motor Control Centers

MCC #1 is a new Seimans 480V unit. This equipment was being installed during our assessment. This unit replaced an older motor control center that was destroyed by fire.

MCC-00004 is a 480V Westinghouse motor control center with no nameplates or sizes. It is approximately 50 years old with considerable dust and dirt.

MCC-00016 is a 208V Square D motor control center. It has no serial number or rated size. The age is unknown and considerable dust and dirt was observed in all compartments

Automatic Transfer Switches

All of the Automatic Transfer Switches in the building are in the process of being replaced, with the exception of the 13.2KV transfer switch at the feeder entry into the building. DFM has purchased new Zenith units to replace the original ones, several of which have already been installed.

Docking State Office Building
Electrical Cost Testing Estimate
Preliminary Design

Item No.	Description	Qty.	Unit	Unit Cost	Total Cost
1	13.2kv Switch gear	6	EA	\$274	\$1,644
2	13.2kv ATS	1	EA	274	274
3	13200-480V Transformer	3	EA	548	1,644
4	13200-208V Transformer	17	EA	548	9,316
5	13.2kv Disconnect	17	EA	274	4,658
6	208V Switchboard	17	EA	274	4,658
7	480V MCC	2	EA	1,108	2,216
8	208V MCC	2	EA	1,108	2,216
9	MCC 480V Centravac Breaker	3	EA	274	822
10	208V ATS	15	EA	274	4,110
11	150 KVA Transformer	1	EA	274	274
12	13.2kv Bus Duct	1300	FT	5	6,500
14	208V Bus Duct	1300	FT	5	6,500
	Subtotal				\$44,832
	OH & P	49%			22,102
	Contingency	20%			8,966
	TOTAL				\$75,901

On August 13, 2002 an electrical fire at the Docking State Office Building in Topeka prompted an immediate evacuation of the building. Fortunately, the fire was confined to one area in the basement of the building and no one was hurt. It did however destroy the motor control center that provided power to the building's air conditioning equipment. On the morning of the fire, Kansas Division of Facilities Management personnel called DRG for assistance. Within hours a DRG employee was on site helping to assess the damage and get temporary power to critical systems in the building.

The fire brought to the State's attention the need for a complete inspection and analysis of all of the major electrical equipment in this facility. DRG had provided a proposal for such a study more than a year prior to the fire. After making some minor changes to the scope of work, DRG was given the notice-to-proceed on this very important project.

The Docking State Office Building is a 14-story office building located immediately west of the Kansas State Capitol. Approximately 2,700 people work in the Docking building.

Executive Summary

The Kansas Division of Facilities Management retained Delich, Roth & Goodwillie P.A. Engineers to perform an equipment assessment for all of the major electrical equipment in the Docking State Office Building. The first part of the assessment included a visual inspection and assessment of each piece of equipment. The second part of the assessment involved preparation of specifications for future testing of the equipment. This report is a summary of our findings from the inspection, and the aforementioned specifications.

Overall Condition

Most of the equipment in the building is approximately 50 years old, and visually in good condition with minimal corrosion observed. Maintenance has not been performed in most cases and is strongly warranted. The bus ducts were not inspected due to steel plating surrounding the bus. It is suggested that an infrared test be performed on the bus ducts during Phase 2 of this project.

Code Violations Observed

<u>Equipment</u>	<u>Floors</u>	<u>NEC Code</u>
Disconnect	Basement,1,2,3,6,9,10,12	110-26(a)
Disconnect	7 & 11	110-26(a) & 110-26(d)
Switchboard	Basement, 5	110-26(a)
Switchboard	2 & 12	110-26(a) & 110-12(a)
Switchboard	3,5,8,10,11	110-12(a)
Automatic Trans. Switch	Basement (5 Locations)	110-26(a)

Spare Parts Availability

<u>Equipment</u>	<u>Manufacturer</u>	<u>Yes/No</u>
Switchgear	S & C	Yes
Disconnect	S & C	Yes
Disconnect	Allis Chalmers	No
Disconnect	Gould ITE	Yes
Disconnect	G & W	No
Disconnect	ITE Imperial	Yes
Transformer	Allis Chalmers	No
Transformer	Westinghouse	Yes
Transformer	FPT	Yes
Transformer	Brown Boveri Electric	No
Transformer	Niagra	Yes
Transformer	SB	No
Transformer	AED	No
Switchboard	Allis Chalmers	No
Switchboard	Gould ITE	Yes
Switchboard	ITE Imperial	No
Switchboard	Westinghouse	Yes
Motor Control Center	Square D	Yes
Motor Control Center	Siemens	Yes
Motor Control Center	Westinghouse	Yes
Automatic Transfer Switch	Zenith	No

Basement	1st Floor	2nd Floor	3rd Floor	4th Floor	5th Floor	6th Floor	7th Floor
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8th Floor	9th Floor	10th Floor	11th Floor	12th Floor	13th Floor	14th Floor	
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Basement	1st Floor	2nd Floor	3rd Floor	4th Floor	5th Floor	6th Floor	7th Floor
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8th Floor	9th Floor	10th Floor	11th Floor	12th Floor	13th Floor	14th Floor	
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Basement	1st Floor	2nd Floor	3rd Floor	4th Floor	5th Floor	6th Floor	7th Floor
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8th Floor	9th Floor	10th Floor	11th Floor	12th Floor	13th Floor	14th Floor	
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Basement	1st Floor	2nd Floor	3rd Floor	4th Floor	5th Floor	6th Floor	7th Floor
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8th Floor	9th Floor	10th Floor	11th Floor	12th Floor	13th Floor	14th Floor	
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Basement	1st Floor	2nd Floor	3rd Floor	4th Floor	5th Floor	6th Floor	7th Floor
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8th Floor	9th Floor	10th Floor	11th Floor	12th Floor	13th Floor	14th Floor	
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Executive Summary

General

Basement

1st Floor

2nd Floor

3rd Floor

4th Floor

5th Floor

6th Floor

7th Floor

8th Floor

9th Floor

10th Floor

11th Floor

12th Floor

13th Floor

14th Floor

Equipment Manufacturers

Specifications

Delich Roth & Goodwillie, P.A.
Engineers

Automatic Transfer Switch: No Number, 14th Floor Mechanical Room (Elevator #2)

Date: 10/16/02

Photo# 3790

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Zenith SN 1314316.1.3 480V 225A Model # ZTSL22EX-4
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	30" live front to live front. Violates NEC Code 110(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	OK
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	OK
X	8.	Check for availability of replacement parts.		Parts are available
X	9.	Check for age and deterioration of equipment.		2 yrs old (new condition)

Disconnect: [13200V 15amp LCUS-2, Basement - North Mechanical Room](#)
[Photo #3498](#)

Date: 9/10/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		No label. Part of transformer package (see tranformer LCUS 2 (TRN-00018)). Transformer has been replaced. Old tag has been removed and new tag installed in its place.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Code violation (32" live front to live front. 20" to 6" to 8" pipes) Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	Some storage boxes and chairs are in the area.
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, deterioration is minimal.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15amp LCUS 3 \(TRN-00021\) 1st Floor N Mechanical Room](#)
[Photo # 3501](#)

Date: [9/10/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None. Part of transformer package and tag has been removed A/C Allis Chalmers Cabinets
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Live front to pipes at handle, 18". Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	Ok
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure.
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure.
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, deterioration minimal.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: 13200V 15amp LCUS 5 (TRN-00028) 2nd Floor N Mechanical Room
Photo # 3504

Date: 9/10/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Not available, part of package, nameplate removed when the transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	18" to pipes live front, very limited space in all areas. Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, deterioration minimal.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15 amp LCUS 4 \(TRN-00025\) 2nd Floor N Mechanical Room](#)
[Photo # 3507](#)

Date: [9/10/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None, part of package, Nameplate removed when transformer was replaced
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50yrs old, Deterioration minimal.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: 13200V 50A (TRN-00026) 2nd Floor N Mechanical Room
Photo # 3510

Date: 9/10/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Unit installed as backup for any 208V transformer through 208V bus duct Gould ITE Switchboard Mains 600A Voltage 13200 Delta 3phase/3W SO 17-36252-1 Install Manual 5-82
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	Ok
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Replacement Parts are available.
X	9.	Check for age and deterioration of equipment.		20 yrs old, Minimal deterioration

* Grounded with 4/0 cable, routed with 13.2KV buss duct.

Disconnect: 13200V 15A LCUS 6 (TRN-00030) 3rd Floor N Mechanical Room

Date: 9/10/02

Photo # 3513

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None, part of package. Nameplate removed when transformer was replaced
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	west wall is wire mesh with paper storage on other side
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS 7 \(TRN-00032\) 3rd Floor N. Mechanical Room](#)

Date: [9/10/02](#)

[Photo # 3516](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None, part of package. Nameplate removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure.
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure.
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Rplacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS 8 \(TRN-00031\) 3rd Floor N Mechanical Room \(Serves 4th Floor\)](#)

Date: [9/10/02](#)

[Photo # 3519](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Nameplate was removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 12" to pipes at disc. Live front less than 24" for enclosure door
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: 13200V 15A LCUS 13 (TRN-00033) 5th Floor Mechanical Room

Photo # 3521

Date: 9/10/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None, part of package. Nameplate removed when transformer was replaced
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 18" from pipe to disc. handle. Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure.
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure.
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS-12 \(TRN-00035\) 6th Floor Mechanical Room](#)

Date: [9/10/02](#)

[Photo # 3524](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None. Part of transformer package. Nameplate removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 18" to disc handle from pipe. Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS-11 \(TRN-00037\) 7th Floor Mechanical Room](#)
[Photo # 3527](#)

Date: [9/10/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None. Part of transformer package. Nameplate was removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 18" from pipe to disc. handle. Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	No lighting in Disconnect area. Violates NEC Code 110-26(d).
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS-10 \(TRN-00039\) 8th Floor Mechanical Room](#)
[Photo # 3590](#)

Date: [9/10/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None. Part of transformer package. Nameplate was removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 18" to pipe
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	No lighting in disconnect area.
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure.
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure.
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS-9 \(TRN-00041\) 9th Floor Mechanical Room](#)

Date: [9/10/02](#)

[Photo # 3593](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		None, part of transformer package, nameplate removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 19" from disc. Handle to pipe
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	No lighting in disconnect area.
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure.
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure.
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V 15A LCUS-14 \(TRN-00060\) 10th Floor Mechanical Room](#)
[Photo # 3535](#)

Date: [9/10/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Part of transformer package and Nameplate was removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 18" to pipe from disc. Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure.
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure.
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer ou of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [LCUS-15 \(TRN-00061\) 11th Floor Mechanical Room](#)

Date: [9/11/02](#)

[Photo # 3538](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Part of transformer package, namplate was removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Less than 18" from pipe to disconnect. Violates NEC Code 110-26(a).
	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	No lighting in disconnect area. Violates NEC Code 110-26(d).
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old. Minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V LCUS-16 \(TRN-00043\) 12th Floor Mechanical Room](#)
[Photo # 3542, 3543, 3544](#)

Date: [9/11/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Part of a Package, nameplate was removed when transformer was replaced.
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	Disconnect handle less than 18" from pipes. Door won't open, 24" to 13.2 buss duct. Violates NEC Code 110-26(a).
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Dirty, but very little corrosion
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13800V MDP-00039 13th Floor Mechanical Room](#)

[Photo # 3549](#)

Date: [9/11/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		G&W Electric Specialty 3500 S. 127th St Blue Island IL
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Enclosed unit with oil
	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	
	8.	Check for availability of replacement parts.		
X	9.	Check for age and deterioration of equipment.		50 yrs

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [MDP-00042 \(XF-22\)Secondary Disconnect, 13th Floor Mechanical Room](#)
[Photo # 3548](#)

Date: [9/11/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		ITE Imperial Corporation 120/208 3phase-4W SO 17-41220-1 Oct 1976
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to determine
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	8.	Check for availability of replacement parts.		Replacement Parts are available.
X	9.	Check for age and deterioration of equipment.		27 years old, Minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [13200V LCUS-18 \(TRN-00059\) 14th Floor Mechanical Room](#)
[Photo # 3553](#)

Date: [9/11/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Original Transformer (Package) Tag Allis Chalmers, Pittsburg, PA 225KVA SN 2887379 13800 208/120
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	No lighting above or around disconnect
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacment parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2V buss duct.

Disconnect: [13200V LCUS 17 \(TRN-00058\) 14th Floor Mechanical Room](#)
[Photo # 3556](#)

Date: [9/11/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Original Transformer (Package) Tag Allis Chalmers 225KVA SN 2887381 13800 208/120
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	No lighting above disconnect
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2V buss duct.

Disconnect: [MDP-00005 DSOB-SB23 to Transformer 00009](#)
[Photo # 3489](#)

Date: [9/11/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Westinghouse 3 phase Disc. Switch Max volts 15000 Max Int Cur Rat 600 amps SN WER 75691 SO WER 7569
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Replacement kits are available.
X	9.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

* Grounded with 4/0 cable, routed with 13.2V buss duct.

Disconnect: [CCM-1 \(B\) Basement mezzanine](#)

Date: [9/9/02](#)

[Photo # 3469](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		S&C Electric Company, Chicago IL S&C Metal Enclosed Switchgear Cat # CD-409512 13.8V Duty cycle fault closing amps 40000
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Replacement parts are available
X	9.	Check for age and deterioration of equipment.		20 yrs old

MCC: [MCC-00010 Basement Mezzanine \(operates centrvac #1\)](#)
[Photo # 3480, 3483](#)

Date: 9/9/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Allis Chalmers Type RC-216B HP 300 30 440 volt SN 2-1468-24540 Part # 14-224-853
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to determine
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	8.	Check for availability of replacement parts.		Replacement parts are not available. Retrofit replacement kits are available.
X	9.	Check for age and deterioration of equipment.		Breaker will not trip when trip button is pressed. Opened bottom door and breaker should have tripped. Typical dirt & debris. Last cleaned 1988

* Grounded with 4/0 cable, routed with 13.2v buss duct.

MCC: MCC-00013 Basement Mezzanine (operates central HVAC #3)
Photo #3481

Date: 9/9/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Allis chalmers Type RC-216B HP 300 3 phase 440 volt 60 cycle SN 2-1468-24540 Part # 14-224-853
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	8.	Check for availability of replacement parts.		Replacement parts not available. Retrofit kits are available.
X	9.	Check for age and deterioration of equipment.		Breaker won't reset after tripping--takes 2-3 times to reset. 50 yrs old.

* Grounded with 4/0 cable, routed with 13.2v buss duct.

MCC: [MCC-0014 Basement Mezznine \(Operates Centravac #2\)](#)
[Photo # 3482](#)

Date: 9/9/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Allis Chalmers Type ARC-216B HP 300 3 phase 440 volt 60 cycles SN # 2-1468-24540 Part # 14-224-853
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Replacement parts not available. Retrofit kits are available.
X	9.	Check for age and deterioration of equipment.		50 yrs old

* Grounded with 4/0 cable, routed with 13.2V buss duct.

Working normally. Question on ACC(3) which centravac goes to which breaker? Need to label accordingly.

Disconnect: [Boiler Disc. 800A](#)
[Photo # 3485](#)

Date: 9/9/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Square D Panel Board 480V Cat # 4590-8 EI Series 800 amps 3 pahse Door cat #QMB0367-W Series EI Hi-cap fuses time delay current limiting
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	working normally
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	OK
X	8.	Check for availability of replacement parts.		Replacement parts are available
X	9.	Check for age and deterioration of equipment.		Approx. 10 yrs old

* Grounded with 4/0 cable, routed with 13.2v buss duct.

Disconnect: [LCUS-1 \(TRN-00015\) \(Disconnect not labeled\) at Center Mezzanine](#)
[Photo # 3474](#)

Date: 9/9/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		S&C Cat # CD-409512 Volt 13.8 Fused at 600v
X	2.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	3'-8" front clearance
X	3.	Verify that working space or dedicated space is not used for storage.	110-26(b)	OK
X	4.	Check adequacy of access to working space.	110-26(c)	OK
X	5.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	6.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure
X	7.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to open enclosure
X	8.	Check for availability of replacement parts.		Replacement parts are available
X	9.	Check for age and deterioration of equipment.		Approx. 10 yrs old

* Grounded with 4/0 cable, routed with 13.2V buss duct.

Emergency Distribution Panel: [MCC-0007](#)

Date: [9/9/02](#)

[Photo # 3496, 3497](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Nameplate Data	700-5	No serial number Westinghouse SO KC-36831 IT.11 120/208Y 3phase 4W 1200 amp
X	2.	Verify that power sources are suitable and capable of supplying the load within 10 seconds and maintaining the load for at least 1 1/2 hours.	700-12	Yes
X	3.	Verify that generators, if used, have on-site fuel adequate for at least 2 hours of operation and that fuel pumps, if any, are supplied by emergency power.	700-12(b)	Yes
	4.	Verify that unit equipment, if used, is fixed in place and connected to the same circuit that supplies normal lighting to the area, ahead of any local switches.	700-12(e)	Yes
X	5.	Verify that transfer equipment is automatic, identified for emergency use, equipped with means for bypass, electrically operated, and mechanically held.	700-6	Yes
X	6.	Verify that transfer equipment supplies only emergency loads.	700-6(d)	Yes
	7.	Verify that audible and visual signals are provided as required. (Automatic disconnection of emergency systems on ground faults is not required.)	700-7, 700-26	N/A
X	8.	Check for signs at service equipment indicating emergency system type and location, and for signs at grounding locations indicating sources connected.	700-8	No signs
X	9.	Check boxes and enclosures for permanent identification as components of the emergency system.	700-9(a)	labeled with paper tags
X	10.	Verify that emergency wiring is entirely independent of other wiring, except as specifically permitted for common enclosures, fixtures, and boxes.	700-9(b)	Yes
X	11.	Verify that testing is conducted as required and that a written schedule and record for periodic testing and maintenance is provided.	700-4	All compartments are dirty. No maintenance provided.

Motor Control Center: [MCC-00016 208V Fed from 550 amp breaker in LCUS-1 dist panel](#)
[Photo # 3477, Typ. bucket #3478, 3479](#)

Date: [9/9/02](#)

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Square D Class 8938 208V Type WE 122FA2166 Diagram 306097-A1, 306097-Sa
X	2.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Inspected all compartments (but one) main centravac control locked in off position with keyed lock. All compartments dirty, dusty, some have foreign debris. Several compartments have wire ??? and splices.
X	3.	Verify that unused openings are closed.	110-12(a)	OK
X	4.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	5.	Check temperature ratings of terminations.	110-14(c)	Unable to determine
X	6.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	7.	Verify that working space or dedicated space is not use for storage.	110-26(b)	OK
X	8.	Check adequacy of access to working space.	110-26(c)	OK
X	9.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	10.	Check labeling and identification.		Need work on labeling. Several labels are not current.
X	11.	Check for availability of replacement parts.		Replacement Parts are available
X	12.	Check for age and deterioration of equipment.		Equipment is dirty, does not look as though it has a maint. program. All compartments have dust, dirt and foreign debris. Age is Unknown.

Switchboard: [208V LCUS-10 \(TRN-00039\) 8th Floor Mechanical Room](#)
[Photo # 3532](#)

Date: 9/10/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		Nametag removed when transformer was replaced.
X	2.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Dirty No maintenance for 5 years.
X	3.	Verify that unused openings are closed.	110-12(a)	One panel missing
X	4.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	5.	Check temperature ratings of terminations.	110-14(c)	Unable to determine
X	6.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	7.	Verify that working space or dedicated space is not use for storage.	110-26(b)	OK
X	8.	Check adequacy of access to working space.	110-26(c)	OK
X	9.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	10.	Check labeling and identification.		OK
X	11.	Check for availability of replacement parts.		Equipment no longer made. Manufacturer out of business. Replacement parts not found.
X	12.	Check for age and deterioration of equipment.		50 yrs old, minimal deterioration.

*Grounded with 4/0 cable, routed with 13.2v buss duct

Switchgear: CCM-1 (A) No. 5 AC Elec Boiler Bank; No. 6 Kitchen water & Sewer, elevator exhaust fan, No. 7 Bus Duct Riser --Building through 14th floor
Photo# 3472

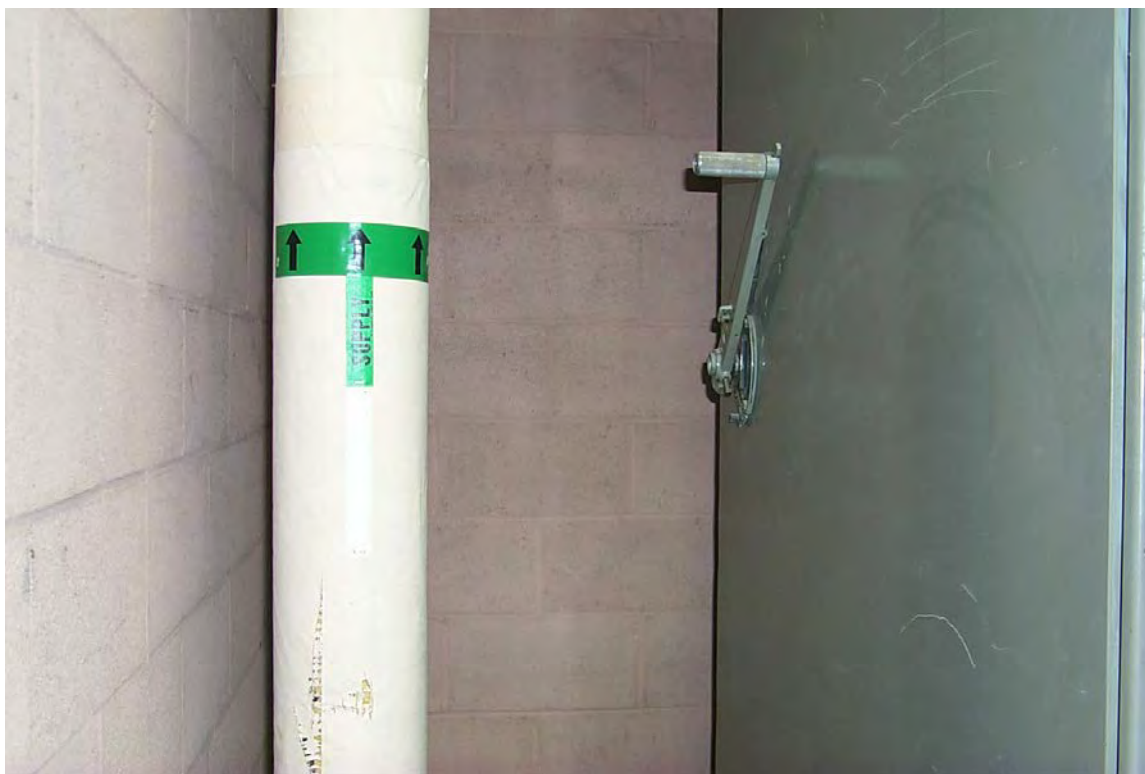
Date: 9/9/2002

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Check name plate data.		S&C Cat # CD28102 Volts 15000
X	2.	Check for broken or damaged parts and contamination by foreign materials.	110-12(c)	Unable to open enclosure. Western Resources provides maintenance.
X	3.	Verify that unused openings are closed.	110-12(a)	OK
X	4.	Check for proper use and ratings of splices and terminations.	110-14(a), 110-14(b)	Unable to determine
X	5.	Check temperature ratings of terminations.	110-14(c)	Unable to determine
X	6.	Verify adequate working clearances, dedicated spaces, and headroom around equipment.	110-26(a), 110-26(e), 110-26 (f)	OK
X	7.	Verify that working space or dedicated space is not use for storage.	110-26(b)	OK
X	8.	Check adequacy of access to working space.	110-26(c)	OK
X	9.	Verify that working spaces have adequate illumination.	110-26(d)	OK
X	10.	Check labeling and identification.		Labels should be engraved (Now tape)
X	11.	Check for availability of replacement parts.		Replacement parts available
X	12.	Check for age and deterioration of equipment.		Age is unknown

Transformer: [No Label--Heat Plant fed from Statehouse Chiller MC0004](#)
[Photo #3495](#)

Date: 9/9/02

X	Item	Inspection Activity	NEC Reference	Comments
X	1.	Nameplate Data		Westinghouse 150KVA SN 84F33985 Style V48M28F49N 480V 208/120 Model DT-3
	2.	Verify that overcurrent protection for transformers over 600 volts is provided and properly sized.	Table 450-3(a)	N/A
X	3.	Verify that overcurrent protection for transformers 600 volts or less is provided and properly sized.	Table 450-3(b)	OK
X	4.	Verify that overcurrent protection is provided for transformer primary conductors.	240-4, 240-21, 240-100	OK
X	5.	Verify that overcurrent protection is provided for transformer secondary conductors.	240-4, 240-21 240-100	OK
X	6.	Check transformer installations for adequate ventilation and spacing from walls and obstructions.	450-9	OK
X	7.	Check transformers for ready access or proper installation in the open or in hollow spaces.	450-13	OK
X	8.	Check indoor dry-type transformers for separation from combustibles or, based on ratings, installation in fire-resistant rooms or vaults.	450-21	OK



Picture #3535

Disconnect for LCUS-14 (TRN-00060)
13200V
15A
10th Floor Mech. Room



Picture #3536

Transformer LCUS-14 (TRN-00069)

300kva

13200V

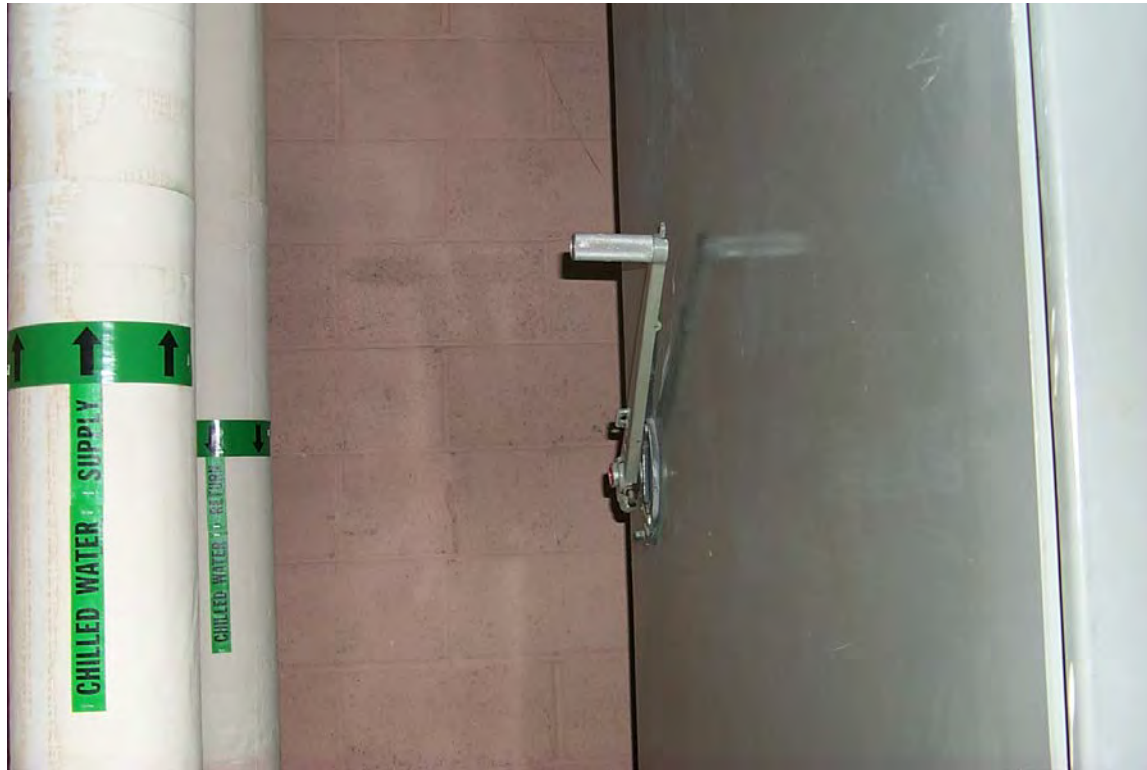
208Y/120

10th Floor Mech. Room



Picture #3537

Switchboard for LCUS-14 (TRN-00060)
208V
10th Floor Mech. Room



Picture #3538

Disconnect for LCUS-15 (TRN-00061)
13200V
15A
11th Floor Mech. Room



Picture #3538

Transformer LCUS-15 (TRN-00061)

300kva

13200V

208Y/120

11th Floor Mech. Room



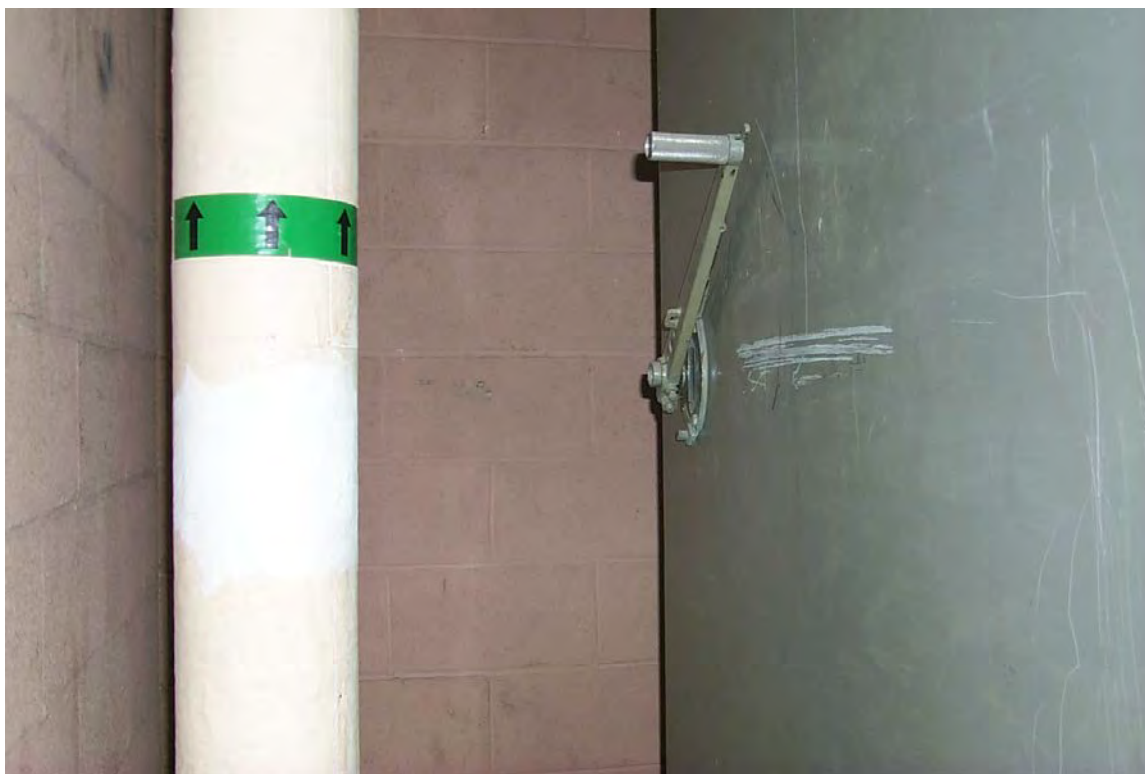
Picture #3540

Switchboard for LCUS-15 (TRN-00061)
208V
11th Floor Mech. Room



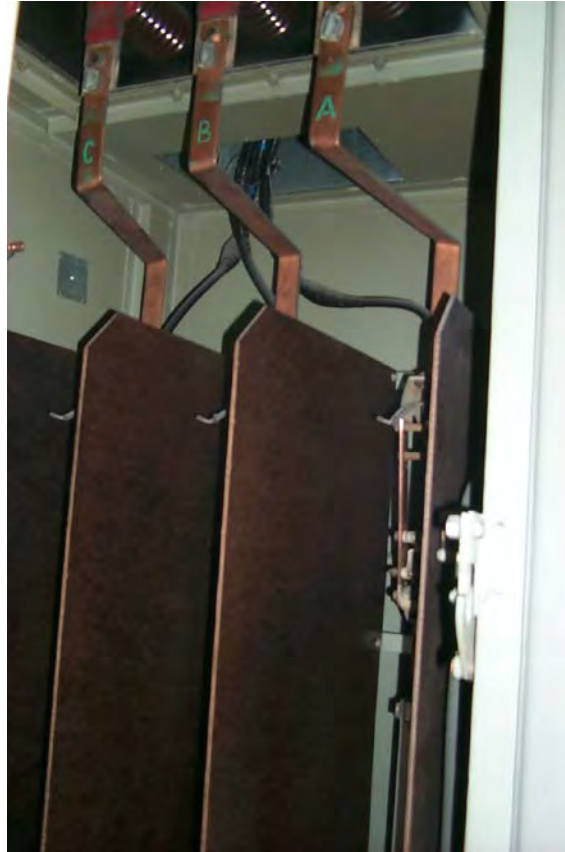
Picture #3541

Switchboard for LCUS-15 (TRN-00061) Continued
208V
11th Floor Mech. Room



Picture #3544

Disconnect for LCUS-16 (TRN-00043)
13200V
15A
12th Floor Mech. Room



Picture #3542

Disconnect for LCUS-16 (TRN-00043) Continued
13200V
15A
12th Floor Mech. Room



Picture #3543

Disconnect for LCUS-16 (TRN-00043) Continued
13200V
15A
12th Floor Mech. Room



Picture #3545

Transformer LCUS-16 (TRN-00043)

300kva

13200V

208Y/120

12th Floor Mech. Room



Picture #3547

Switchboard for LCUS-16 (TRN-00043)
208V
12th Floor Mech. Room



Picture #3549

Disconnect MDP-00039
13800V
15A
13th Floor Mech. Room



Picture #3550

Transformer TRN-00046
300kva
13800V
208Y/120
13th Floor Mech. Room



Picture #3548

Disconnect MDP-00042
208V
13th Floor Mech. Room



Picture #3552

Switchboard for LCUS-18
208V
13th Floor Mech. Room



Picture # 3789

Automatic Transfer Switch (No number)
(Freight Elevator)
600V Rating, 208V
200A
13th Floor-Freight Elevator Head House



Picture #3553

Disconnect for LCUS-18 (TRN-00059)
13200V
15A
14th Floor Mech. Room



Picture #3554

Transformer LCUS-18 (TRN-00059)

225kva

13800V

208Y/120

14th Floor Mech. Room



Picture #3555

Switchboard LCUS-18 (TRN-00059)
208V
14th Floor Mech. Room



Picture #3556

Disconnect for LCUS-17 (TRN-00058)
13200V
15A
14th Floor Mech. Room



Picture #3557

Transformer LCUS-17 (TRN-00058)

225kva

13800V

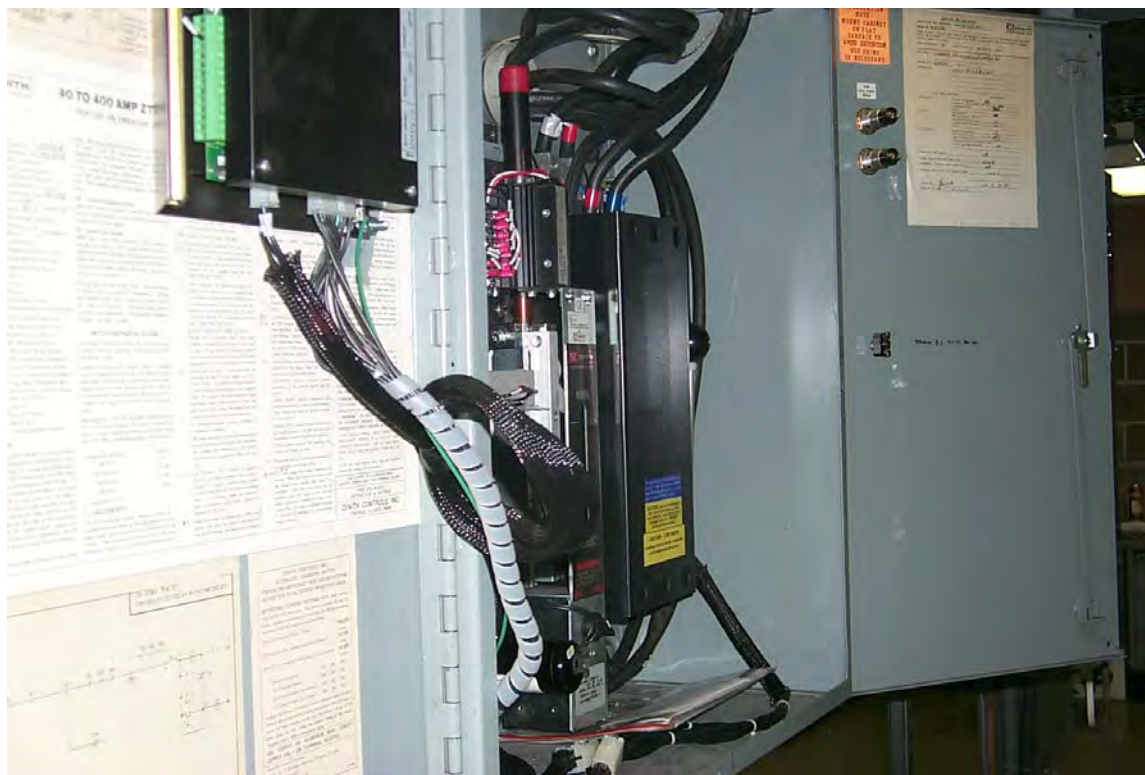
208Y/120

14th Floor Mech. Room



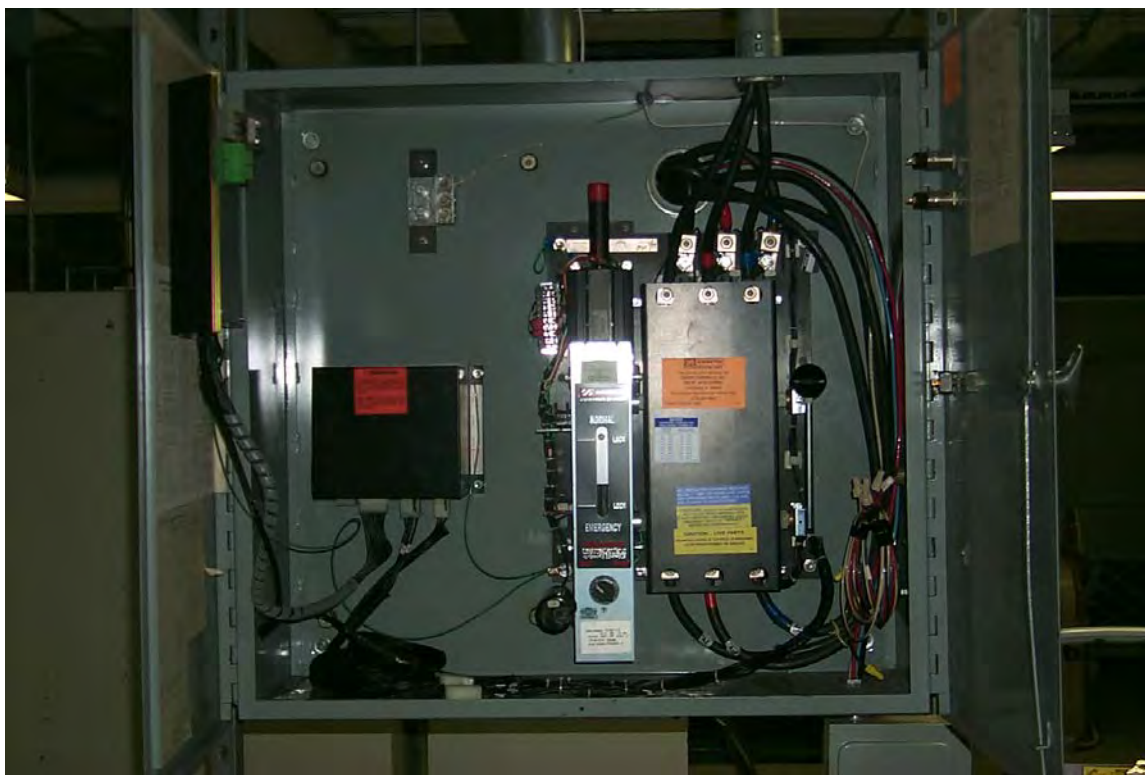
Picture #3557

Switchboard for LCUS-17 (TRN-00058)
208V
14th Floor Mech. Room



Picture # 3790

Automatic Transfer Switch (No number)
(Elevator #2)
480V rating, 208V
225A
14th Floor Mech. Room



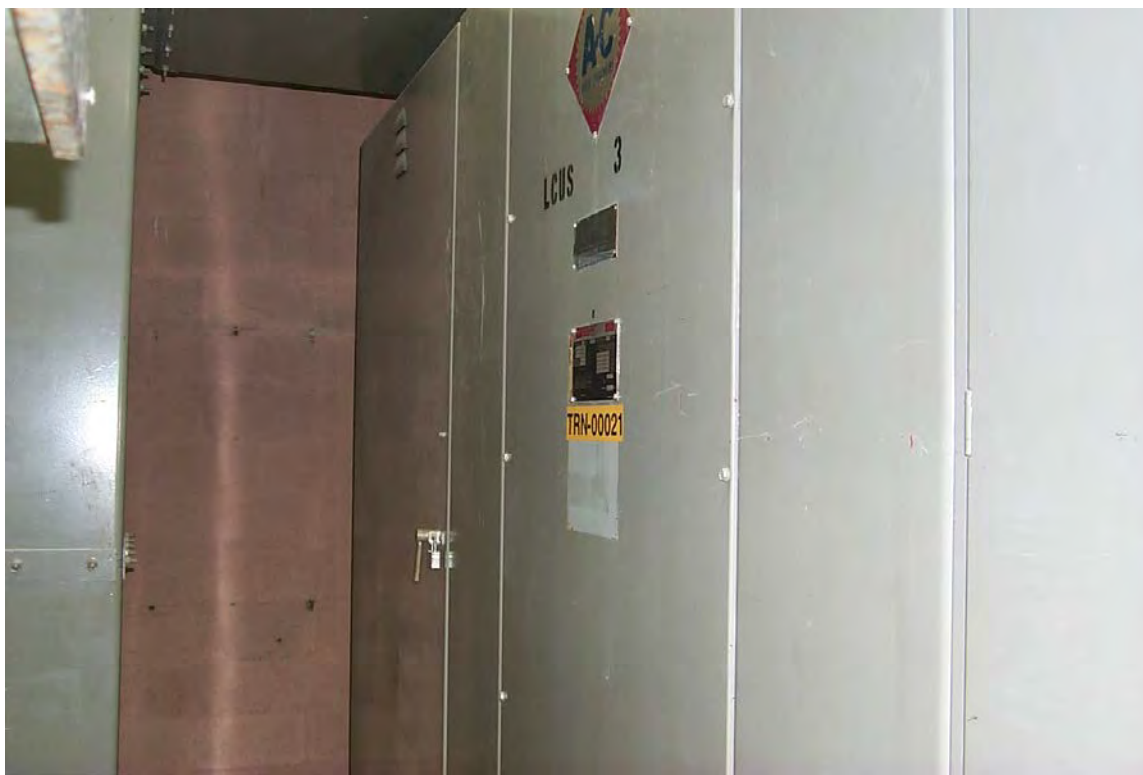
Picture # 3791

Automatic Transfer Switch ATS-17
(Elevator # 5)
480V Rating, 208V
225A
14th Floor Mech. Room



Picture #3501

Disconnect for LCUS-3 (TRN-00021)
13200V
15A
1st Floor- North Mech. Room



Picture #3502

Transformer LCUS-3 (TRN-00021)

300kva

13200V

208Y/120

1st Floor- North Mech. Room



Picture #3503

Switchboard for LCUS-3 (TRN-00021)
208V
1st Floor-North Mech. Room



Picture #3504

Disconnect for LCUS-5 (TRN-00028)
13200V
15A
2nd Floor-North Mech. Room



Picture #3503

Transformer LCUS-5 (TRN-00028)

300kva

13200V

208Y/120

2nd Floor-North Mech. Room



Picture #3506

Switchboard for LCUS-5 (TRN-00028)
208V
2nd Floor-North Mech. Room



Picture #3507

Disconnect for LCUS-4 (TRN-00024)
13200V
15A
2nd Floor-North Mech. Room



Picture #3508

Transformer LCUS-4 (TRN-00024)

300kva

13200V

208Y/120

2nd Floor-North Mech. Room



Picture #3509

Switchboard for LCUS-4 (TRN-00024)
208V
2nd Floor-North Mech. Room



Picture #3510

Disconnect for TRN-00026
13200V
15A
2nd floor-North Mech. Room



Picture #3511

Transformer TRN-00026

300kva

13200V

208Y/120

2nd Floor-North Mech. Room



Picture #3512

Switchboard for TRN-00026
208V
600A
2nd Floor-North Mech. Room



Picture #3513

Disconnect for LCUS-6 (TRN-00030)
13200V
15A
3rd Floor-North Mech. Room



Picture #3514

Transformer LCUS-6 (TRN-00030)

300kva

13200V

208Y/120

3rd Floor-North Mech. Room



Picture # 3515

Switchboard for LCUS-6 (TRN-00030)
208V
3rd Floor-North Mech. Room



Picture # 3516

Disconnect for LCUS-7 (TRN-00032)
13200V
15A
3rd Floor-North Mech. Room



Picture #3517

Transformer LCUS-7 (TRN-00032)
13200V
208Y/120
3rd Floor-North Mech. Room



Picture #3518

Switchboard for LCUS-7 (TRN-00032)
208V
3rd Floor-North Mech. Room



Picture #3519

Disconnect for LCUS-8 (TRN-00031)
13200V
15A
3rd Floor-North Mech. Room



Picture # 3787

Transformer LCUS-8 (TRN-00031)

300kva

13200V

208Y/120

3rd Floor-North Mech. Room



Picture #3520

Switchboard for LCUS-8 (TRN-00031)
208V
3rd Floor-North Mech. Room



Picture # 3521

Disconnect for LCUS-13 (TRN-00033)
13200V
15A
5th Floor-North Mech. Room



Picture #3522

Transformer LCUS-13 (TRN-00033)

300kva

13200V

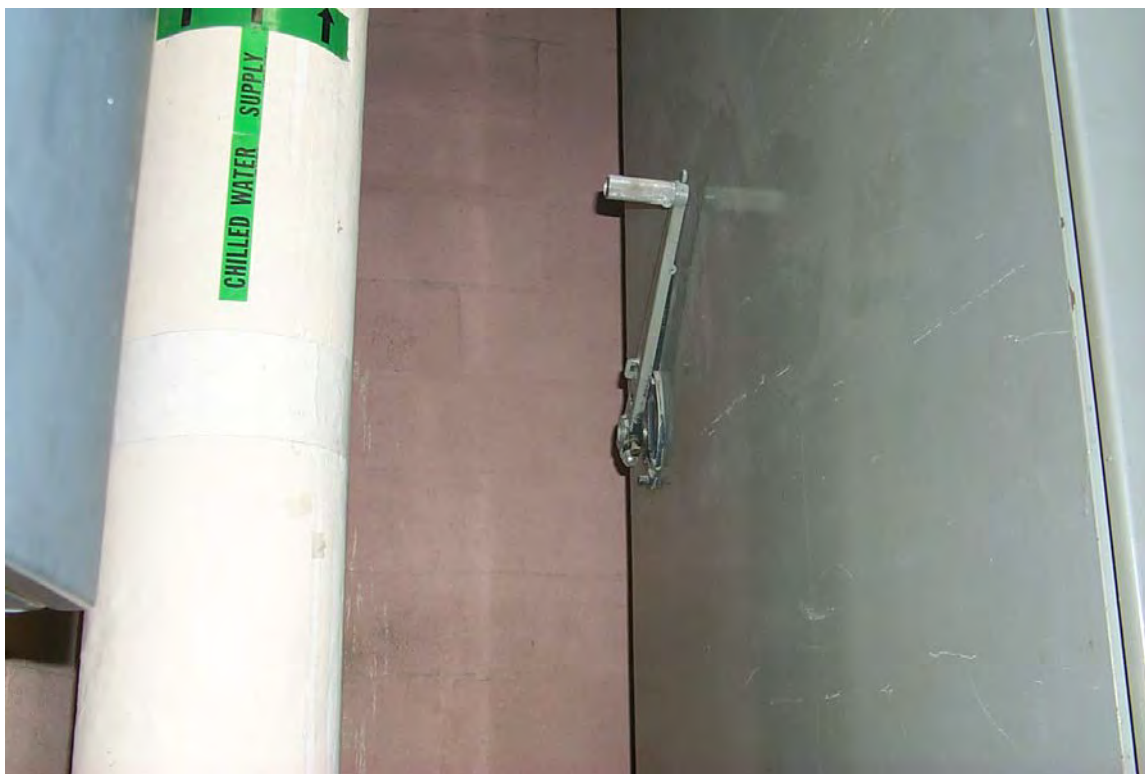
208Y/120

5th Floor-North Mech. Room



Picture #3523

Switchboard for LCUS-13 (TRN-00033)
208V
5th Floor-North Mech. Room



Picture #3524

Disconnect for LCUS-12 (TRN-00035)
13200V
15A
6th Floor-North Mech. Floor



Picture #3525

Transformer LCUS-12 (TRN-00035)

300kva

13200V

208Y/120

6th Floor-North Mech. Room



Picture #3526

Switchboard for LCUS-12 (TRN-00035)
208V
6th Floor-North Mech. Room



Picture #3527

Disconnect for LCUS-11 (TRN-00037)
13200V
15A
7th Floor-North Mech. Room



Picture #3528
Transformer LCUS-11 (TRN-00037)
300kva
13200V
208Y/120
7th Floor-North Mech. Room



Picture #3529

Switchboard for LCUS-11 (TRN-00037)
208V
7th Floor-North Mech. Room



Picture #3530

Disconnect for LCUS-10 (TRN-00039)

13200V

15A

8th Floor Mech. Room



Picture #3531

Transformer LCUS-10 (TRN-00039)

300kva

13200V

208Y/120

8th Floor Mech. Room



Picture #3532

Switchboard for LCUS-10 (TRN-00039)
208V
8th Floor Mech. Room



Picture #3533

Disconnect for LCUS-9 (TRN-00041)
13200V
15A
9th Floor Mech. Room



Picture #3534

Transformer LCUS-9 (TRN-00041)

300kva

13200V

208Y/120

9th Floor Mech. Room



Picture # 3788

Switchboard for LCUS-9 (TRN-00041)
208V
9th Floor Mech. Room



Picture #3471

Automatic Transfer Switch
15000V
400A
Basement-North Electrical Room



Picture #3472

Switchgear CCM-1 (A) 4 Sections
15000V
Bay 3, Bay 6, Bay 7
Basement-North Electrical Room



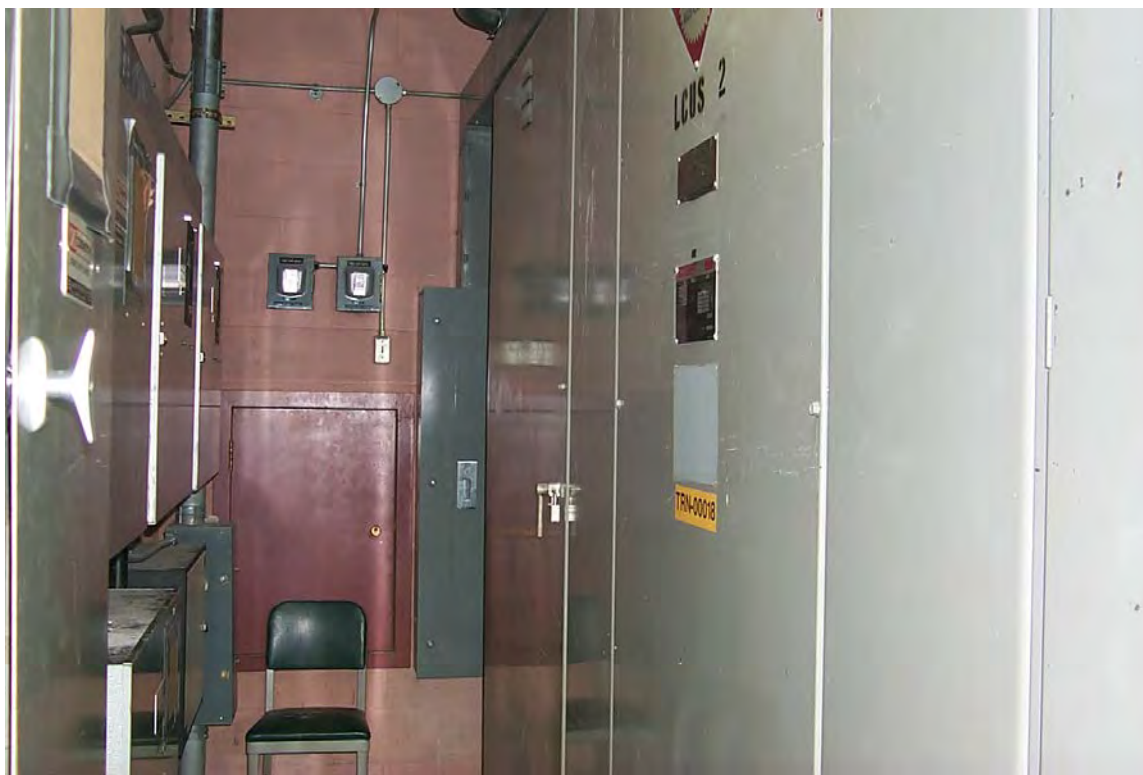
Picture #3473

Switchgear CCM-1 (A) Continued
15000V, 200A
Bay-9
Basement-North Electrical Room



Picture #3498

Disconnect for LCUS-2 (TRN-00018)
13200V
Basement-North Mech. Room



Picture #3499

Transformer LCUS-2 (TRN-00018)

300kva

13200V

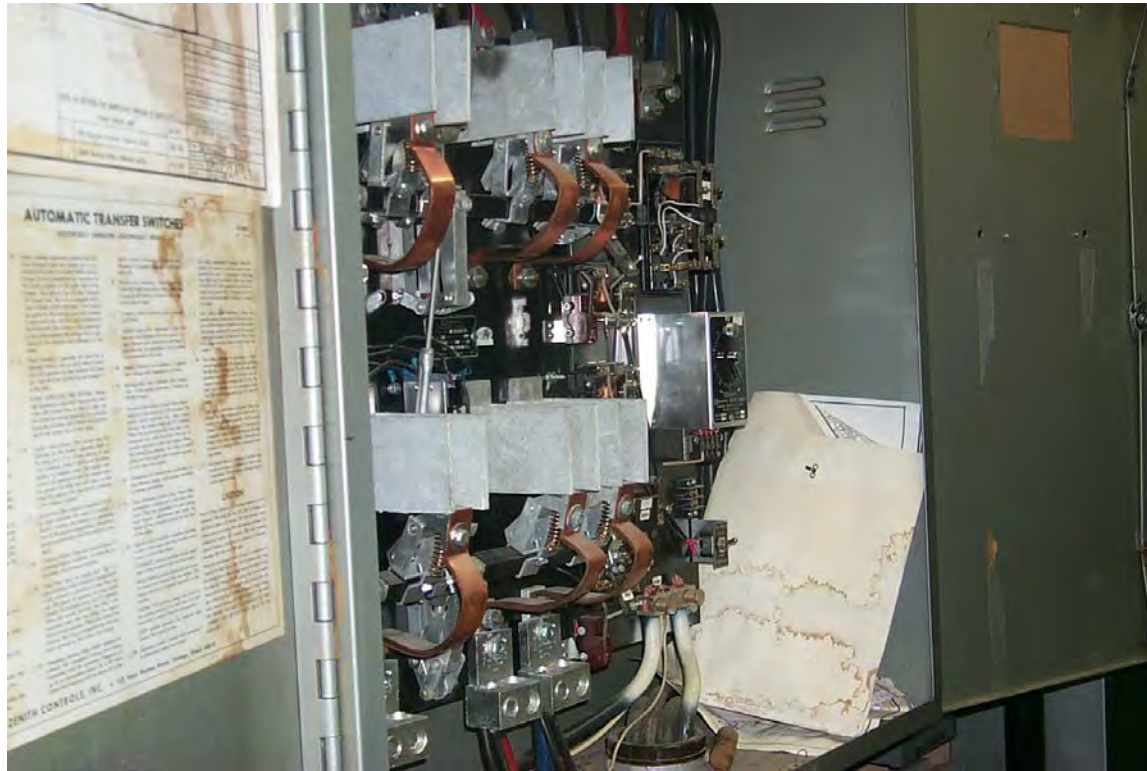
208Y/120

Basement-North Mech. Room



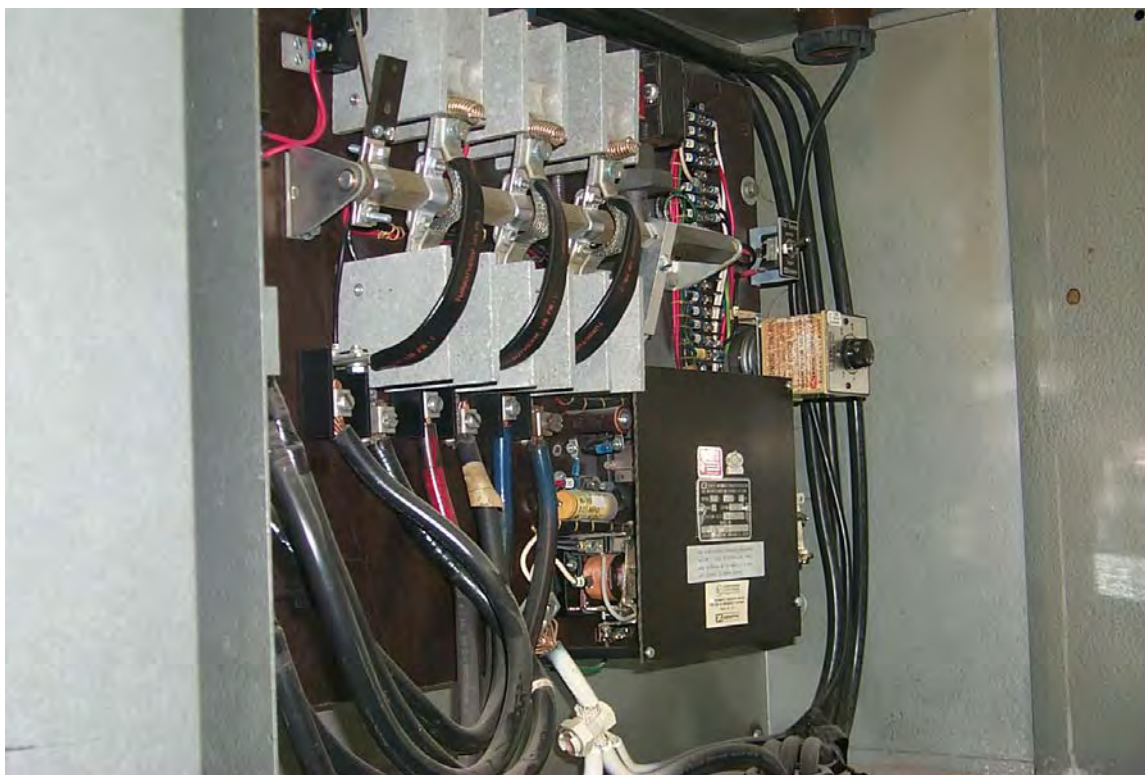
Picture #3500

Switchboard for LCUS-2 (TRN-00018)
208V
Basement-North Mech. Room



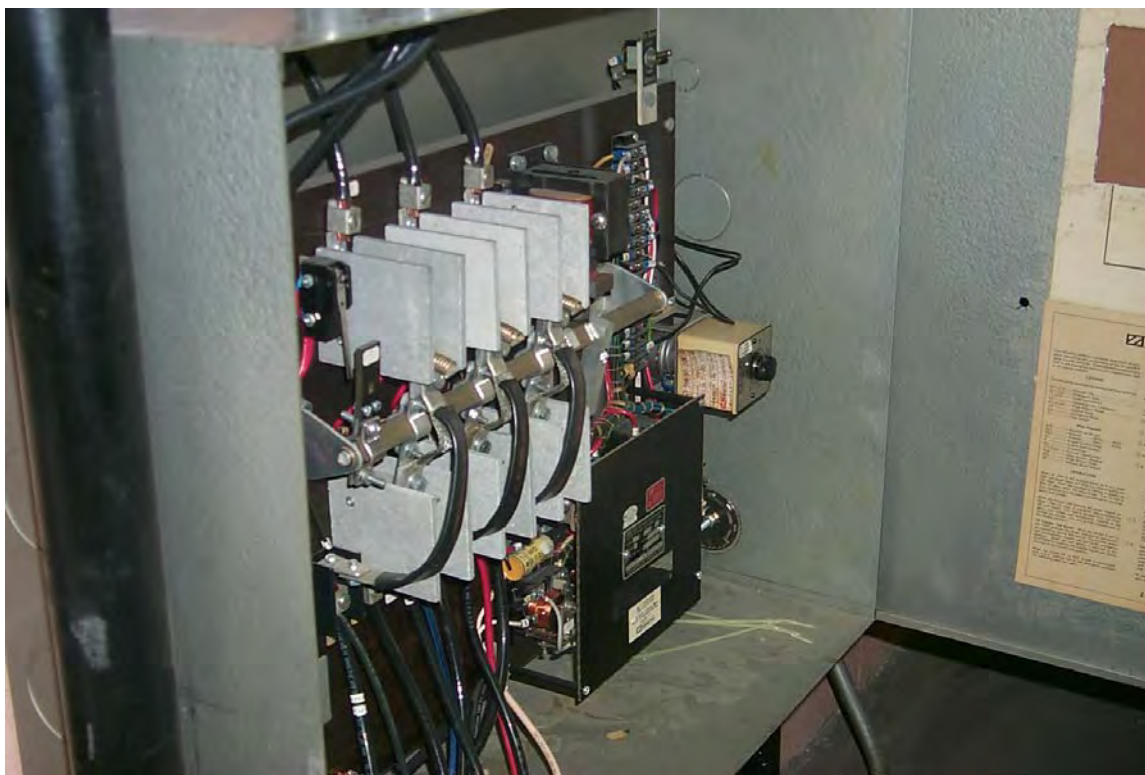
Picture # 3782

Automatic Transfer Switch (No number)
(Lighting LB-3)
250V Rating, 208V
200A
Basement-North Mech. Room



Picture # 3783

Automatic Transfer Switch (No number)
(Stairway Lights)
208V
100A
Basement-North Mech. Room



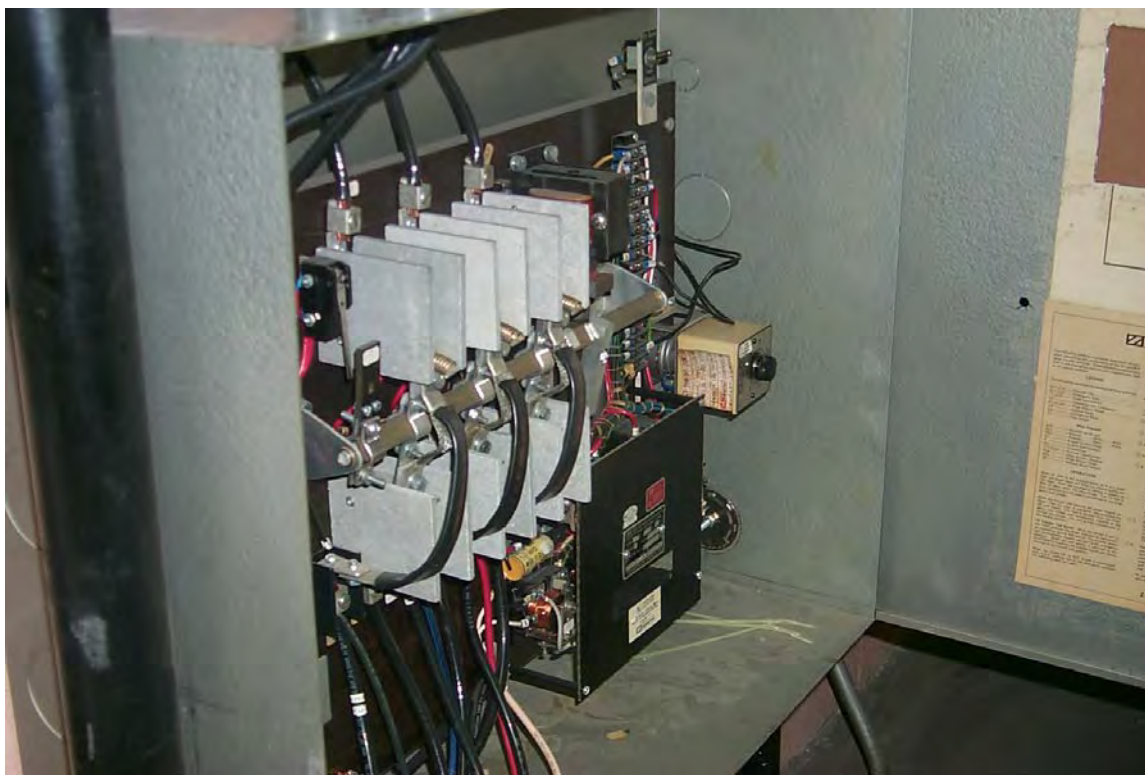
Picture # 3787

Automatic Transfer Switch ATS-10
(Air Hand. Unit #2)
480V Rating, 208V
40A
Basement-North Mech. Room



Picture # 3785

Automatic Transfer Switch ATS-11
(Air Hand. Unit #1)
480V Rating, 208V
40A
Basement-North Mech. Room



Picture # 3786

Automatic Transfer Switch (No Number)
(Emergency Lights, Lobbies/Restrooms)

208V

100A

Basement-North Mech. Room



Picture #3474

Disconnect for LCUS-1 (TRN-00015)
13800V
Basement-Center Mezzanine



Picture #3475

Transformer LCUS-1 (TRN-00015)
300kva
13200V
208Y/120
Basement-Center Mezzanine



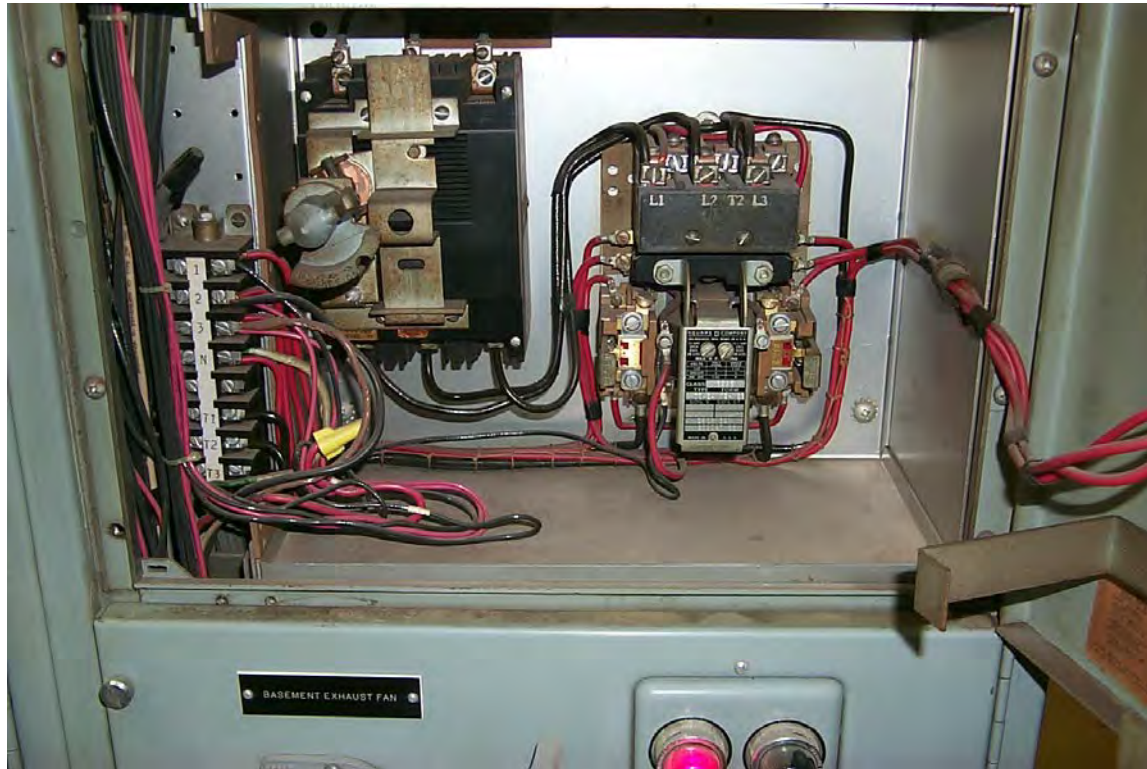
Picture #3476

Switchboard for LCUS-1 (TRN-00015)
208V
Basement-Center Mezzanine



Picture #3477

Motor Control Center MCC-00016
208V
Basement-Center Mezzanine



Picture #3478

Motor Control Center MCC-00016 (Continued)
208V
Basement-Center Mezzanine



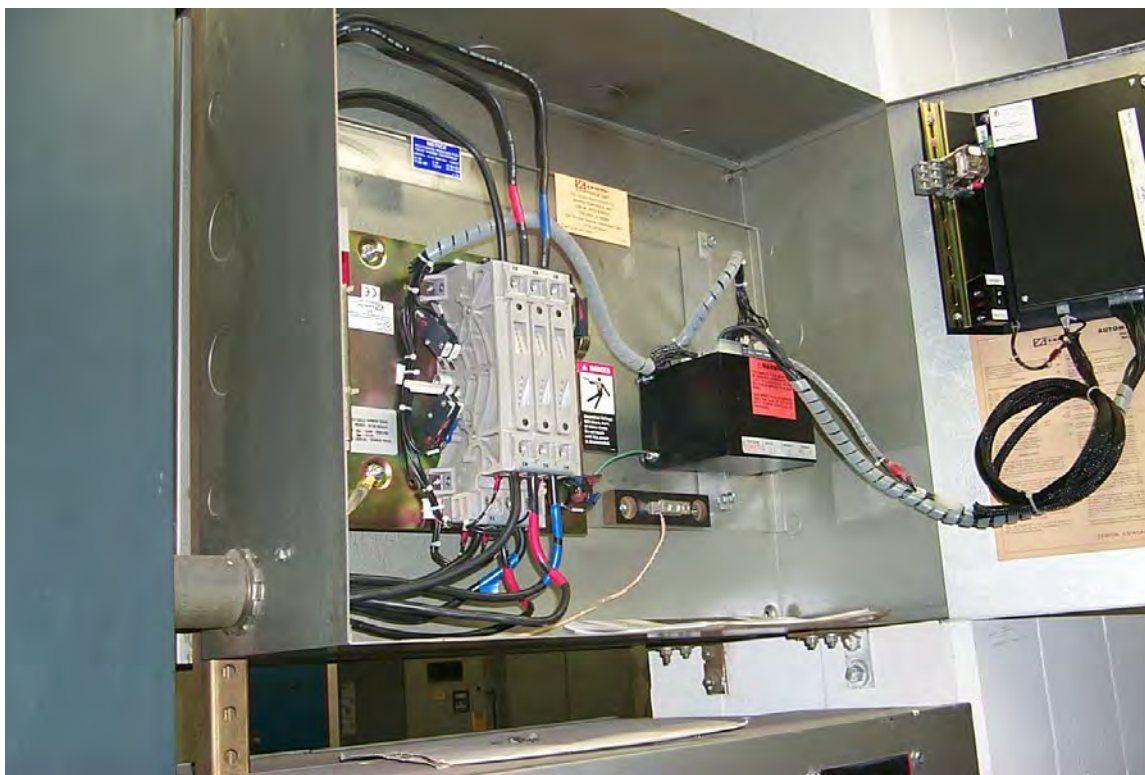
Picture #3776

Automatic Transfer Switch ATS-2 (Sump Pump)
208V
40A
Basement Mezzanine



Picture # 3778

Automatic Transfer Switch ATS-1
(Aux. Hot Water Pump)
208V
225A
Basement Mezzanine



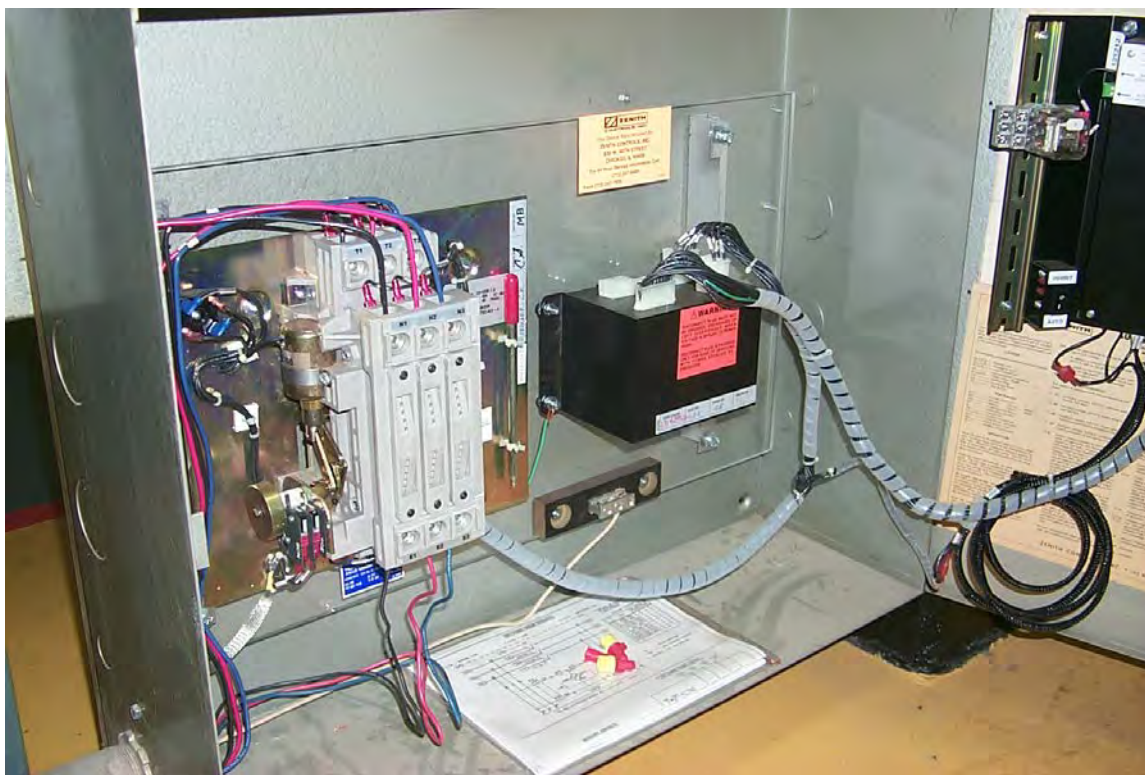
Picture # 3779

Automatic Transfer Switch ATS-3
(Air Comp. #1 and #2)
208V
100A
Basement Mezzanine



Picture # 3780

Automatic Transfer Switch ATS-4
(Sewage Lift Pump)
208V
80A
Basement Mezzanine



Picture # 3781

Automatic Transfer Switch ATS-5
(Condensate Pump P2/Emergency Feed Pump)
208V
40A
Basement Mezzanine



Picture #3496

Motor Control Center MCC-00007
208V
Basement-Statehouse Chiller Room



Picture #3497

Motor Control Center MCC-00007 (Continued)
208V
Basement-Statehouse Chiller Room



Picture #3486

Transformer TRN-00011

1500kva

12470V

480/277

Basement



Picture #3487

Transformer TRN-00011 (Continued)

1500kva

12470V

480/277

Basement



Picture #3469

Disconnect CCM-1 (B)
13800V
Basement-Mezzanine



Picture #3470

Transformer CCM-1
1500kva
13800V
480/277V
Basement-Mezzanine



Picture #3480

Breaker MCC-00010
480V
50A
Basement-Mezzanine



Picture #3483

Breaker MCC-00010 (Continued)
480V
50A
Basement-Mezzanine



Picture #3481

Breaker MCC-00013
480V
50A
Basement-Mezzanine



Picture #3482

Breaker MCC-00014
480V
50A
Basement-Mezzanine



Picture #3484

Motor Control Center MCC-1

Basement-Mezzanine



Picture #3485

Disconnect for Boiler
480V
800A
Basement-Mezzanine



Picture #3489

Disconnect MDP-00005 (DSOB-SB23)
13200V
60A
Basement-Statehouse Chiller Room



Picture #3488

Transformer MDP-00005 (DSOB-SB23)

1500kva

13800V

480Y/277

Basement-Statehouse Chiller Room



Picture #3490

Switchboard for MDP-00005 (DSOB-SB23)
480V
1500A
Basement-Statehouse Chiller Room



Picture #3491

Transformer MDP-00005 (DSOB-SB23)
112.5kva
480V
208Y/120
Basement-Statehouse Chiller Room



Picture #3493

Motor Control Center MCC-00004
480V
Basement-Statehouse Chiller Room



Picture #3494

Motor Control Center MCC-00004 (continued)
480V
Basement-Statehouse Chiller Room



Picture #3495

Transformer to Heat Plant
150kva
480V
208Y/120
Basement-Heat Plant



Picture #3492

Switchboard
208V

Basement-Statehouse Chiller Room



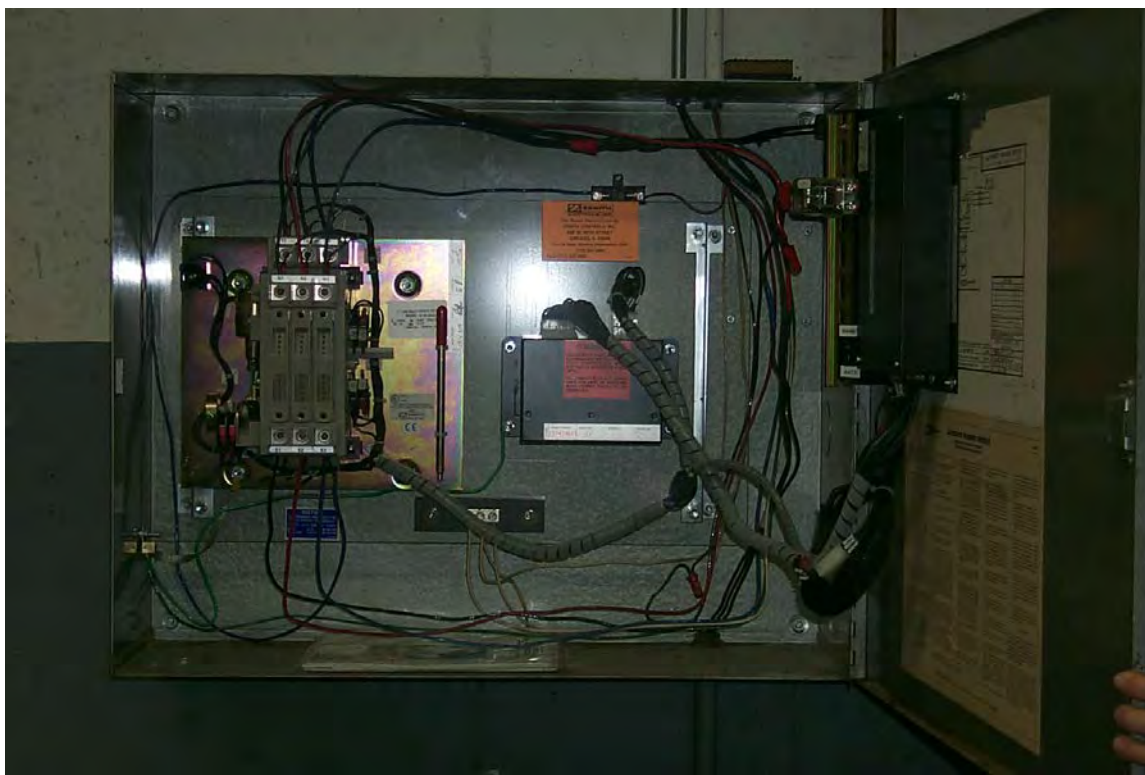
Picture #3773

Automatic Transfer Switch for Panel B Lighting
208V
200A
Basement-Statehouse Chiller area



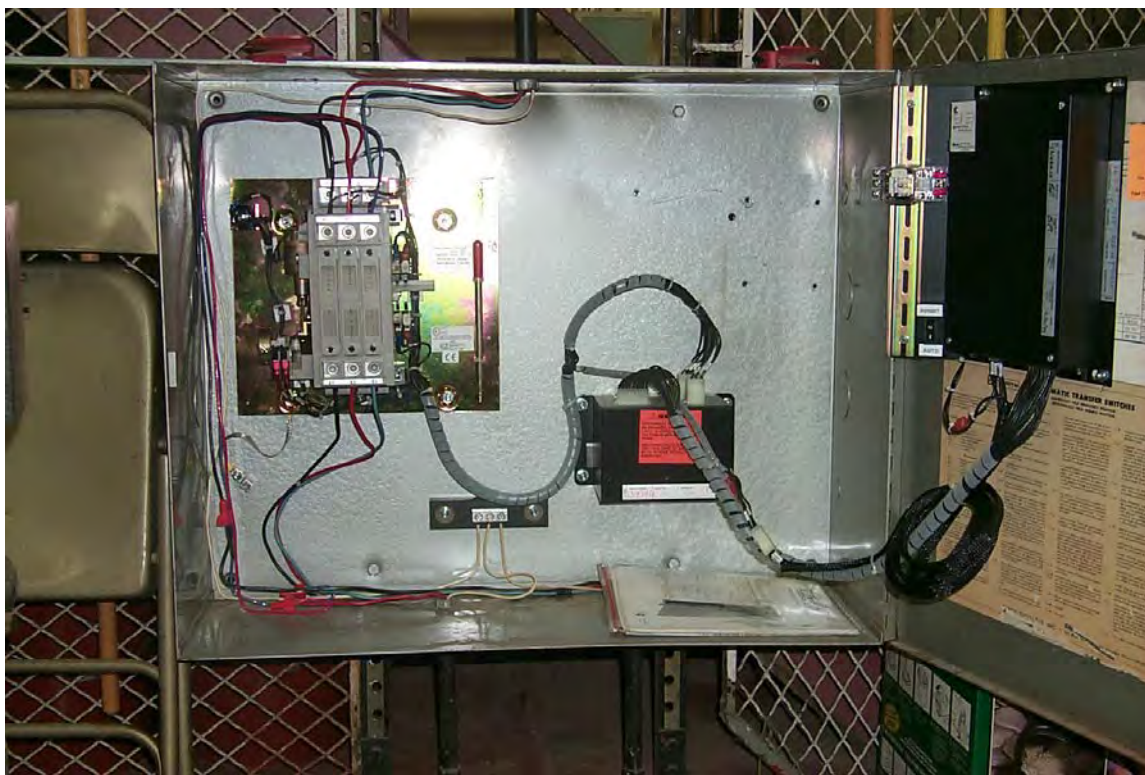
Picture #3774

Automatic Transfer Switch (No number)
208V
600A
Basement Distribution System-Heat Plant



Picture # 3771

Air Compressor
Automatic Transfer Switch
480V
40A
Basement-Statehouse Chiller Room



Picture #3772

Sump Pump
Automatic Transfer Switch
480V
40A
Basement-Statehouse Chiller Room

AUTOMATIC TRANSFER SWITCHES

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Automatic Transfer Switches should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)
- Megger (5,000 volt with selectable voltages)
- Phase Rotation Meter

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect physical and mechanical condition.
2. Lubrication
 - 2.1. Verify appropriate contact lubricant on moving current-carrying parts.
 - 2.2. Verify appropriate lubrication on moving and sliding surfaces.
3. Verify that manual transfer warnings are attached and visible.
4. Verify tightness of all control connections.
5. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 5.1. Use of low-resistance ohmmeter in accordance with Step 2 of the “Electrical Tests” section of this document.
 - 5.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 5.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
6. Perform manual transfer operation.
7. Verify positive mechanical interlocking between normal and alternate sources.

Electrical Tests

1. Perform a contact-resistance test.
2. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 5 of the “Visual and Mechanical Inspection” section of this document.
3. Perform insulation-resistance tests, phase-to-phase and phase-to-ground, with switch in both source positions.
4. Verify settings and operation of control devices.
5. Calibrate and set all relays and timers in accordance with [Protective Relays: Maintenance Testing Guidelines](#).
6. Perform automatic transfer tests:
 - 6.1. Simulate loss of normal power.
 - 6.2. Return to normal power.
 - 6.3. Simulate loss of emergency power.
 - 6.4. Simulate all forms of single-phase conditions.
7. Verify correct operation and timing of the following functions:
 - 7.1. Normal source voltage-sensing relays.
 - 7.2. Engine start sequence.
 - 7.3. Time delay upon transfer.
 - 7.4. Alternate source voltage-sensing relays.
 - 7.5. Automatic transfer operation.
 - 7.6. Interlocks and limit switch function.

- 7.7. Time delay and retransfer upon normal power restoration.
- 7.8. Engine cool down and shutdown feature.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values that deviate from adjacent poles or similar switches by more than 25 percent of the lowest value.
4. Insulation-resistance test voltages and minimum values shall be in accordance with Table 3.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2 (cont.)
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 4 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

METAL-ENCLOSED BUSWAYS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Metal Enclosed Busways should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (5,000 volt with selectable voltages)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect busway for physical damage and evidence of corona.
2. Inspect for appropriate bracing, suspension, alignment, and enclosure ground.
3. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 3.1. Use of low-resistance ohmmeter in accordance with Step 3 of the “Electrical Tests” section of this document.
 - 3.2. Verify tightness of accessible bolted electrical connections and bus joints by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 3.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
4. Confirm physical orientation in accordance with manufacturer's labels to insure adequate cooling.
5. Examine outdoor busway for removal of "weep-hole" plugs, if applicable, and the correct installation of joint shield.
6. Inspect and clean all ventilating openings.

Electrical Tests

1. Measure insulation resistance of each busway, phase-to-phase and phase-to-ground for one minute, in accordance with Table 3.
2. Perform an overpotential test on each busway, phase-to-ground with phases not under test grounded, in accordance with Table 4. Where no dc test value is shown in Table 14, ac value shall be used. The test voltage shall be applied for one minute.
3. Perform resistance measurements through all bolted connections and bus joints with a low-resistance ohmmeter, if applicable, in accordance with Step 3 of the “Visual and Mechanical Inspection” section of this document.
4. Verify operation of busway heaters.

Test Values

1. Compare bolted connection resistances and bus joint resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar bus joints and connections by more than 25 percent of the lowest value.

4. Insulation-resistance test voltages and resistance values shall be in accordance with manufacturer's specifications or Table 3. Minimum resistance values are for a nominal 1000-foot busway run or megohms for 1000 feet. For busway runs over 1000 feet, derate accordingly by the formula:

$$R_{1000ft} = \text{Measured Resistance} \times \text{Length of Run}/1000$$

Values of insulation resistance less than this table or manufacturer's minimum should be investigated. Overpotential tests should not proceed until insulation-resistance levels are raised above minimum values.

5. The insulation shall withstand the overpotential test voltage applied.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2 (cont.)
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 5 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Metal-Enclosed Bus Dielectric Withstand Test Voltages

Type of Bus	Rated kV	Maximum Test Voltage, kV	
		ac	dc
Isolated Phase for Generator Leads	24.5	37.0	52.0
	29.5	45.0	--
	34.5	60.0	--
Isolated Phase for Other than Generator Leads	15.5	37.0	52.0
	25.8	45.0	--
	38.0	60.0	--
Nonsegregated Phase	0.635	1.6	2.3
	4.76	14.2	20.0
	15.0	27.0	37.0
	25.8	45.0	63.0
	38.0	60.0	--
Segregated Phase	15.5	37.0	52.0
	25.8	45.0	63.0
	38.0	60.0	--
DC Bus Duct	0.3	1.6	2.3
	0.8	2.7	3.9
	1.2	3.4	4.8
	1.6	4.0	5.7
	3.2	6.6	9.3

Derived from ANSI-IEEE C37.23-1987, Tables 3A, 3B, 3C, 3D and paragraph 6.4.2. The table includes a 0.75 multiplier with fractions rounded down.

NOTE: The presence of the column headed "dc" does not imply any requirement for a dc withstand test on ac equipment. This column is given as a reference only for those using dc tests and represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each class of bus.

Direct current withstand tests are recommended for flexible bus to avoid the loss of insulation life that may result from the dielectric heating that occurs with rated frequency withstand testing.

Because of the variable voltage distribution encountered when making dc withstand tests and variances in leakage currents associated with various insulation systems, the manufacturer should be consulted for recommendations before applying dc withstand tests to this equipment.

TABLE 5
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

Electrical Equipment Testing Specifications

ENGINE GENERATORS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Engine Generators should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- RMS Ammeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)
- Megger (5,000 volt with selectable voltages)
- Vibration Tester

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

NOTE: The prime mover is not addressed in these specifications.

Visual and Mechanical Inspection

1. Inspect physical and mechanical condition.
2. Inspect correct anchorage and grounding.

Electrical and Mechanical Tests

1. Perform an insulation-resistance test on generator winding with respect to ground in accordance with ANSI/IEEE Standard 43. Calculate polarization index.
2. Test protective relay devices in accordance with [Protective Relays: Maintenance Testing Guidelines](#).
3. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other features as applicable.
4. Perform vibration test for each main bearing cap.
5. Conduct performance test in accordance with NFPA Standard 110.
6. Verify correct functioning of governor and regulator.

Test Values

1. Polarization index values shall be in accordance with ANSI/IEEE Standard 43.
2. Vibration levels shall be in accordance with manufacturer's published data and compared to baseline data.
3. Performance tests shall conform to manufacturer's published data and ANSI/NFPA Standard 110.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

GROUNDING SYSTEMS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Grounding Systems should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- RMS Ammeter
- Ground Resistance Tester
- Megger (1,000 volt)
- Megger (5,000 volt with selectable voltages)
- Test Leads and Test Rods
- Earth Megger

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Verify ground system.
2. Electrical Tests
 - 2.1. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.
 - 2.2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

Test Values

1. The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142)
2. Investigate point-to-point resistance values which exceed 0.5 ohm.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

LOW-VOLTAGE POWER CIRCUIT BREAKERS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Low-Voltage Power Circuit Breakers should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)
- Single Phase High Current Test Source with Timer
- Trip Unit Test Set

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect physical and mechanical condition.
2. Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
3. Verify that all maintenance devices are available for servicing and operating the breaker.
4. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
5. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.
6. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 6.1. Use of low-resistance ohmmeter in accordance with Step 3 of the “Electrical Tests” section of this document.
 - 6.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 6.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
7. Verify cell fit and element alignment.
8. Verify racking mechanism.
9. Thoroughly clean unit prior to testing unless as-found and as-left tests are required.
10. Lubrication
 - 10.1. Verify appropriate contact lubricant on moving current-carrying parts.
 - 10.2. Verify appropriate lubrication on moving and sliding surfaces.

Electrical Tests

1. Perform a contact-resistance test.
2. Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
3. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 3.1. Use of low-resistance ohmmeter in accordance with Step 6 of the “Visual and Mechanical Inspection” section of this document.
 - 3.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 3.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
4. Perform an insulation-resistance test at 1000 volts dc on all control wiring. For units with solid-state components, follow manufacturer's recommendations. (Optional)
5. Make adjustments for the final settings in accordance with the coordination study supplied by owner.
6. Determine minimum pickup current by primary current injection.
7. Determine long-time delay by primary current injection.
8. Determine short-time pickup and delay by primary current injection.
9. Determine ground-fault pickup and delay by primary current injection.
10. Determine instantaneous pickup value by primary current injection.
11. Verify the calibration of all functions of the trip unit by means of secondary injection.
12. Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to insure operation of shunt trip devices. Check the operation of electrically-operated breakers in their cubicles.
13. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

14. Verify operation of charging mechanism.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 25 percent of the lowest value.
4. Circuit breaker insulation resistance shall be in accordance with Table 3.
5. Control wiring insulation resistance shall be a minimum of two megohms.
6. Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
**Thermographic Survey
Suggested Actions Based on Temperature Rise**

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 4 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

LOW-VOLTAGE CABLES, 600 VOLT MAXIMUM

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Low-Voltage Cables should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (5,000 volt with selectable voltages)
- Hi-Pot Tester
- Phase Rotation Meter

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect exposed sections of cables for physical damage and evidence of overheating.
2. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 2.1. Use of low-resistance ohmmeter in accordance with Step 2 of the “Electrical Tests” section of this document.
 - 2.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 2.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
3. Inspect compression-applied connectors for correct cable match and indentation.

Electrical Tests

1. Perform insulation-resistance tests on each cable phase-to-phase and phase-to-ground. Applied potential to be 1000 volts dc for one minute.
2. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 5 of the “Visual and Mechanical Inspection” section of this document.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 1 unless otherwise specified by the manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 25 percent of the lowest value.
4. Minimum insulation-resistance values should be comparable to previously obtained results but not less than two megohms.
5. Investigate deviations between adjacent phases.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:

- 3.1. Discrepancies.
- 3.2. Temperature difference between the area of concern and the reference area.
- 3.3. Cause of temperature difference.
- 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
- 3.5. Identify load conditions at time of inspection.
- 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

LOW-VOLTAGE MOTOR CONTROL STARTERS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Low-Voltage Motor Control Starters should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Single Phase Variable Power Supply
- Ductor
- Megger (1,000 volt)
- Phase Rotation Meter

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect physical and mechanical condition.
2. Inspect contactors.
 - 2.1. Verify mechanical operation.
 - 2.2. Inspect and adjust contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.
3. Motor-Running Protection
 - 3.1. Compare overload element rating with motor full-load current rating to verify correct sizing.
 - 3.2. If power-factor correction capacitors are connected on the load side of the overload protection, include the effect of the capacitive reactance in determining appropriate overload element size.
 - 3.3. If motor-running protection is provided by fuses, verify correct fuse rating considering motor characteristics and power-factor correction capacitors.
4. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 4.1. Use of low-resistance ohmmeter in accordance with Step 1 of the "Electrical Tests" section of this document.
 - 4.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 4.3. Perform thermographic survey in accordance with the "Thermographic Survey Procedures" section of this document.
5. Thoroughly clean unit prior to testing unless as-found and as-left tests are required.
6. Lubrication
 - 6.1. Verify appropriate contact lubricant on moving current-carrying parts.
 - 6.2. Verify appropriate lubrication on moving and sliding surfaces.

Electrical Tests

1. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 4 of the "Visual and Mechanical Inspection" section of this document.
2. Measure insulation resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Test voltage shall be in accordance with Table 3. Refer to manufacturer's published data for devices with solid-state components.
3. Perform an insulation-resistance test at 1000 volts dc on all control wiring. For units with solid-state components, follow manufacturer's recommendations. (Optional)
4. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

5. NOTE: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison. (Refer to ANSI/NEMA ICS 2, Part 4.)
6. Test circuit breakers in accordance with [Low-Voltage Insulated Case/Molded Case Circuit Breakers](#).
7. Perform operational tests by initiating control devices.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values that deviate from similar connections by more than 25 percent of the lowest value.
4. Insulation-resistance values shall be in accordance with Table 3.
5. Control wiring insulation test resistance shall be a minimum of two megohms.
6. Overload trip times shall be in accordance with manufacturer's published data.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2 (cont.)
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 4 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

LOW-VOLTAGE MOTOR CONTROL CENTERS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Low-Voltage Motor Control Centers should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

1. Refer to [Switchgear and Switchboard Assemblies: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center bus.
2. Refer to [Low-Voltage Air Switches: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center switches.
3. Refer to [Low-Voltage Insulated Case/Molded Case Circuit Breakers: Maintenance Testing Guidelines](#) and [Low-Voltage Power Circuit Breakers: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center circuit breakers.
4. Refer to [Low-Voltage Motor Control Starters: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center starters.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

MEDIUM-VOLTAGE CABLES, 69 KV VOLT MAXIMUM Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Medium-Voltage Cables should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (5,000 volt with selectable voltages)
- Hi-Pot Tester
- Phase Rotation Meter

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect exposed sections of cables for physical damage and evidence of overheating and corona.
2. Inspect terminations and splices for evidence of overheating and corona.
3. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 3.1. Use of low-resistance ohmmeter in accordance with Step 3 of the “Electrical Tests” section of this document.
 - 3.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 1.
 - 3.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
4. Inspect compression-applied connectors for correct cable match and indentation.
5. Inspect for shield grounding, cable support, and termination.
6. Verify that visible cable bends meet or exceed ICEA and/or manufacturer's minimum allowable bending radius.
7. Inspect fireproofing in common cable areas, if specified.
8. If cables are terminated through window-type current transformers, make an inspection to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

Electrical Tests

1. Perform a shield-continuity test on each power cable by ohmmeter method.
2. Perform an insulation-resistance test utilizing a megohmmeter with a voltage output of at least 2500 volts. Individually test each conductor with all other conductors and shields grounded. Test duration shall be one minute.
3. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 3 of the “Visual and Mechanical Inspection” section of this document.
4. Perform a dc high-potential test on all cables. Adhere to all precautions and limits as specified in the applicable NEMA/ICEA Standard for the specific cable. Perform tests in accordance with ANSI/IEEE Standard 400. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. Test voltages shall not exceed 60 percent of cable manufacturer's factory test value or the maximum test voltage in Table 2.
 - 4.1. Insure that the input voltage to the test set is regulated.
 - 4.2. Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.
 - 4.3. Record wet- and dry-bulb temperatures or relative humidity and temperature.
 - 4.4. Test each section of cable individually.

- 4.5. Individually test each conductor with all other conductors grounded. Ground all shields.
- 4.6. Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.
- 4.7. Insure that the maximum test voltage does not exceed the limits for terminators specified in ANSI/IEEE Standard 48 or manufacturer's specifications.
- 4.8. Apply a dc high-potential test in at least five equal increments until maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. Record dc leakage current at each step after a constant stabilization time consistent with system charging current.
- 4.9. Raise the conductor to the specified maximum test voltage and hold for five minutes. Record readings of leakage current at 30 seconds and one minute and at one minute intervals thereafter.
- 4.10. Reduce the conductor test potential to zero and measure residual voltage at discrete intervals.
- 4.11. Apply grounds for a time period adequate to drain all insulation stored charge.

Test Values

- 1. Compare bolted connection resistances to values of similar connections.
- 2. Bolt-torque levels shall be in accordance with Table 1 unless otherwise specified by manufacturer.
- 3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 25 percent of the lowest value.
- 4. Shielding must exhibit continuity. Investigate resistance values in excess of ten ohms per 1000 feet of cable.
- 5. Graphic plots may be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.
- 6. The step voltage slope should be reasonably linear.
- 7. Capacitive and absorption current should decrease continually until steady state leakage is approached.
- 8. Compare test results to previously obtained results.

Thermographic Survey Procedures

- 1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
- 2. Equipment to be inspected shall include all current-carrying devices.
- 3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
- 4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.

4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).

5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
**Thermographic Survey
Suggested Actions Based on Temperature Rise**

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Medium-Voltage Cables
Maximum Maintenance Test Voltages (kV, dc)

Insulation Type	Rated Cable Voltage	Insulation Level	Test Voltage kV, dc
Elastomeric:	5 kV	100%	19
Butyl and Oil Base	5 kV	133%	19
	15 kV	100%	41
	15 kV	133%	49
	25 kV	100%	60
Elastomeric:	5 kV	100%	19
EPR	5 kV	133%	19
	8 kV	100%	26
	8 kV	133%	26
	15 kV	100%	41
	15 kV	133%	49
	25 kV	100%	60
	25 kV	133%	75
	28 kV	100%	64
	35 kV	100%	75
Polyethylene	5 kV	100%	19
(see Note 4)	5 kV	133%	19
	8 kV	100%	26
	8 kV	133%	26
	15 kV	100%	41
	15 kV	133%	49
	25 kV	100%	60
	25 kV	133%	75
	35 kV	100%	75

Derived from ANSI/IEEE Standard 141-1993 Table 12-9 and by factoring the applicable ICEA/NEMA Standards by 75% as recommended in Section 18-9.2.4 of NFPA 70B, 1994 Edition *Electrical Equipment Maintenance*.

TABLE 3 - NOTES

- NOTE 1: Selection of test voltage for in-service cables depends on many factors. The owner should be consulted and/or informed of the intended test voltage prior to performing the test. Caution should be used in selecting the maximum test voltage and performing the test since cable failure during the test will require repair or replacement prior to re-energizing.
- NOTE 2: AEIC C55 and C56 list test voltages approximately 20 percent higher than the ICEA values for the first five years of service. These values are based on 65 percent of the factory test voltages. A reduction to 40 percent is recommended for a cable in service longer than five years.
- NOTE 3: ANSI/IEEE 400-1991 specifies much higher voltages than either the ICEA or the AEIC. These voltages overstress cables and are intended to find marginal cable during shutdown to avoid in-service failures. These test voltages should not be used without the concurrence of the owner. If the cable is still in warranty, the cable manufacturer should be consulted for their concurrence. (See the Standard for a discussion of the pros and cons of high direct-voltage tests.)
- NOTE 4: See Electric Power Research Institute Report, EPRI TR-101245, "Effect of DC Testing on Extruded Cross-Linked Polyethylene Insulated Cables." DC high potential testing of **aged** XLPE-insulated cable in wet locations may reduce remaining life.

MEDIUM-VOLTAGE MOTOR CONTROL STARTERS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Medium-Voltage Motor Control Starters should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)
- Megger (5,000 volt with selectable voltages)
- Single Phase Variable Power Supply
- Vacuum Bottle Tester (if required)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect physical, electrical, and mechanical condition, including evidence of moisture and/or corona.
2. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 2.1. Use of low-resistance ohmmeter in accordance with Step 1 of the “Electrical Tests” section of this document.
 - 2.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 2.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
3. Test all electrical and mechanical interlock systems for correct operation and sequencing.
4. Verify correct barrier and shutter installation and operation.
5. Exercise all active components and confirm correct operation of all indicating devices.
6. Inspect contactors.
 - 6.1. Verify mechanical operation.
 - 6.2. Inspect and adjust contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.
7. Compare overload protection rating with motor nameplate to verify correct size. Set adjustable or programmable devices according to the protective device coordination study.
8. Thoroughly clean unit prior to testing unless as-found and as-left tests are required.
9. Lubrication
 - 9.1. Verify appropriate contact lubricant on moving current-carrying parts.
 - 9.2. Verify appropriate lubrication on moving and sliding surfaces.

Electrical Tests

1. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 2 of the “Visual and Mechanical Inspection” section of this document.
2. Perform system function tests at 1000 volts dc on all control wiring. For units with solid-state components, follow manufacturer's recommendations.
3. Perform system function test in accordance with “General System Tests” section of this document.
4. Test control power transformers:
 - 4.1. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 2 unless otherwise specified by manufacturer.
 - 4.2. Verify correct function of control transfer relays located in switchgear with multiple power sources.

5. Perform insulation-resistance tests on contactor(s), phase-to-ground, phase-to-phase, and across the open contacts for one minute in accordance with Table 3.
6. Perform an overpotential test in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it shall be in accordance with Table 2.
7. Perform vacuum bottle integrity test (overpotential), if applicable, across each vacuum bottle with the contacts in the open position in strict accordance with manufacturer's published data. Do not exceed maximum voltage stipulated for this test.
8. Perform a contact-resistance test.
9. Measure blowout coil circuit resistance.
10. Measure resistance of power fuses.
11. Energize contactor using an auxiliary source. Adjust armature to minimize operating vibration where applicable.
12. Test motor overload relay elements by injecting primary current through overload circuit and monitoring trip time of the overload element.
13. NOTE: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison.
14. Test ground-fault protection by injecting primary current through sensor. Confirm pickup level and timing.
15. If solid-state or microprocessor-type protective relaying is used, test in accordance with [Protective Relays: Maintenance Testing Guidelines](#).
16. Verify operation of cubicle space heater.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque values shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values that deviate from similar connections by more than 25 percent of the lowest value.
4. Starter insulation resistance shall be in accordance with Table 3.
5. Control wiring insulation resistance shall be a minimum of two megohms.
6. The insulation shall withstand the overpotential test voltage applied.
7. Resistance values shall not deviate by more than 15 percent between identical fuses.
8. Overload trip times shall be in accordance with manufacturer's published data.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.

- 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
- 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 5 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Switchgear Low-Frequency Withstand Test Voltages

Type of Switchgear	Rated Maximum Voltage (kV) (rms)	Maximum Test Voltage kV	
		ac	dc
LV (Low-Voltage Power Circuit Breaker Switchgear)	.254/.508/.635	1.6	2.3
MC	4.76	14.0	20.0
(Metal-Clad Switchgear)	8.25	27.0	37.0
	15.0	27.0	37.0
	38.0	60.0	+
SC	15.5	37.0	+
(Station-Type Cubicle	38.0	60.0	+
Switchgear)	72.5	120.0	+
MEI	4.76	14.0	20.0
(Metal-Enclosed	8.25	19.0	27.0
Interrupter Switchgear)	15.0	27.0	37.0
	15.5	37.0	52.0
	25.8	45.0	+
	38.0	60.0	+

Derived from ANSI/IEEE C37.20.1-1993, Paragraph 5.5, *Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear*, C37.20.2-1993, Paragraph 5.5, *Standard for Metal-Clad and Station-Type Cubicle Switchgear* and C37.20.3-1993, Paragraph 5.5, *Standard for Metal-Enclosed Interrupter Switchgear*, and includes 0.75 multiplier with fraction rounded down.

The column headed "DC" is given as a reference only for those using dc tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for voltage rating of switchgear. The presence of this column in no way implies any requirement for a dc withstand test on ac equipment or that a dc withstand test represents an acceptable alternative to the low-frequency withstand tests specified in this specification, either for design tests, production tests, conformance tests, or field tests. When making dc tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Because of the variable voltage distribution encountered when making dc withstand tests, the manufacturer should be contacted for recommendations before applying dc withstand tests to the switchgear. Voltage transformers above 34.5kV should be disconnected when testing with dc. Refer to ANSI/IEEE C57-13-1978 (R1987) *IEEE Standard Requirements for Instrument Transformers* [10], Section 8 and, in particular 8.8.2, (the last paragraph) which reads "Periodic kenotron tests should not be applied to transformers of higher than 34.5 kV voltage rating."

+ Consult Manufacturer

TABLE 5
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

MEDIUM-VOLTAGE MOTOR CONTROL CENTERS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Medium-Voltage Motor Control Centers should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)
- Megger (5,000 volt with selectable voltages)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

1. Refer to [Switchgear and Switchboard Assemblies: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center bus.
2. Refer to [Medium-Voltage Air Switches: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center switches.
3. Refer to [Medium-Voltage Air Circuit Breakers: Maintenance Testing Guidelines](#) and [Medium-Voltage Oil Circuit Breakers: Maintenance Testing Guidelines](#), [Medium-Voltage Vacuum Circuit Breakers: Maintenance Testing Guidelines](#), or [Medium-Voltage SF₆ Circuit Breakers: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center circuit breakers.
4. Refer to [Medium-Voltage Motor Control Starters: Maintenance Testing Guidelines](#) for appropriate inspections and tests of the motor control center starters.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

LOW-VOLTAGE INSULATED CASE/MOLDED CASE CIRCUIT BREAKERS

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Low-Voltage Insulated Case/Molded Case Circuit Breakers should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- Ductor
- Megger (1,000 volt)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect circuit breaker for correct mounting.
2. Operate circuit breaker to insure smooth operation.
3. Inspect case for cracks or other defects.
4. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 4.1. Use of low-resistance ohmmeter in accordance with Step 3 of the “Electrical Tests” section of this document.
 - 4.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 4.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
5. Inspect mechanism contacts and arc chutes in unsealed units.

Electrical Tests

1. Perform a contact-resistance test.
2. Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
3. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 4 of the “Visual and Mechanical Inspection” section of this document.
4. Perform insulation resistance test at 1000 volts dc on all control wiring. For units with solid-state components, follow manufacturer's recommendations.
5. Perform long-time delay time-current characteristic tests by passing 300 percent rated current through each pole separately unless series testing is required to defeat ground fault functions.
6. Determine short-time pickup and delay by primary current injection.
7. Determine ground-fault pickup and time delay by primary current injection.
8. Determine instantaneous pickup current by primary injection using run-up or pulse method.
9. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
10. Verify the calibration of all functions of the trip unit by means of secondary injection.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available,

investigate any values which deviate from adjacent poles or similar breakers by more than 25 percent of the lowest value.

4. Circuit breaker insulation resistance shall be in accordance with Table 3.
5. Control wiring insulation resistance shall be a minimum of two megohms.
6. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
7. For molded-case circuit breakers all trip times shall fall within Table 4. Circuit breakers exceeding specified trip time at 300 percent of pickup shall be tagged defective.
8. For molded-case circuit breakers instantaneous pickup values shall be within values shown in Table 5.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2 (cont.)
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 6 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Molded-Case Circuit Breakers
Values for Inverse Time Trip Test
(At 300% of Rated Continuous Current of Circuit Breaker)

Range of Rated Continuous Current Amperes	Maximum Trip Time in Seconds For Each Maximum Frame Rating*	
	≤ 250V	251 - 600V
0-30	50	70
31-50	80	100
51-100	140	160
101-150	200	250
151-225	230	275
226-400	300	350
401-600	-----	450
601-800	-----	500
801-1000	-----	600
1001-1200	-----	700
1201-1600	-----	775
1601-2000	-----	800
2001-2500	-----	850
2501-5000	-----	900

Reproduction of Table 5-3 from NEMA Standard AB4-1991.

* For integrally fused circuit breakers, trip times may be substantially longer if tested with the fuses replaced by solid links (shorting bars).

TABLE 5
Instantaneous Trip Setting Tolerances for Field
Testing of Marked Adjustable Trip Circuit Breakers

Ampere Rating	Tolerances of High and Low Settings	
	High	Low
≤ 250	+ 40% - 25%	+ 40% - 30%
> 250	± 25%	± 30%

Reproduction of Table 5-4 from NEMA publication AB4-1991.

For circuit breakers with nonadjustable instantaneous trips, tolerances apply to the manufacturer's published trip range, i.e., +40 percent on high side, -30 percent on low side.

TABLE 6
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Switchgear and Switchboard Assemblies should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- Ductor
- Phase rotation meter
- RMS Multimeter
- Single phase high current source
- Torque Wrench
- Megger
- Thermometer

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Compare equipment nameplate data with latest one-line diagram when available.
2. Inspect physical, electrical, and mechanical condition including evidence of moisture or corona.
3. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
4. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
5. Verify that current and voltage (potential) transformer ratios correspond to drawings.
6. Inspect all bus connections for high resistance using one of the following methods:
 - 6.1. Use of low-resistance ohmmeter in accordance with Step 3 of the "Electrical Tests" section of this document.
 - 6.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 6.3. Perform thermographic survey in accordance with the "Thermographic Survey Procedures" section of this document.
7. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 7.1. Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - 7.2. Make key exchange with devices operated in off-normal positions.
8. Thoroughly clean unit prior to testing unless as-found and as-left tests are required.
9. Inspect insulators for evidence of physical damage or contaminated surfaces.
10. Verify correct barrier and shutter installation and operation.
11. Lubrication
 - 11.1. Verify appropriate contact lubricant on moving current-carrying parts.
 - 11.2. Verify appropriate lubrication on moving and sliding surfaces.
12. Exercise all active components.
13. Inspect all mechanical indicating devices for correct operation.
14. Verify that filters are in place and/or vents are clear.
15. Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding, in accordance with [Instrument Transformers: Maintenance Testing Guidelines](#). Inspect for control power transformers.
 - 15.1. Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 15.2. Verify that primary and secondary fuse ratings or circuit breakers match drawings.
 - 15.3. Verify correct functioning of drawout disconnecting and grounding contacts and interlocks

Electrical Tests

1. Perform tests on all instrument transformers in accordance with [Instrument Transformers: Maintenance Testing Guidelines](#).
2. Perform ground-resistance tests in accordance with [Grounding Systems: Maintenance Testing Guidelines](#).
3. Perform resistance measurements through all bus joints with a low-resistance ohmmeter, if applicable, in accordance with Step 6 of the "Visual and Mechanical Inspection" section of this document.
4. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for one minute in accordance with Table 3.

5. Perform an overpotential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it shall be in accordance with Table 4. The test voltage shall be applied for one minute. Refer to Step 4 of the "Test Values" section of this document before performing test.
6. Perform insulation-resistance tests at 1000 volts dc on all control wiring. For units with solid-state components, follow manufacturer's recommendations.
7. Perform system function tests in accordance with the "General System Function Tests" section of this document.
8. Control Power Transformers
 - 8.1. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 3 unless otherwise specified by manufacturer.
 - 8.2. Verify correct function of control transfer relays located in switchgear with multiple power sources.
9. Voltage (Potential) Transformers
 - 9.1. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 3 unless otherwise specified by manufacturer.
 - 9.2. Verify secondary voltages.
10. Verify operation of switchgear/switchboard heaters.

Test Values

1. Compare bus connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 2 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values that deviate from similar bus by more than 25 percent of the lowest value.
4. Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 3. Values of insulation resistance less than this table or manufacturer's minimum should be investigated. Overpotential tests should not proceed until insulation-resistance levels are raised above minimum values.
5. The insulation shall withstand the overpotential test voltage applied.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.

4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

General System Function Tests

1. Perform system function tests upon completion of equipment tests as previously defined in this document. It is the purpose of system function tests to prove the correct interaction of all sensing, processing, and action devices.
2. Implementation
 - 2.1. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
 - 2.2. Perform these tests:
 - 2.2.1. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
 - 2.2.2. Verify the correct operation of all sensing devices, alarms, and indicating devices.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Insulation Resistance Tests on
Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage, dc in Volts	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values. See Table 5 for temperature correction factors.

Actual test results are dependent on the length of the conductor being tested, the temperature of the insulating material, and the humidity of the surrounding environment at the time of the test. In addition, insulation resistance tests are performed to establish a trending pattern and a deviation from the baseline information obtained during maintenance testing enabling the evaluation of the insulation for confined use.

TABLE 4
Switchgear Low-Frequency Withstand Test Voltages

Type of Switchgear	Rated Maximum Voltage (kV) (rms)	Maximum Test Voltage kV	
		ac	dc
LV (Low-Voltage Power Circuit Breaker Switchgear)	.254/.508/.635	1.6	2.3
MC	4.76	14.0	20.0
(Metal-Clad Switchgear)	8.25	27.0	37.0
	15.0	27.0	37.0
	38.0	60.0	+
SC	15.5	37.0	+
(Station-Type Cubicle Switchgear)	38.0	60.0	+
	72.5	120.0	+
MEI	4.76	14.0	20.0
(Metal-Enclosed Interrupter Switchgear)	8.25	19.0	27.0
	15.0	27.0	37.0
	15.5	37.0	52.0
	25.8	45.0	+
	38.0	60.0	+

Derived from ANSI/IEEE C37.20.1-1993, Paragraph 5.5, *Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear*, C37.20.2-1993, Paragraph 5.5, *Standard for Metal-Clad and Station-Type Cubicle Switchgear* and C37.20.3-1993, Paragraph 5.5, *Standard for Metal-Enclosed Interrupter Switchgear*, and includes 0.75 multiplier with fraction rounded down.

The column headed "DC" is given as a reference only for those using dc tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for voltage rating of switchgear. The presence of this column in no way implies any requirement for a dc withstand test on ac equipment or that a dc withstand test represents an acceptable alternative to the low-frequency withstand tests specified in this specification, either for design tests, production tests, conformance tests, or field tests. When making dc tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Because of the variable voltage distribution encountered when making dc withstand tests, the manufacturer should be contacted for recommendations before applying dc withstand tests to the switchgear. Voltage transformers above 34.5kV should be disconnected when testing with dc. Refer to ANSI/IEEE C57-13-1978 (R1987) *IEEE Standard Requirements for Instrument Transformers* [10], Section 8 and, in particular 8.8.2, (the last paragraph) which reads "Periodic kenotron tests should not be applied to transformers of higher than 34.5 kV voltage rating."

+ Consult Manufacturer

TABLE 5
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

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SMALL DRY TYPE TRANSFORMERS < 600 VOLT (167 KVA SINGLE-PHASE, 500 KVA THREE-PHASE, AND SMALLER) Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Dry Type Transformers should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- TTR Meter
- RMS Multimeter
- Torque Wrench
- Megger
- Power Factor Test Set (if required)
- Dissipation Factor Tester (if required)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect physical and mechanical condition.
2. Thoroughly clean unit prior to testing unless as-found and as-left tests are required.
3. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 3.1. Use of low-resistance ohmmeter in accordance with Step 1 of the “Electrical Tests” section of this document.
 - 3.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 2.
 - 3.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.

Electrical Tests

1. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 3.1 of the “Visual and Mechanical Inspection” section of this document.
2. Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with Table 3. Calculate polarization index.
3. Perform turns ratio tests at the designated tap position.
4. Verify that as-left tap connections are as specified.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 1 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 25 percent of the lowest value.
4. Insulation-resistance test values at one minute should not be less than values recommended in Table 3. Results shall be temperature corrected in accordance with Table 4.
5. The polarization index should be compared to previously obtained results.
6. Turns-ratio test results should not deviate more than one-half percent from either the adjacent coils or the calculated ratio.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Transformer Insulation-Resistance

Transformer Coil Rating Type in Volts	Minimum dc Test Voltage	Recommended Minimum Insulation Resistance in Megohms	
		Liquid Filled	Dry
0 - 600	1000	100	500
601 - 5000	2500	1000	5000
5001 - 15000	5000	5000	25000

In the absence of consensus standards, the NETA Technical Committee suggests the above representative values.
NOTE: Since insulation resistance depends on insulation rating (kV) and winding capacity (kVA), values obtained should be compared to manufacturer's published data.

TABLE 4
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

LARGE DRY TYPE TRANSFORMERS > 600 VOLT AND < 600 VOLT (> 167 KVA SINGLE-PHASE AND 500 KVA THREE-PHASE) Maintenance Testing Guidelines

The following information is a guide for maintenance services. Consult specific instruction manuals and drawings for detailed installation and operating procedures. Dry Type Transformers of all voltages should be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1910 subpart 5. These instructions do not cover all details, variations, or combinations of the equipment, its installation, checkout, and safe operation. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment.

Prior To Testing

- Procure and review all drawing associated with the equipment being tested.
- Study all instructional documents (Operation and Maintenance Manuals) applicable to the equipment.
- Obtain a copy of the appropriate test form to record test results.
- Verify suitability and accuracy of equipment to be used for testing.
- Record all existing equipment settings as well as settings resulting from any necessary adjustments.

Necessary Equipment

- Personnel Protective Equipment (PPE)
- RMS Multimeter
- Torque Wrench
- TTR Meter
- Megger (5,000 volt with selectable voltages)
- Power Factor Test Set (if required)
- Dissipation Factor Tester (if required)

DO NOT ATTEMPT TO INSTALL OR WORK ON EQUIPMENT WHILE IT IS ENERGIZED



Always verify that no voltage is present before proceeding with testing. Assume all circuits are energized. Confirm primary sources of power are disconnected, tagged, and locked out. Always follow all local, state, and national regulations including OSHA requirements and generally accepted safety procedures.

Inspection and Test Procedures

Visual and Mechanical Inspection

1. Inspect physical, electrical, and mechanical condition including evidence of moisture, corona, or brittleness.
2. Verify that control and alarm settings on temperature indicators are as specified.
3. Verify that cooling fans operate.
4. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 4.1. Use of low-resistance ohmmeter in accordance with Step 2 of the “Electrical Tests” section of this document.
 - 4.2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 1.
 - 4.3. Perform thermographic survey in accordance with the “Thermographic Survey Procedures” section of this document.
5. Perform specific inspections and mechanical tests as recommended by manufacturer.
6. Verify that resilient mounts are free and that any shipping brackets have been removed.
7. Verify that the core, frame, and enclosure are grounded.
8. Verify the presence of transformer surge arresters.
9. Thoroughly clean unit prior to testing unless as-found and as-left tests are required.
10. Verify that as-left tap connections are as specified.

Electrical Tests

1. Perform insulation-resistance tests winding-to-winding and each winding-to-ground, with test voltage in accordance with Table 2. Calculate polarization index.
2. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Step 4 of the “Visual and Mechanical Inspection” section of this document.
3. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.
4. Perform turns-ratio tests at the designated tap position.
5. Perform an excitation-current test on each phase.
6. Measure the resistance of each winding at the designated position.
7. Measure core insulation-resistance at 500 volts dc if core is insulated and if the core ground strap is removable.
8. Perform an overpotential test on all high- and low-voltage windings-to-ground.
NOTE: Field dielectric tests may be warranted in specific circumstances. However periodic dielectric tests are not recommended because of the severe stress imposed on the insulation. (ANSI/IEEE C57.12.91, Section 10.2.)
9. Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

Test Values

1. Compare bolted connection resistances to values of similar connections.
2. Bolt-torque levels shall be in accordance with Table 1 unless otherwise specified by manufacturer.
3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 25 percent of the lowest value.
4. Insulation-resistance test values at one minute should not be less than values recommended in Table 2. Results shall be temperature corrected in accordance with Table 3.
5. The polarization index should be compared to previously obtained results.
6. Turns-ratio test results should not deviate more than one-half percent from either the adjacent coils or the calculated ratio.
7. C_H and C_L dissipation-factor/power-factor values will vary due to support insulators and bus work utilized on dry transformers. The following should be expected on C_{HL} power factors:
 - Power Transformers: two percent or less
 - Distribution Transformers: five percent or less
8. Consult transformer manufacturer's or test equipment manufacturer's data for additional information.
9. Winding-resistance test results should compare within one percent of previously obtained results after factoring in temperature correction.
10. Typical excitation current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.
11. Core insulation resistance values should be comparable to previously obtained results but not less than one megohm at 500 volts dc.
12. AC overpotential test shall not exceed 65 percent of factory test voltage for one minute duration.
DC overpotential test shall not exceed 100 percent of the factory rms test voltage for one minute duration. The insulation shall withstand the overpotential test voltage applied.

Thermographic Survey Procedures

1. Visual and Mechanical Inspection
 - 1.1. Inspect physical, electrical, and mechanical condition.
 - 1.2. Remove all necessary covers prior to thermographic inspection.
2. Equipment to be inspected shall include all current-carrying devices.
3. Provide report including the following:
 - 3.1. Discrepancies.
 - 3.2. Temperature difference between the area of concern and the reference area.
 - 3.3. Cause of temperature difference.
 - 3.4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - 3.5. Identify load conditions at time of inspection.
 - 3.6. Provide photographs and/or thermograms of the deficient area.
4. Test Parameters
 - 4.1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 - 4.2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 4.3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B, Section 18-16 (Infrared Inspection).
5. Test Results: Suggested actions based on temperature can be found in Table 1.

After Testing

- Finish recording data on the test form, completely filling in all the appropriate blocks.
- Remove all test equipment and tools used during testing. Replace all barriers and covers, close all doors, and secure all latches.

TABLE 1
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1°C - 3°C	0°C - 10°C	Possible deficiency; warrants investigation
4°C - 15°C	11°C - 20°C	Indicates probable deficiency; repair as time permits
-- -- --	22°C - 40°C	Monitor continuously until corrective measures can be accomplished
> 16°C	> 40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT . In the absence of consensus standards for ΔT , the values in this table will provide reasonable guidelines.

TABLE 2
US Standard
Bolt Torques for Bus Connections
Heat-Treated Steel - Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

TABLE 2
Bolt Torques for Bus Connections
Silicon Bronze Fasteners*
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

* Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 2 (cont.)
Aluminum Alloy Fasteners**
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

** Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

TABLE 2
Bolt Torques for Bus Connections
Stainless Steel Fasteners***
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

*** Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

TABLE 3
Transformer Insulation-Resistance

Transformer Coil Rating Type in Volts	Minimum dc Test Voltage	Recommended Minimum Insulation Resistance in Megohms	
		Liquid Filled	Dry
0 - 600	1000	100	500
601 - 5000	2500	1000	5000
5001 - 15000	5000	5000	25000

In the absence of consensus standards, the NETA Technical Committee suggests the above representative values.
NOTE: Since insulation resistance depends on insulation rating (kV) and winding capacity (kVA), values obtained should be compared to manufacturer's published data.

TABLE 4
Insulation Resistance Conversion Factors
For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

APPENDIX A: CAPITAL ELECTRIC REPORT

December 22, 2010

Kansas Department of Administration
900 WS Jackson Street, Suite 600
Topeka, KS 66612

Attn: George Werth

Subject: Summary of work performed on electrical distribution system in the Docking Building.

Dear Mr. Werth:

Capital Electric Construction was contracted to perform maintenance and cleaning of the 13.2kV electrical distribution system in the Docking Building. The work was started on Wednesday, November 24 and completed on Saturday, November 27. This report summarizes our findings.

To perform our work, power to the Docking building was turned off and maintenance to the Main Electrical gear and bus riser took place. During this maintenance, several medium voltage (M.V). switches were cleaned and repaired along with the main riser bus that runs the length and height of the building. The protective metal covers on the bus were removed where assessable and the electrical bus was visually inspected and cleaned. Included with this report are several photos of different items of concern that need varying degrees of attention.

Below is a list of our concerns:

1. Nameplates on the equipment indicate that the gear was manufactured/installed in the mid 1950's. This makes this equipment between 50 and 60 years old. It is generally expected that electrical gear has a life expectancy of 15-30 years. Many factors affect the life expectancy, including ambient temperature, environmental conditions, electrical load (and the characteristics of the load) on the equipment, maintenance, and other factors. Assuming all of these factors have been ideal, the gear would still be considered to have out-lived its normal life expectancy.
2. Many of the sections of the bus are inaccessible. This means that these sections have never been cleaned or maintained. Routine maintenance is not possible on these sections. There was an extreme amount of dust/dirt accumulation in all areas of the system. We were able to clean many of the areas, but these particular areas could not be accessed, so they remain with over 50 years of dirt accumulation. The presence of the dust/dirt and in some areas oil and moisture

could lead to tracking (unwanted current flow from phase to phase or phase to ground). The result of this could potentially be severe damage to the equipment and building, and also potential safety risk to people in the building. An electrical outage affecting the entire building could also result.

3. The age of the electrical equipment is such that replacement parts are unavailable or difficult to find. Repairs may require custom fabrication, which could require extensive engineering or re-engineering.
4. The gear is 13.2kV. Any maintenance or repairs requires special equipment, tools, and training.
5. The gear is very open in design and allows air flow into the bus duct thru the M.V. switches. With these transformer housings being in the air handler rooms and the elevator exhaust ports feeding into these rooms the accumulation is much more than normal. The bus is covered and has taped joints but those tape joints are showing some tracking and age. To re-tape these joints would extend the life of the bus but would be very labor intensive and require a very lengthy outage to do so.
6. Transformer TRN-0015 has bus that is wrapped in 20,000v electrical blanket and extremely close to the access points of the transformer housing. It is possible that during the removal of the transformer housing covers that the bus could become exposed and cause significant hazards to the personnel working on the gear. Due to the nature of these pieces of electrical gear every precaution should be taken to protect any personnel inspecting these items. A detailed safety agenda should be followed and all personnel should adhere to any and all PPE requirements of NFPA 70e. An arc flash incident is highly possible with gear of this nature if the proper precautions are not followed extensively. The consequences of an arc flash in this gear and in these confined locations would be very severe and would likely result in death to the personnel working on the gear. It is highly recommended that only qualified and trained personnel have access to this gear for maintenance purposes.
7. As mentioned above the M.V. switches are open into the bus area. These had varying degrees of dust and dirt accumulation as well. These however can be de-energized and maintenance performed on a regular basis to extend their life span. While energized a visual inspection of these switches and of the transformers would be recommended along with an IR scan on a routine maintenance schedule. With the exception of one transformer this is recommended.
8. An arc flash study is recommended for this and all electrical gear in the Docking building. This would include the proper labeling of the arc hazard and calorie requirements onto all electrical doors.
9. It was also observed during the maintenance that some of the fuses were not seated properly and that the switches were not engaging fully. The only reason this had not been an issue was due to the amount of load on these switches. If these had additional load on them when not fully seated it would result in arcing and heating issues.
10. It was noted on the first and basement floors that the wires feeding off the load side of the switches have corrosion developing at the insulators holding them in place. These were cleaned and re-taped but this is not a permanent fix and

these should be replaced in the near future before the insulation breaks down to the point of failure.

11. Mechanical mechanisms in some of the MV switches have failed. These are a safety mechanism that keeps the door of the enclosure closed when the switch is in the energized state. Because these could not be repaired, we were forced to install padlocks on the doors as the only means of safety. Signage should be installed on these switches to alert personnel of the danger.

SUMMARY

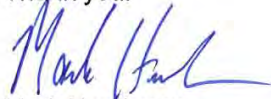
We believe the electrical distribution system in the Docking Building is nearing the failure point, and we recommend a complete replacement of the system.

- Insulation in the system is deteriorating and may fail.
- The equipment is obsolete and replacement parts are not available.
- Safety mechanisms are failing.

I have attached the Emerson Test Report for the switches and equipment that were tested during the project. Their report includes additional recommendations.

Please contact me if there are any questions or additional information is required.

Thank you.



Mark Hurshman
Capital Electric



Electrical Reliability Services, Inc.
Kansas City Area Office

348 N.W. Capital Drive
Lee's Summit, MO 64086
T (816) 525-7156
F (816) 524-3274

December 6, 2010

Capital Electric
P.O. Box 410079
Kansas City, MO 64141

Attention: Mr. Mark Hurshman

Subject: Electrical Equipment Maintenance Test Report
Reference No. 3126895

Dear Mr. Hurshman:

Enclosed is the subject test report as prepared by our lead field engineer. It was our pleasure to be of service to you on this project. If you have any questions, or if we can be of further assistance, please do not hesitate to call.

Sincerely,

Electrical Reliability Services, Inc

A handwritten signature in blue ink, appearing to read "Bob Ross".

Bob Ross
Service Center Manager

Enclosures



Electrical Reliability Services, Inc.
Kansas City Area Office

348 N.W. Capital Drive
Lee's Summit, MO 64086
T (816) 525-7156
F (816) 524-3274

**Electrical Equipment Maintenance
Test Report**

At

DOCKING STATE OFFICE BLDG
Topeka, KS

for

Capital Electric
P.O.Box 410079
Kansas City, MO 64141

Attention: Mr. Mark Hurshman
Order No: PO#196031, JOB#56763

Reference No. 3126895

Submitted By: David Duncan
Field Engineer

December 6, 2010

Reviewed By:


Bob Ross
Service Center Manager

1 PURPOSE

- 1.1 The equipment and components listed in Section 3.0 of this report have been inspected and tested to help assure their proper and safe operation. Defective or marginal equipment can be identified, repaired, replaced or scheduled for future repairs without costly or unexpected interruptions during normal operating periods.
- 1.2 The test results are particularly valuable when kept for comparison with past and future maintenance test results. This historic database enables one to predict the probability of equipment failure and thus schedule facility production and financial budgets to accommodate preventive maintenance or repair rather than breakdown maintenance.

2 SUMMARY

- 2.1 This project was initiated by Mr. Mark Hurshman with Capital Electric. All testing was performed by Electrical Reliability Services Field Engineers David Duncan and Charles Howell on Saturday, November 27, 2010.
- 2.2 Please refer to Section 5 "Results and Recommendations" for complete details of the testing.

3 EQUIPMENT TESTED AND INSPECTED

- 3.1 **Three (3)** medium voltages disconnect switches, S&C, SM-5, and 400 Amp.
- 3.2 **Seventeen (17)** medium voltages disconnect switches, electrical engineering equipment co, S.O. # 50542, 300 Amp.

4 PROCEDURES

4.1 Medium Voltage Air Switches

4.1.1 Visual and Mechanical Inspection

- .1 Compared equipment nameplate data with drawings and specifications.
- .2 Inspected for physical damage, proper installation, required area clearances, anchorage and grounding. Cleaned interior, insulators, arc chutes and interphase barriers.
- .3 Performed mechanical operator tests in accordance with manufacturer's instructions. Cleaned and lubricated contacts and mechanism as applicable. Confirmed correct application of manufacturer's recommended lubricants.
- .4 Checked contact alignment, wipe and pressure.
- .5 Inspected for correct phase barrier materials and installation.
- .6 Checked fuse linkage and element for proper holder and current rating. Recorded fuse data.
- .7 Verified tightness of accessible bolted electrical connections by calibrated torque-wrench method.
- .8 Verified that fuse sizes and types were in accordance with drawings and power system studies.
- .9 Inspected all indicating and control devices for correct operation.
- .10 Tested all interlocking systems for correct operation and sequencing. Checked key interlock for proper operation and proper key distribution.
- .11 Verified arc interrupter operation.

4.1.2 Electrical Tests

- .1 Performed contact resistance test across each switch blade and fuse link.
- .2 Measured fuse resistance.
- .3 Performed insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute.

5 RESULTS AND RECOMMENDATIONS

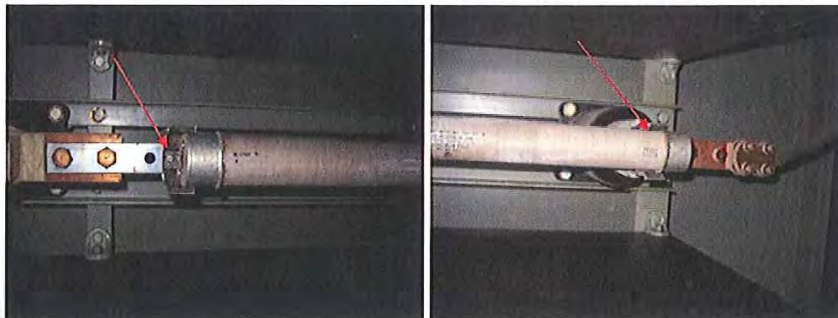
- 5.1 The following is a list of problems discovered during this testing project along with any corrective action that was made by Electrical Reliability Services. Those corrections beyond the scope of the project that require your additional corrective action are in bolded text.
- 5.1.1 If the equipment tested in Section 3 is not discussed in this section, the results of the tests indicate the equipment to be satisfactory.
- 5.2 Feeder #10 - A phase contact resistance was found to be higher than the other two phases and was outside of NETA contact resistance tolerances. This could cause contact heating of the other two phases, deterioration, and eventual failure of the switch. This problem was corrected at time of testing by ERS personnel. No further action required at this time.
- 5.3 Feeders 9 & 10 automatic transfer operator could not be tested because of customer restrictions. Because of the age, condition, and unavailability of repair parts the customer did not want the transfer mechanism operated. The customer is aware of the deficiencies with the ATS System and is attempting to have it repaired or replaced.
- **It is recommended that the ATS System should be tested once repairs have been made. Electrical Reliability Services would be pleased offer this service.**
- 5.4 Riser #7 B phase contact resistance was found to be higher than the other two phased and was outside of NETA contact resistance tolerances. This could cause contact heating of the other two phases, deterioration, and eventual failure of the switch. This problem was corrected at time of testing. No further action required at this time.

- 5.5 During the outage for Capital Electric Inc. to perform low voltage retrofits, on down stream equipment, it was discovered that a large percentage of the transformer disconnects were not closing fully. The cause of the problems was found to be the mechanical door interlocks which are bent out of shape. State of Kansas personnel directed Electrical Reliability Services personnel to remove the interlocking mechanism and State of Kansas personnel would install locks and signs to adjust for the safety issues.
- 5.6 During the inspection of Medium Voltage Air Switch LUCS 18, on the (14th) floor it was discovered that the moving contacts were not fully engaging the stationary contact. This could cause contact heating, deterioration, and eventual failure of the switch. Electrical Reliability Services personnel corrected this condition. This same condition was found at the following locations:
- LUCS 17, on the (14th) floor
 - LUCS 16, on the (12th) floor
 - LUCS 15, on the (11th) floor
 - LUCS 14, on the (10th) floor
 - LUCS 9, on the (9th) floor
 - LUCS 10, on the (8th) floor
 - LUCS 11, on the (7th) floor
 - LUCS 12, on the (6th) floor
 - LUCS 13, on the (5th) floor
 - LUCS 5, on the (3rd) floor

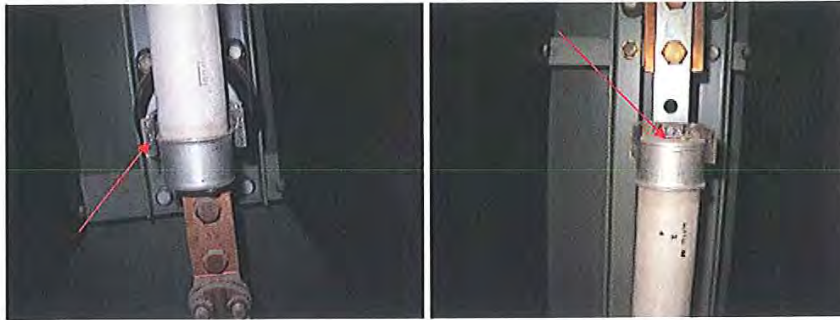
The pictures below are examples of this condition. The left picture is the before adjustment picture and the right picture is after corrections were made.



- It is recommended that all the switches be cleaned and tested. Electrical Reliability Services would be please to provide this service.
- 5.7 LUCS 5, on the (3rd) floor was found with the B phase fuse improperly inserted into the fuse clip. This could cause overheating, premature aging of the fuse and unscheduled outages. Capital Electric Personnel were to correct this problem before restoring service. The left picture is the line side of the fuse and the right picture is load side of the fuse.

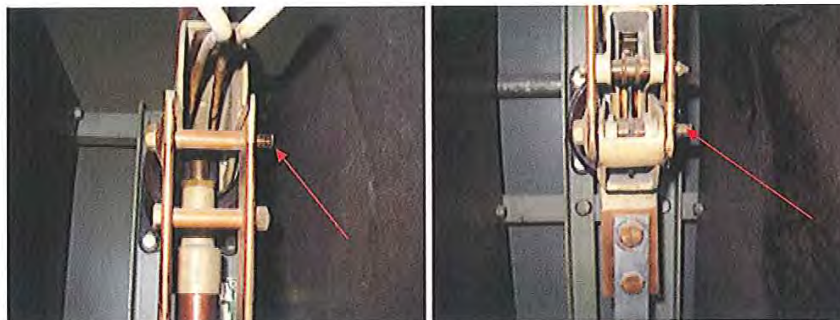


- 5.8 LUCS 5, on the (3rd) floor was found with the C phase fuse improperly inserted into the fuse clip. This could cause overheating, premature aging of the fuse and unscheduled outages. Capital Electric Personnel were to correct this problem before restoring service. The left picture is the load side of the fuse and the right picture is line side of the fuse.



- 5.9 LUCS 3, on the (1st) floor was found with the knife blades fully penetrating the stationary contacts. However the C phase knife switch was found to be missing a nut and cup washer on the line and load side of the switch. This could cause contact heating, deterioration, and eventual failure of the switch. This problem was corrected before restoring utility power by Capital Electric personnel. The left picture is the moving portion of the switch, and the right picture is the elbow or pivot part of the switch. No further mechanical action required at this time.

- It is suggested that a complete cleaning and maintenance test be performed at the next scheduled outage. Electrical Reliability Services would be pleased offer this service.



Ross, Bob [NETPWR/ERS/LEE']

Subject: FW: Docking M.V. switches

Importance: High

-----Original Message-----

From: White, Ben [mailto:bwhite@capitalelectric.com]

Sent: Friday, November 26, 2010 9:32 AM

To: Steele, George [FM]; Flowers, Clifford [FM]

Cc: Werth, George [FM]; Lour, Mike [FM]; Howell, Chuck [NETPWR/ERS/LEE']; Hurshman, Mark

Subject: RE: Docking M.V. switches

Importance: High

Gentlemen this is to document our earlier conversation today in which the door latches were discussed. As directed we will have Emerson Reliability Services remove the door latch mechanism from the throw rod so as to allow complete operation of the switches off the Bus Duct riser only. These components will be placed in the bottom of the cabinets for future needs if it is desired to repair and reattach these at a later date.

In cleaning these switches we noticed the knife blades not fully engaged. During further inspection it was noted that the latch rods have been bent during operation and are obstructing the switches from engaging fully and properly. These latch rods are part of the mechanism that holds the door shut while in the energized state. These will be removed off all these common disconnect switches on the Bus riser so no further issues arise in the event of operating these switches.

It is understood that you will have padlocks in place that only allow Authorized personnel access to these when the switch when they are in the closed position. In addition signage will be placed on all these disconnects to signify this modification and the hazards involved with opening these while energized. I would also suggest signage being added that signifies the proper PPE require to open these switches and the proper CAL requirement for Arc Flash.

Your response to this email will serve as our authorization to perform this work.

Thanks,
Ben White
Capital Electric Construction Company
Service Division
816-215-6691 (cell)

From: Steele, George [FM] [mailto:George.Steele@da.ks.gov]

Sent: Thu 11/25/2010 4:50 PM

To: White, Ben; Hurshman, Mark; Flowers, Clifford [FM]

Cc: Werth, George [FM]; Lour, Mike [FM]

Subject: RE: Docking M.V. switches

We agree with having Emerson look at, repair and modify all switches off the Buss Duct on a Time and Material Basis.

George Steele
900 SW Jackson, Suite 600
Topeka, KS 66612
785-296-4693
Cell 785-215-5709

-----Original Message-----

From: White, Ben [mailto:bwhite@capitalelectric.com]
Sent: Thursday, November 25, 2010 4:17 PM
To: Steele, George [FM]; Hurshman, Mark; Flowers, Clifford [FM]
Subject: Docking M.V. switches

Gentlemen this is to confirm our earlier conversations today about the Switches that are not engaging as they should feeding the transformers on each floor off the Bus Duct run.

We will as discussed remove the safety latch that holds the doors closed while energized. It is understood that the padlock on the door handle will become the safety and labeling will be attached to the doors to identify the voltage hazard. As discussed this is being done so that it can be verified that the knife switches have engaged the switch fully.

Secondly we will have Emerson Reliability Services look at and repair or modify all the switches off the Bus Duct run we have been working on to verify the functionality of all the switches. They will make the necessary adjustments to the two switches in the penthouse.

All this work is on a T&M basis. Please respond to this email as our work authorization.

Thanks,
Ben White
Capital Electric Construction Company
Service Division
816-215-6691 (cell)

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895					
LOCATION: 915 SW HARRISON ST			ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS	FEEDER IDENTIFICATION: RISER NO # 7	TEST EQUIP. ASSET NO: 41-01045/1280	CALIBRATION DATE: 05/26/2010						
NAMEPLATE DATA									
MANUFACTURER: S & C	TYPE: N/A	STYLE/SERIAL NUMBER: CD28082	CURRENT RATING: 400	VOLTAGE RATING: 15K					
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4			SYSTEM VOLTAGE: 13.8 KV						
INSPECTION									
CHECK POINT	CONDITION	NOTES	CHECK POINT	CONDITION	NOTES				
PHYSICAL DAMAGE	A		CONTACT ALIGNMENT	A					
CLEANLINESS	C		CONTACT WIPE	A					
MECHANICAL OPERATOR	N/A	(1)	CONTACT PRESSURE	A					
MAIN CONTACTS	A		PHASE BARRIERS	A					
ARC CONTACTS	A		HARDWARE TIGHTNESS	A					
ARC CHUTES	N/A		FUSE HOLDERS	A					
ARC INTERRUPTER SEQUENCE	A		INTERLOCKS	A					
ELECTRICAL TESTS									
		A-PHASE	B-PHASE	C-PHASE					
CONTACT RESISTANCE IN MILLIOHMS		0.373/.112	0.832/.118	.184/.139					
FUSE RESISTANCE IN MILLIOHMS		0.410	0.376	0.386					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS	SWITCH CLOSED						SWITCH OPEN		
	A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
	2.953	3.045	3.099	(4)	(4)	(4)	7040	6150	6200
NOTE									
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED TO TESTIUNG PROCEDCURS									
NOTE 2:) "B" PHASE KNIFE SWITCH HAS HIGHER RESISTANCE THAN OTHER TWO PHASES. ERS CORRECTED WITH AJUSTMENT TO KNIFE SWITCH.									
NOTE 3:) CLOSED INSULATION TEST WERE DONE WITH BUSS RISER ATTACHED.									
NOTE 4:) CANNOT TEST DUE TO METERING EQUIPMMENT CONNECTIONS IN PRIMARY CABINET OWNED BY UTILITY COMPANY.									
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE									

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895					
LOCATION: 915 SW HARRISON ST			ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS		FEEDER IDENTIFICATION: FEEDER # 09		TEST EQUIP. ASSET NO: 41-01045/1280	CALIBRATION DATE: 05/26/2010				
NAMEPLATE DATA									
MANUFACTURER: S & C		TYPE: N/A	STYLE/SERIAL NUMBER: CD28082		CURRENT RATING: 400				
					VOLTAGE RATING: 15K				
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4				SYSTEM VOLTAGE: 13.8 KV					
INSPECTION									
CHECK POINT	CONDITION	NOTES	CHECK POINT	CONDITION	NOTES				
PHYSICAL DAMAGE	A		CONTACT ALIGNMENT	A					
CLEANLINESS	C		CONTACT WIPE	A					
MECHANICAL OPERATOR	N/A	(1)	CONTACT PRESSURE	A					
MAIN CONTACTS	A		PHASE BARRIERS	A					
ARC CONTACTS	A		HARDWARE TIGHTNESS	A					
ARC CHUTES	N/A		FUSE HOLDERS	A					
ARC INTERRUPTER SEQUENCE	A		INTERLOCKS	A					
ELECTRICAL TESTS									
		A-PHASE	B-PHASE	C-PHASE					
CONTACT RESISTANCE IN MILLIOHMS		0.135	0.122	0.101					
FUSE RESISTANCE IN MILLIOHMS		0.369	0.385	0.391					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS	SWITCH CLOSED						SWITCH OPEN		
	A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
	178.5	192.8	177.9	335.2	310.8	470	2779	2983	3181
NOTE									
NOTE 1:) TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED FOR TESTING PROCEDCURS									
NOTE 2:) CABLES & ARRESTORS WERE DISCONNECT FOR TESTING PURPOSES.									
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE									

**MEDIUM VOLTAGE AIR SWITCH
TEST REPORT**

CLIENT: CAPITAL ELECTRIC				JOB NUMBER: 3126895					
LOCATION: 915 SW HARRISON ST			ENGINEER: CH DD		DATE: 11/26/2010				
SWITCHGEAR DESIGNATION: MAIN ATS	FEEDER IDENTIFICATION: FEEDER # 10	TEST EQUIP. ASSET NO: 41-01045/1280	CALIBRATION DATE: 05/26/2010						
NAMEPLATE DATA									
MANUFACTURER: S & C	TYPE: N/A	STYLE/SERIAL NUMBER: CD28082	CURRENT RATING: 400	VOLTAGE RATING: 15K					
FUSE INFORMATION: S & C, SM-5, CAT NO 132400R4, 14.4 KV, 250E, TCC NO. 153-4			SYSTEM VOLTAGE: 13.8 KV						
INSPECTION									
CHECK POINT	CONDITION	NOTES	CHECK POINT	CONDITION	NOTES				
PHYSICAL DAMAGE	A		CONTACT ALIGNMENT	A					
CLEANLINESS	C		CONTACT WIPE	A					
MECHANICAL OPERATOR	N/A	(1)	CONTACT PRESSURE	A					
MAIN CONTACTS	A		PHASE BARRIERS	A					
ARC CONTACTS	A		HARDWARE TIGHTNESS	A					
ARC CHUTES	N/A		FUSE HOLDERS	A					
ARC INTERRUPTER SEQUENCE	A		INTERLOCKS	A					
ELECTRICAL TESTS									
CONTACT RESISTANCE IN MILLIOHMS (2)		A-PHASE	B-PHASE	C-PHASE					
		0.584/.144	0.234/.123	0.232/.143					
FUSE RESISTANCE IN MILLIOHMS		0.338	0.339	0.346					
INSULATION RESISTANCE TEST IN GIGOHMS @ 5000 VOLTS	SWITCH CLOSED						SWITCH OPEN		
	A-Gnd	B-Gnd	C-Gnd	A-B	B-C	C-A	A	B	C
	245.9	228.3	178.3	443	275	418	3381	3065	3265
NOTE									
NOTE 1: TRANSFER OPERATION COULD NOT BE VERIFIED DO TO CUSTOMER RESTRICTIONS. CUSTOMER DID NOT WANT TRANSFER SWITCH OPERATED. SWITCH INTERLINKS HAD TO BE DISCONNECTED FOR TESTING PROCEDCURS									
NOTE 2: "A" PHASE KNIFE SWITCH HAS HIGHER RESISTANCE THAN OTHER TWO PHASES. ERS CORRECTED WITH AJUSTMENT TO KNIFE SWITCH.									
NOTE 3: CABLES & ARRESTORS WERE DISCONNECT FOR TESTING PURPOSES.									
A = ACCEPTABLE R = NEEDS REPAIR C = CORRECTED N/A = NOT APPLICABLE									



Electrical Reliability Services

Project Status Report / Work Authorization

CLIENT	CAPITAL ELECTRIC	JOB NO.	3126895	
PROJECT	915 SW HARRISON ST.	ENGINEER	CH/DD	DATE 11/26/2010

THIS DOCUMENT IS INTENDED TO PROVIDE PRELIMINARY INFORMATION AS TO THE STATUS OF THIS PROJECT. A FORMAL REPORT WILL BE SUBMITTED AT THE PROJECT COMPLETION.

- ☐ THE FOLLOWING ITEMS REQUIRE REPLACEMENT, REPAIR AND/OR ADJUSTMENT:
- ☐ THE FOLLOWING TESTS AND/OR INSPECTIONS ARE REQUIRED PRIOR TO PROJECT COMPLETION:
- ☒ THE FOLLOWING WORK IS AUTHORIZED:

VISUAL INSPECTION AND REMOVAL OF INTERLOCK ARM PER CUSTOMER REQUEST
(SEE E-MAIL) AS PER BEN WHITE ON FLOORS 1-14
OPEN MAIN SWITCHES IN BASEMENT FOR VISUAL INSPECTION BY CUSTOMER.

LCUS "18" 14TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE- PHOTOS
LCUS "17" 14TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "16" 12 FLOOR- REMOVAL OF INTERLOCK-PHOTOS
LCUS "15" 11TH FOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "14" 10TH FLOOR- REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "9" 9TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "10" 8TH FLOOR-REMOVAL OF INTERLOCK
LCUS "11" 7TH FLOOR-REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
LCUS "12" 6TH FLOOR-REMOVAL OF INTERLOCK
LCUS "13" 5TH FLOOR REMOVAL OF INTERLOCK -PHOTOS
LCUS "8" 3TH FLOOR NO REMOVAL REQUIRED, SWITCH RETOR-FITED WITH NEW SW
LCUS "7" 3TH FLOOR REMOVAL OF INTERLOCK
LCUS "6" 3TH FLOOR REMOVAL OF INTERLOCK
LCUS "5" 2TH FLOOR REMOVAL OF INTERLOCK & AJUSTED SWITCH HANDLE-PHOTOS
FUSE B&C ARE MISALIGNED IN HOLDER - SEE PHOTOS
LCUS "4" 2TH FLOOR REMOVAL OF INTERLOCK
LCUS "3" 1ST FLOOR REMOVAL OF INTERLOCK - C PHASE OF SWITCH IS MISSING
NUTS AND WASHERS ON PIVOT POINT & TENTION POINT - PHOTOS
LCUS "2" BASEMENT-REMOVAL OF INTERLOCK

CUSTOMER SIGNATURE	AUTHORIZATION NO.
N/A	SEE EMAIL

WHITE COPY - FILE

PINK COPY - CUSTOMER

PAGE 1 OF 1

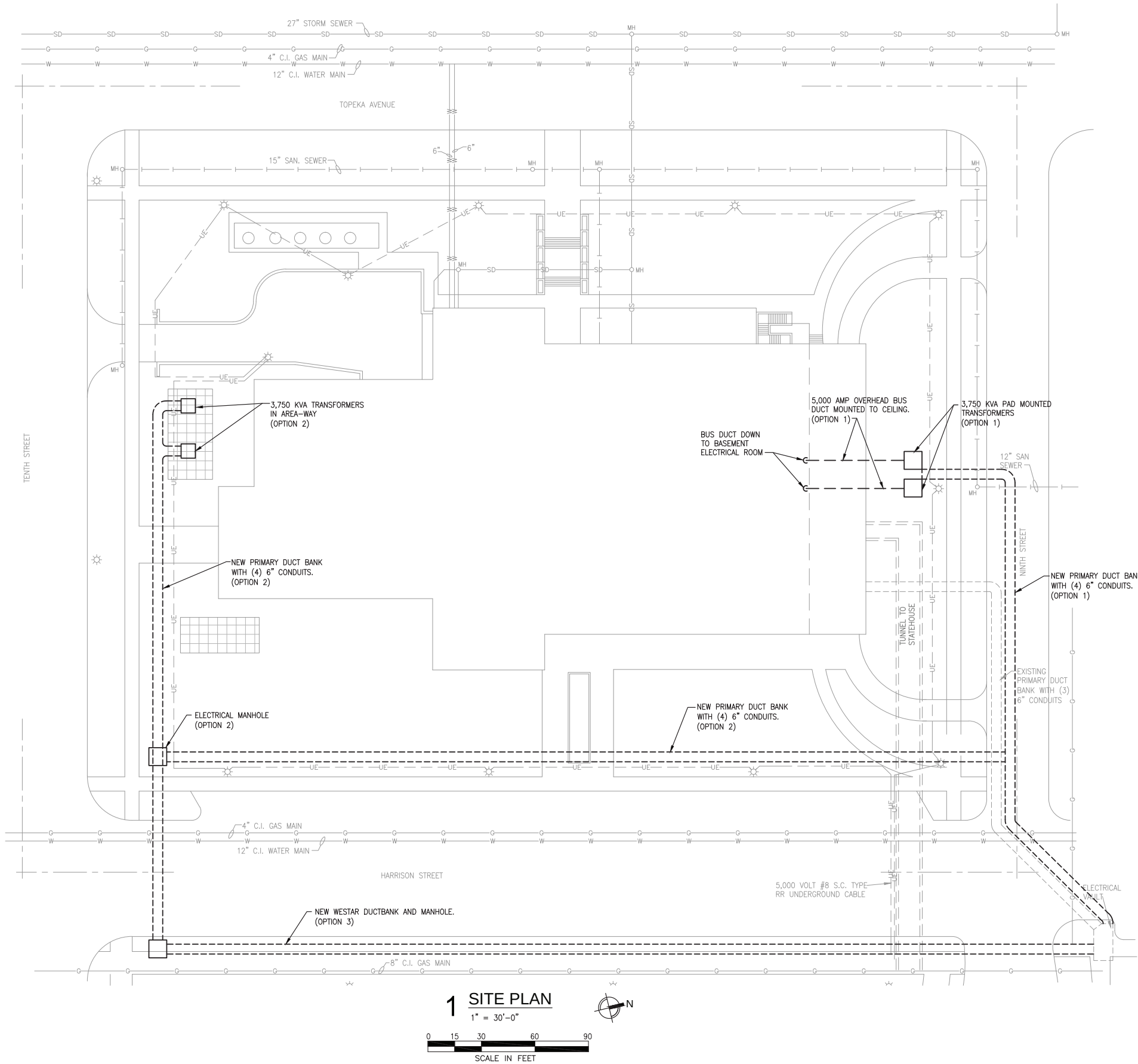
APPENDIX B: WESTAR ENERGY USAGE

Bill Constant: 8800
DOCKING STATE OFFC
915 SW HARRISON ST
TOPEKA KS

METER NUMBER : 2285030 RATE CODE: 345
BILL CONSTANT: 8800 REV CLASS: 3
MANUFACTURER : 28 RELATED : Y
IRREG USE CD : 3 PHASE : 3
MTR LOC : 52 BASEMENT S WALL

S	DATE	DAYS	USE	ACT DEM	PF%	ADJ DEM	BLG DEM
	11/24/10	30	774400		0.25	100	2394
	10/25/10	31	880000		0.25	100	2394
	09/24/10	30	1012000		0.31	100	2728
	08/25/10	29	1100000		0.3	100	2640
	07/27/10	32	1161600		0.3	100	2640
	06/25/10	30	1082400		0.32	100	2816
	05/26/10	29	888800		0.3	100	2640
	04/27/10	29	880000		0.31	100	2728
	03/29/10	31	853600		0.27	100	2376
	02/26/10	29	809600		0.26	100	2288
	01/28/10	30	853600		0.26	100	2288
	12/29/09	35	932800		0.27	100	2376
	11/24/09	32	915200		0.28	100	2464
	10/23/09	29	915200		0.27	100	2376
	09/24/09	30	1073600		0.33	100	2904
	08/25/09	29	1179200		0.33	100	2904
	07/27/09	32	1293600		0.33	100	2904
	06/25/09	29	1135200		0.36	100	3168
	05/27/09	30	1064800		0.31	100	2728
	04/27/09	31	1003200		0.31	100	2728
	03/27/09	29	968000		0.31	100	2728
	02/26/09	29	959200		0.3	100	2640
	01/28/09	30	968000		0.29	100	2552
	12/29/08	35	1064800		0.28	100	2464
	11/24/08	32	1073600		0.29	100	2552
	10/23/08	29	1056000		0.29	100	2552
	09/24/08	30	1152800		0.32	100	2816
	08/25/08	31	1293600		0.33	100	2904
	07/25/08	30	1284800		0.33	100	2904
	06/25/08	29	1170400		0.32	100	2816
	05/27/08	32	1161600		0.32	100	2816
	04/25/08	29	1047200		0.3	100	2640
	03/27/08	29	1020800		0.29	100	2552
	02/27/08	29	976800		0.26	100	2288
	01/29/08	32	1029600		0.28	100	2464

APPENDIX C: SITE PLAN, FLOOR PLANS & ONE-LINE DIAGRAM



1 SITE PLAN
1" = 30'-0"



REVIEW SET
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CONSTRUCTION

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BWR Division

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P 785.827.3603 | F 785.827.3029

Department of Administration
Division of Facilities Management

Landon State Office Building
900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

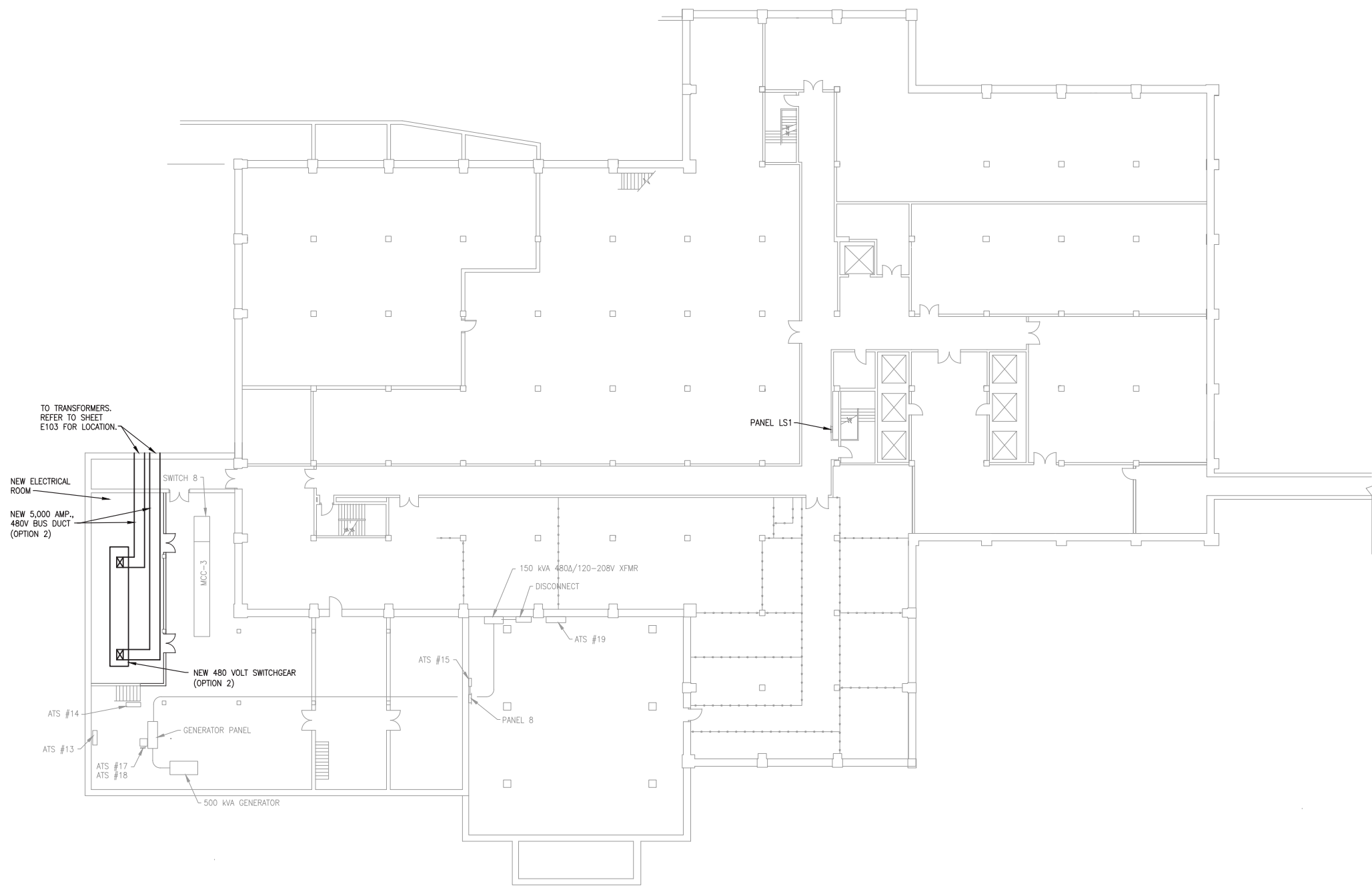
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CHECKED BY: LWS
REVISION:

EXISTING
SITE PLAN

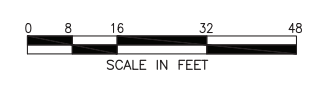
A-XXXXX

E-101

ELECTRICAL
STUDY



1 SUB-BASEMENT POWER PLAN
1/16" = 1'-0"



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SUB-BASEMENT
POWER PLAN

A-XXXXXX

E-102

ELECTRICAL
STUDY

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BWR Division

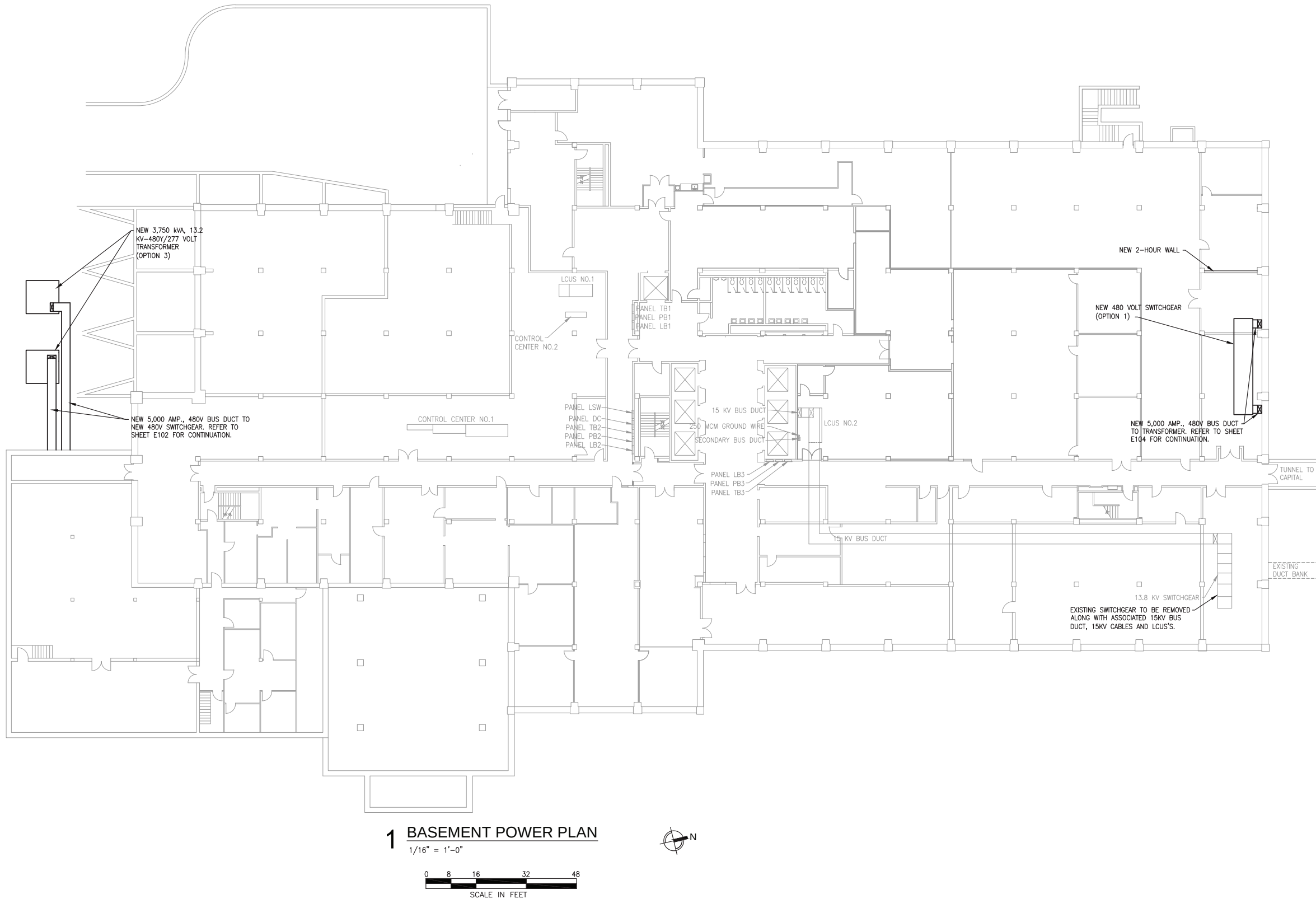
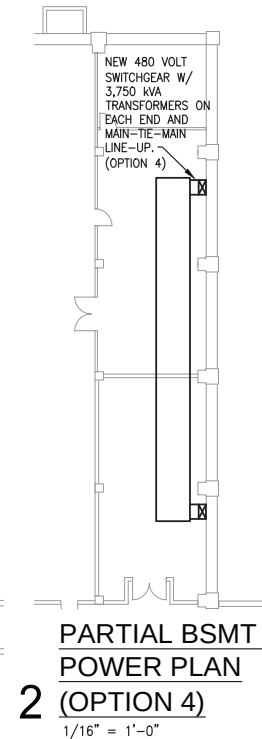
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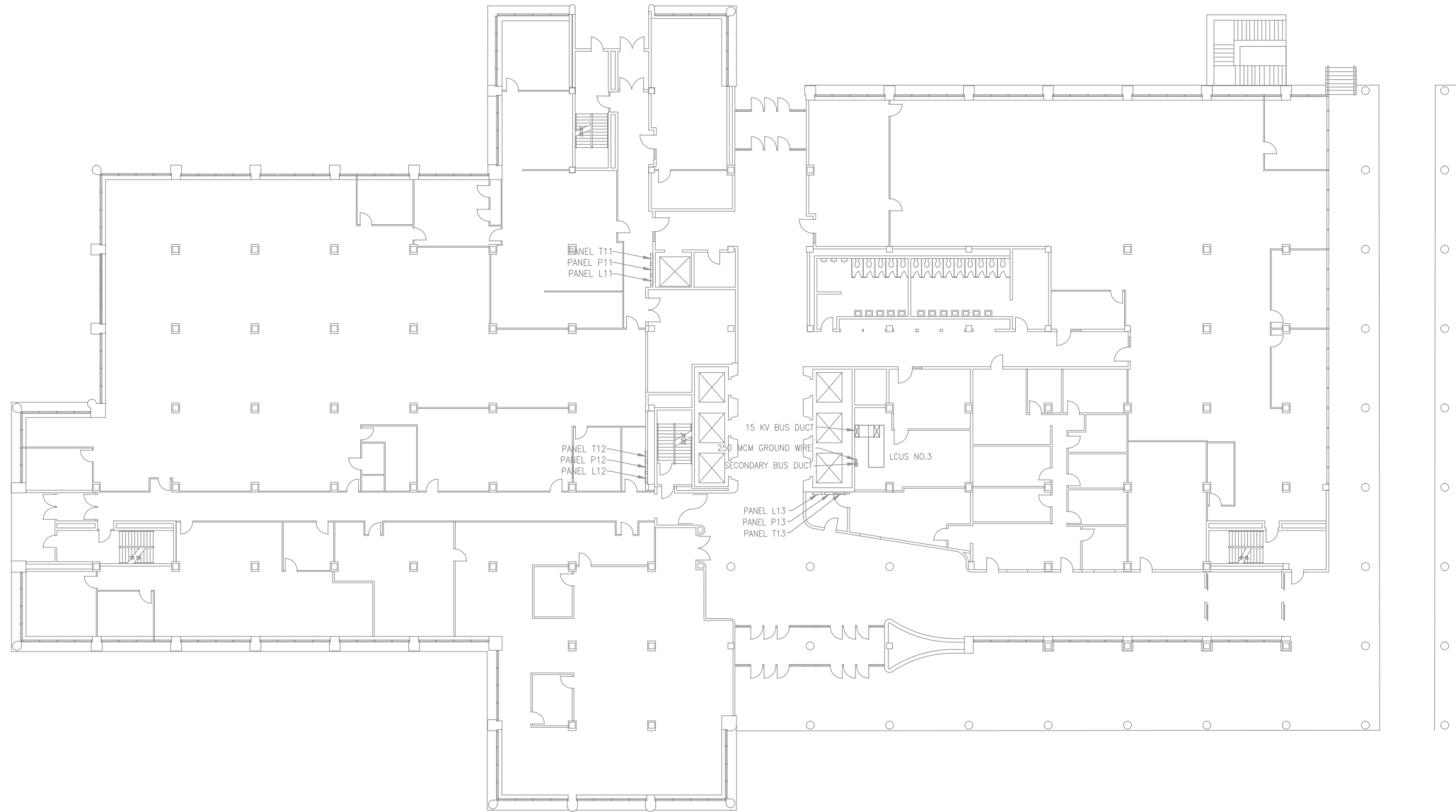
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BASEMENT
POWER PLAN
A-XXXXXX
E-103
ELECTRICAL
STUDY





1 FIRST FLOOR POWER PLAN
1/16" = 1'-0"



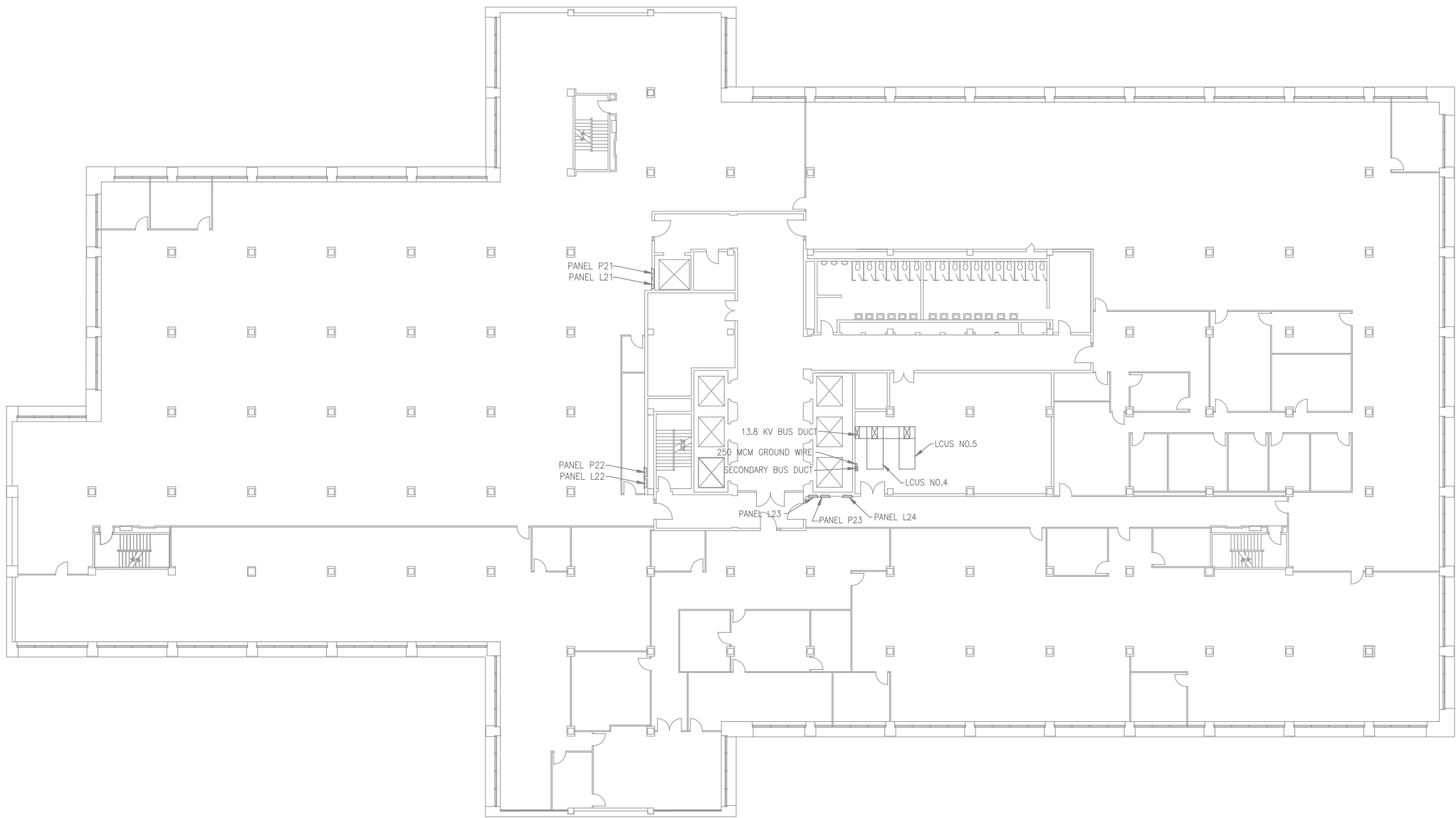
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FIRST FLOOR
POWER PLAN
A-XXXXX
E-104
ELECTRICAL
STUDY



1 SECOND FLOOR POWER PLAN
1/16" = 1'-0"



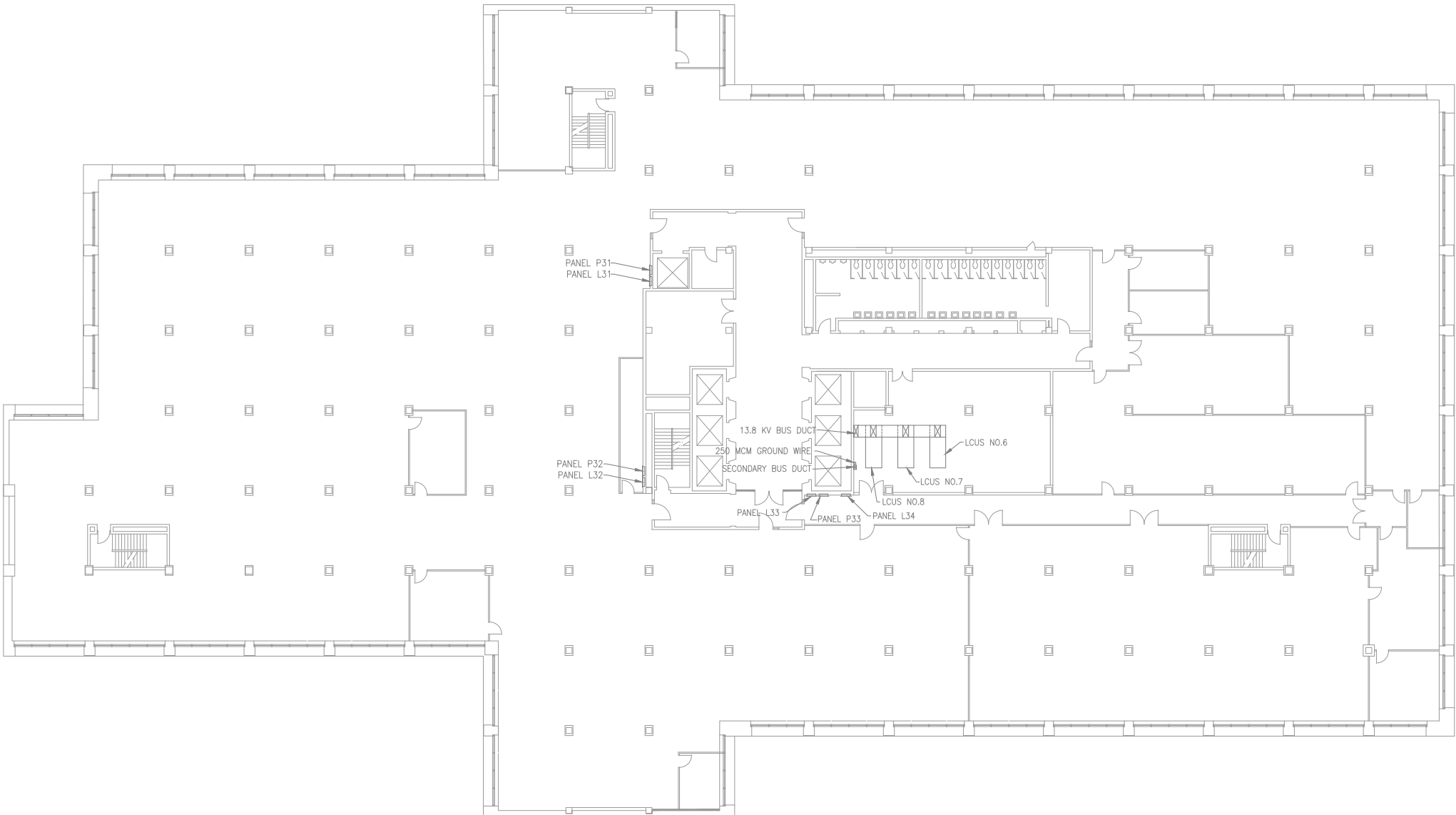
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SECOND FLOOR
POWER PLAN
A-XXXXXX
E-105
ELECTRICAL
STUDY



1 THIRD FLOOR POWER PLAN

1/16" = 1'-0"



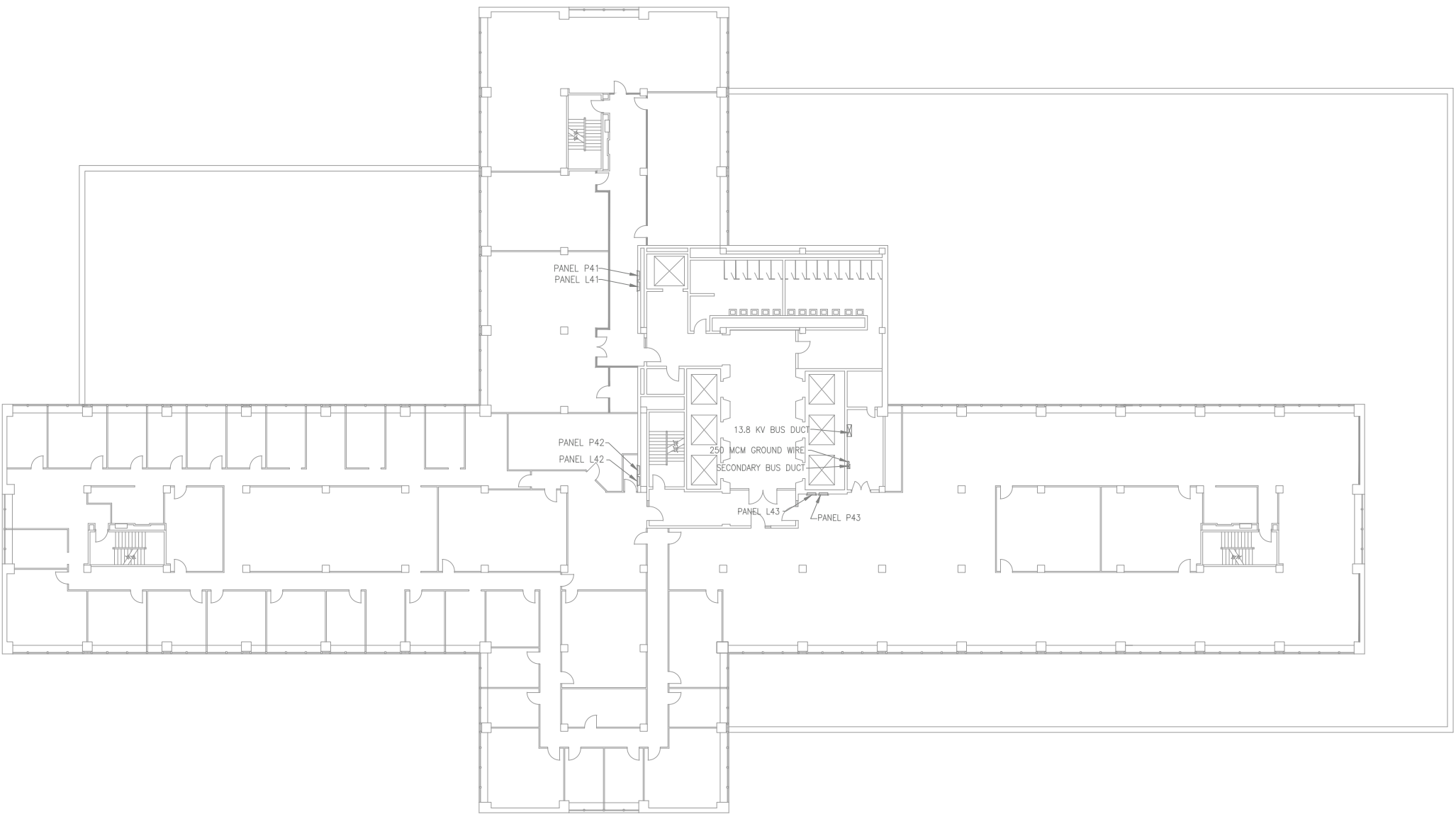
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THIRD FLOOR
POWER PLAN
A-XXXXXX
E-106
ELECTRICAL
STUDY



1 **FOURTH FLOOR POWER PLAN**
1/16" = 1'-0"



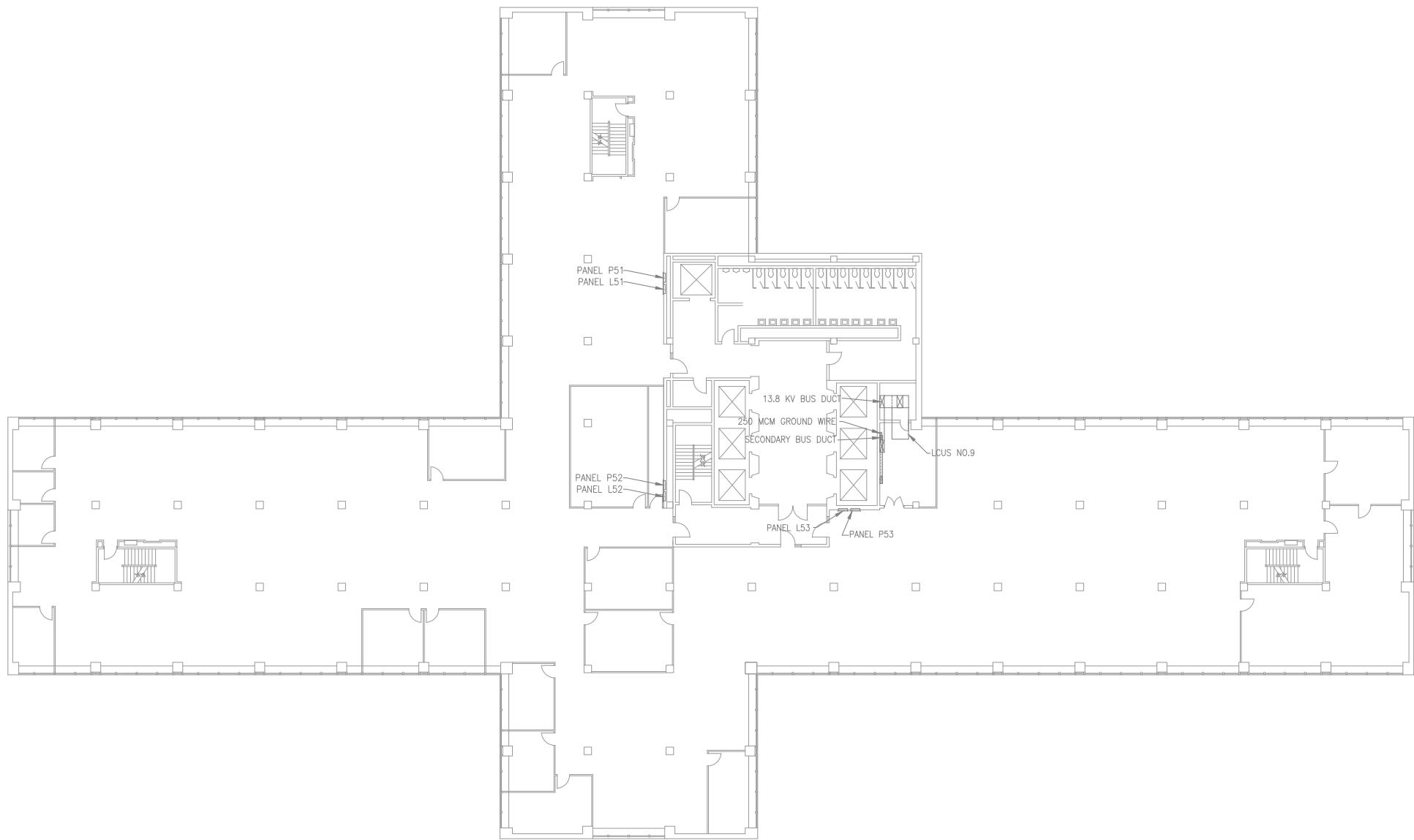
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FOURTH FLOOR
POWER PLAN
A-XXXXXX
E-107
ELECTRICAL
STUDY



1 FIFTH FLOOR POWER PLAN
1/16" = 1'-0"



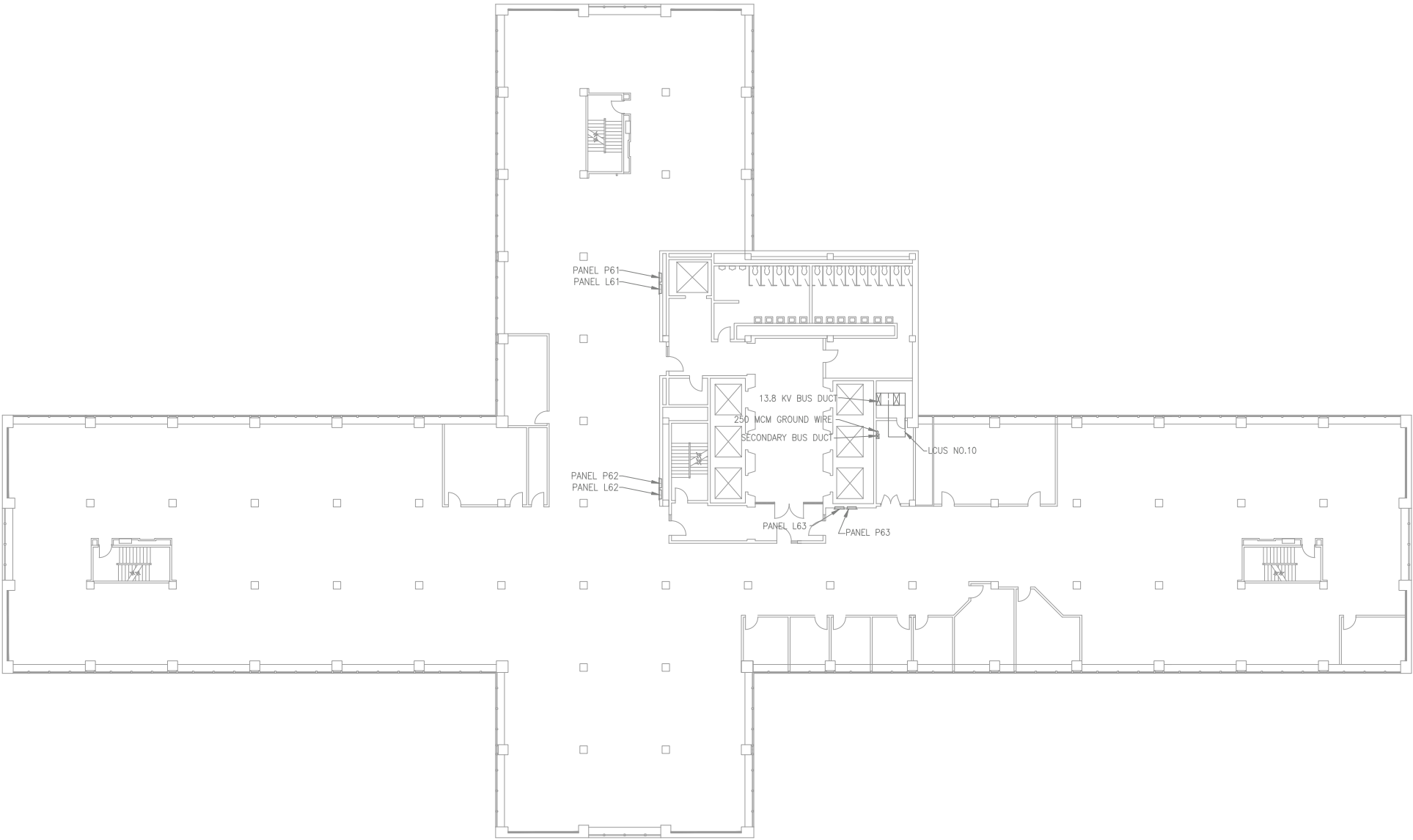
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DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:
1/17/11

FIFTH FLOOR
POWER PLAN
A-XXXXXX
E-108
ELECTRICAL
STUDY



1 SIXTH FLOOR POWER PLAN
1/16" = 1'-0"



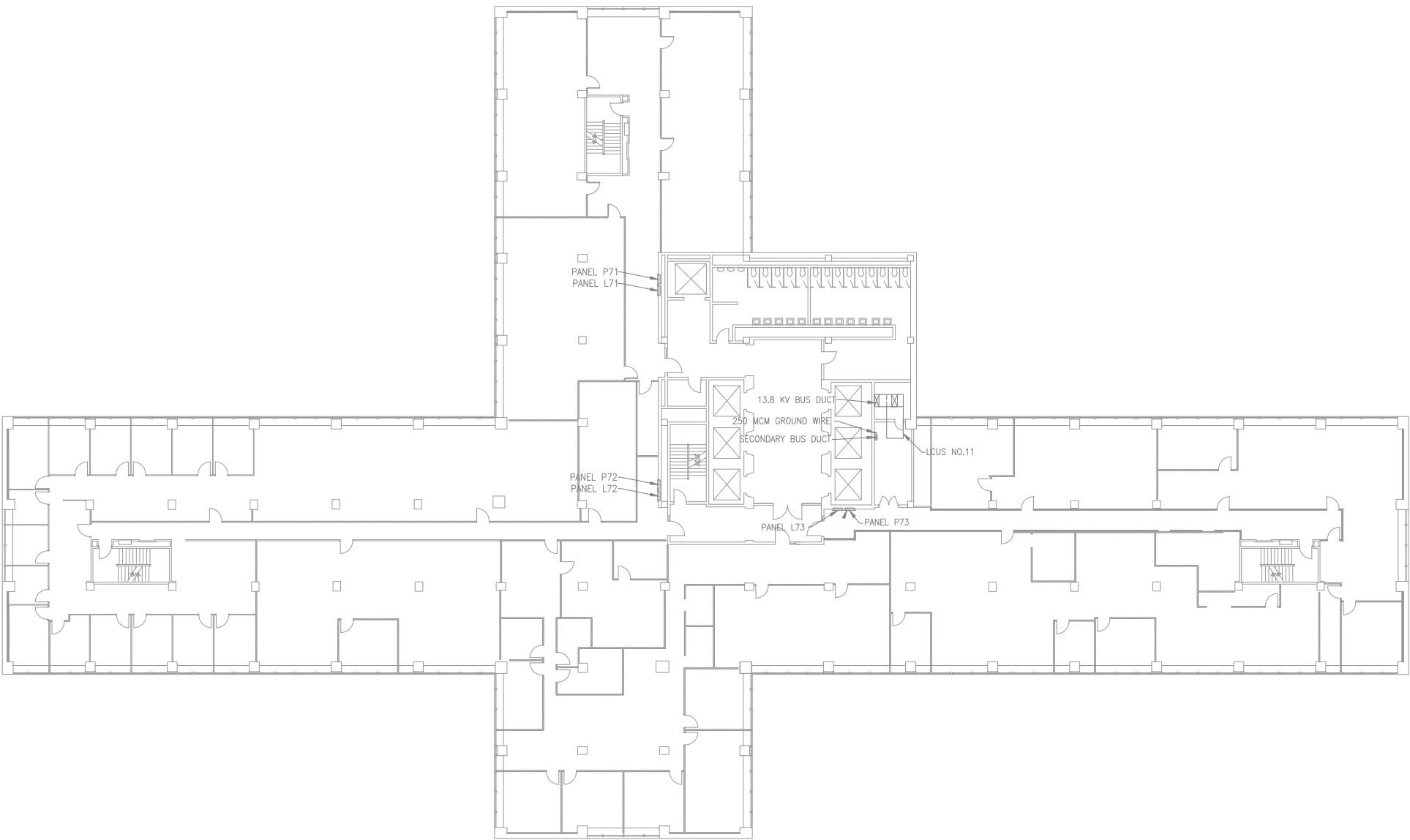
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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

SIXTH FLOOR
POWER PLAN
A-XXXXXX
E-109
ELECTRICAL
STUDY



1 SEVENTH FLOOR POWER PLAN
1/16" = 1'-0"
0 8 16 32 48
SCALE IN FEET



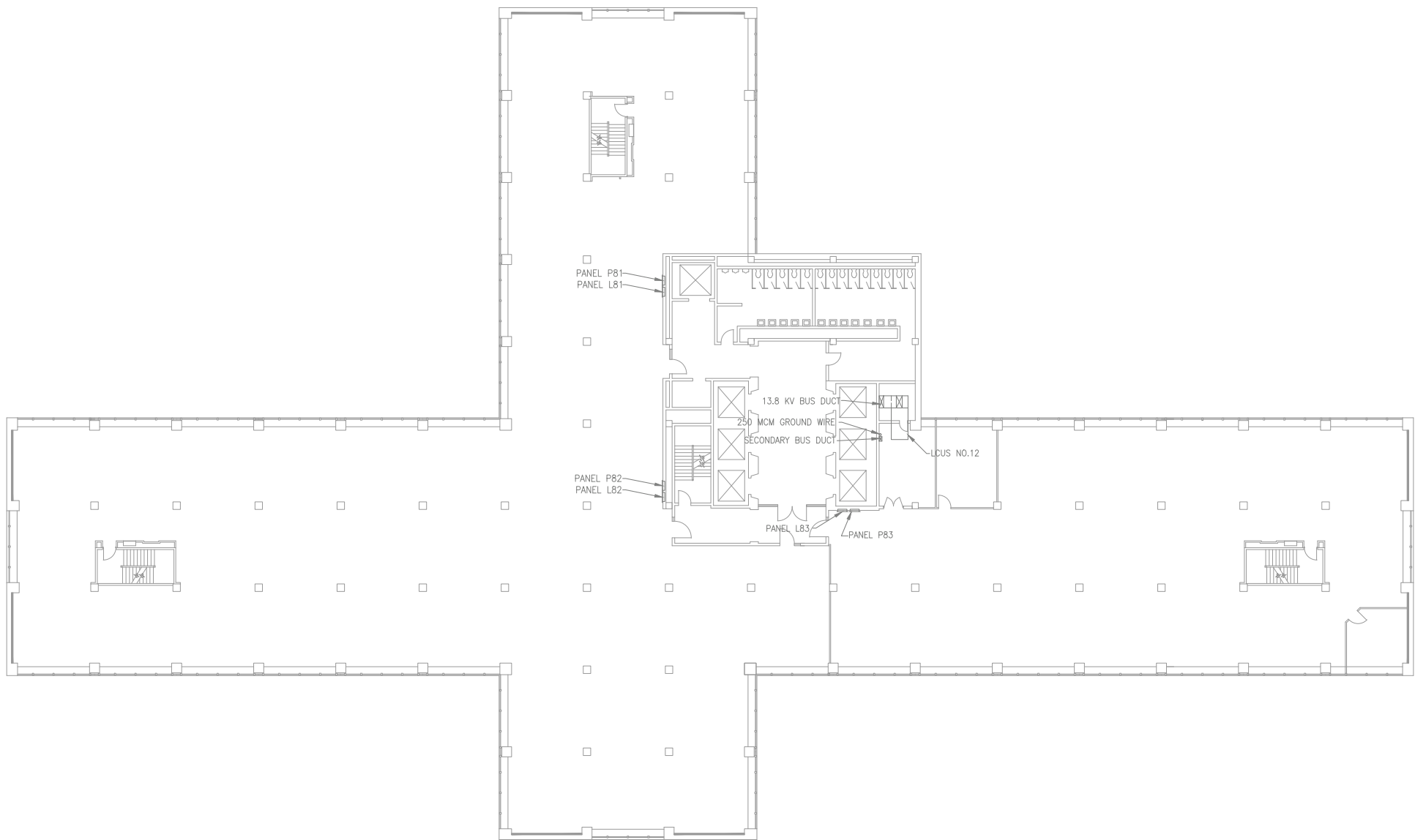
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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

SEVENTH FLOOR
POWER PLAN
A-XXXXXX
E-110
ELECTRICAL
STUDY



1 EIGHTH FLOOR POWER PLAN

1/16" = 1'-0"



REVIEW SET
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USED FOR
BIDDING OR
CONSTRUCTION

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BWR Division

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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE

TOPEKA, KANSAS

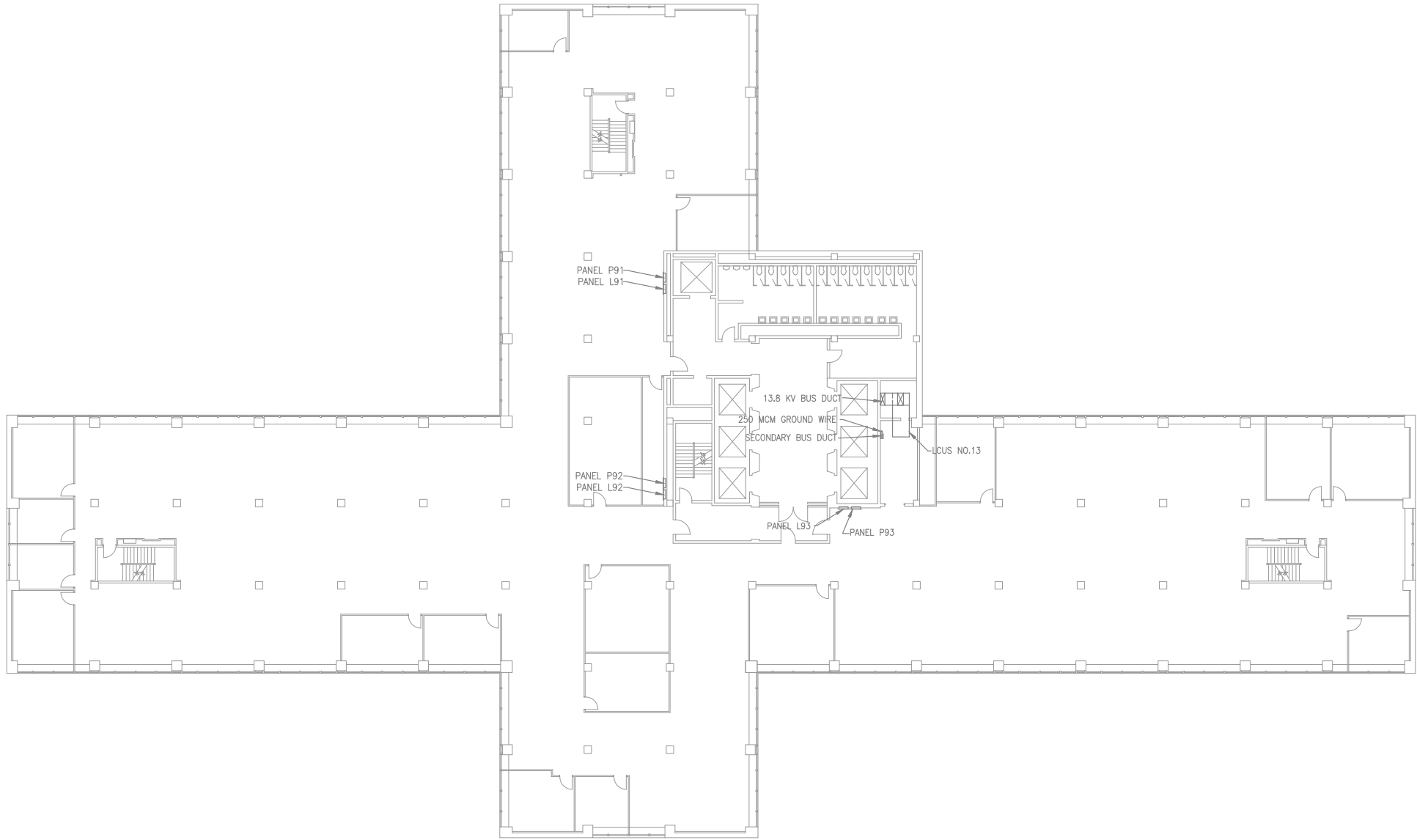
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DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

EIGHTH FLOOR
POWER PLAN

A-XXXXXX

E-111

ELECTRICAL
STUDY



1 **NINTH FLOOR POWER PLAN**
1/16" = 1'-0"



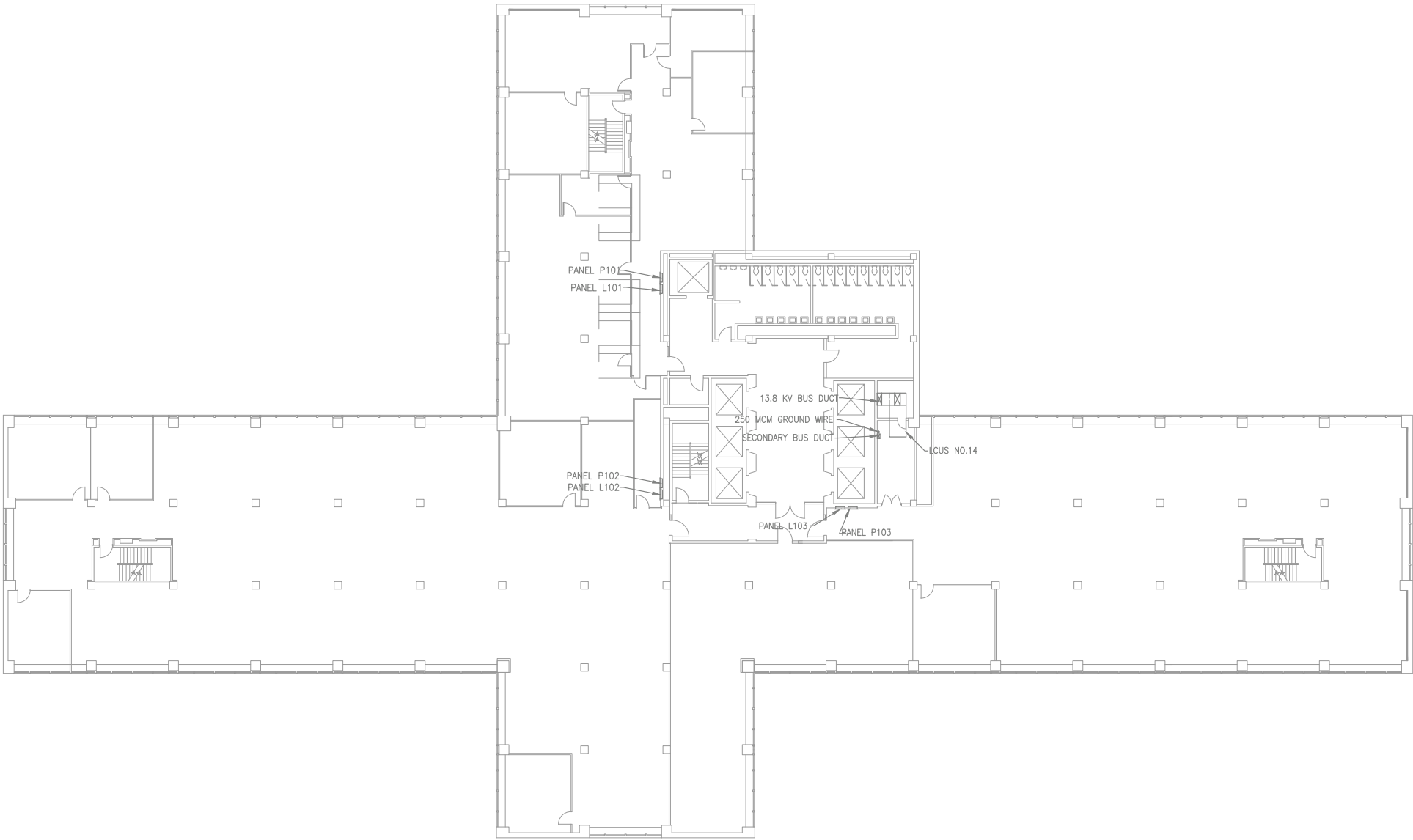
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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

NINTH FLOOR
POWER PLAN
A-XXXXXX
E-112
ELECTRICAL
STUDY



1 TENTH FLOOR POWER PLAN
1/16" = 1'-0"



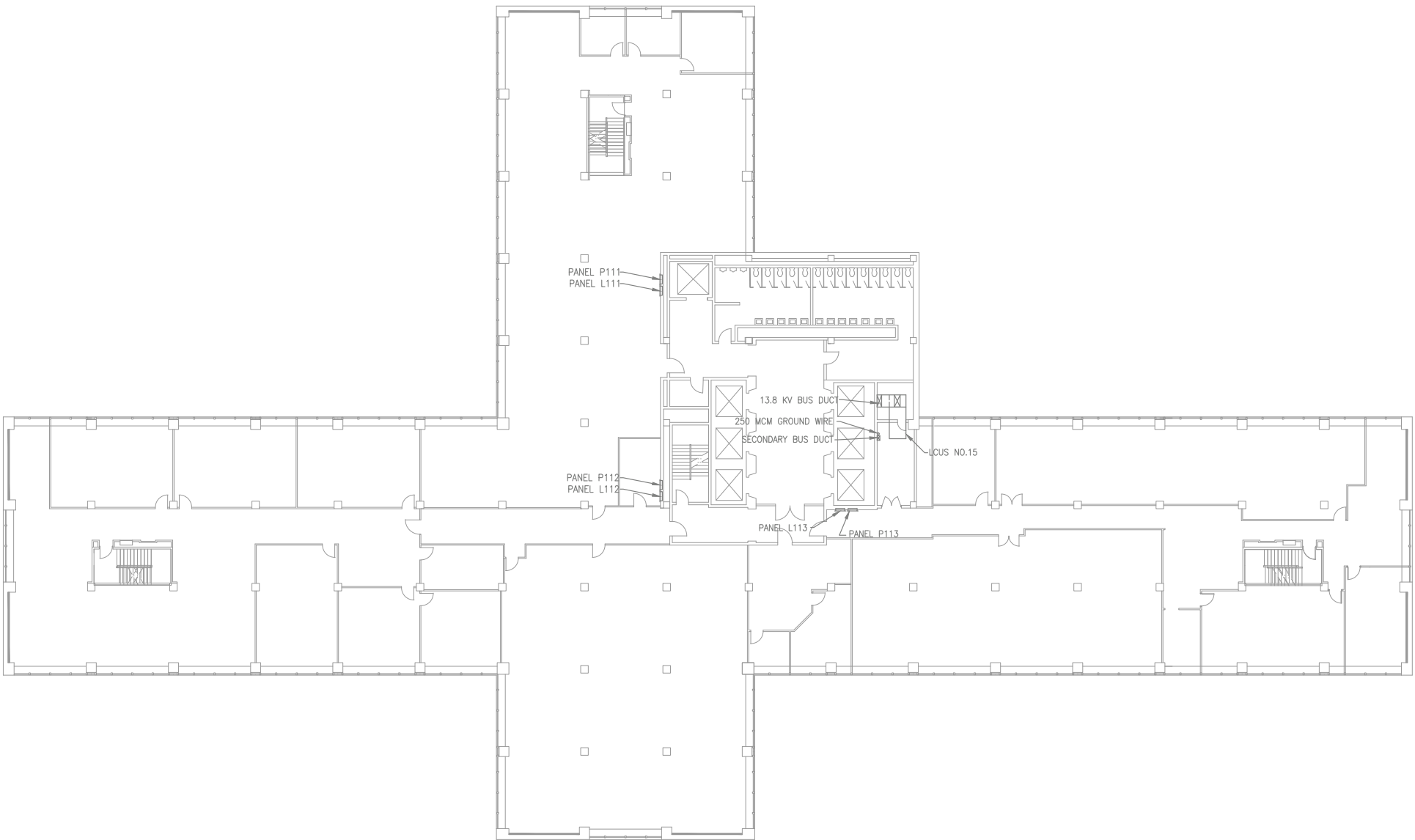
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BIDDING OR
CONSTRUCTION

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BWR Division
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900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

TENTH FLOOR
POWER PLAN
A-XXXXXX
E-113
ELECTRICAL
STUDY



1 ELEVENTH FLOOR POWER PLAN
1/16" = 1'-0"
0 8 16 32 48
SCALE IN FEET



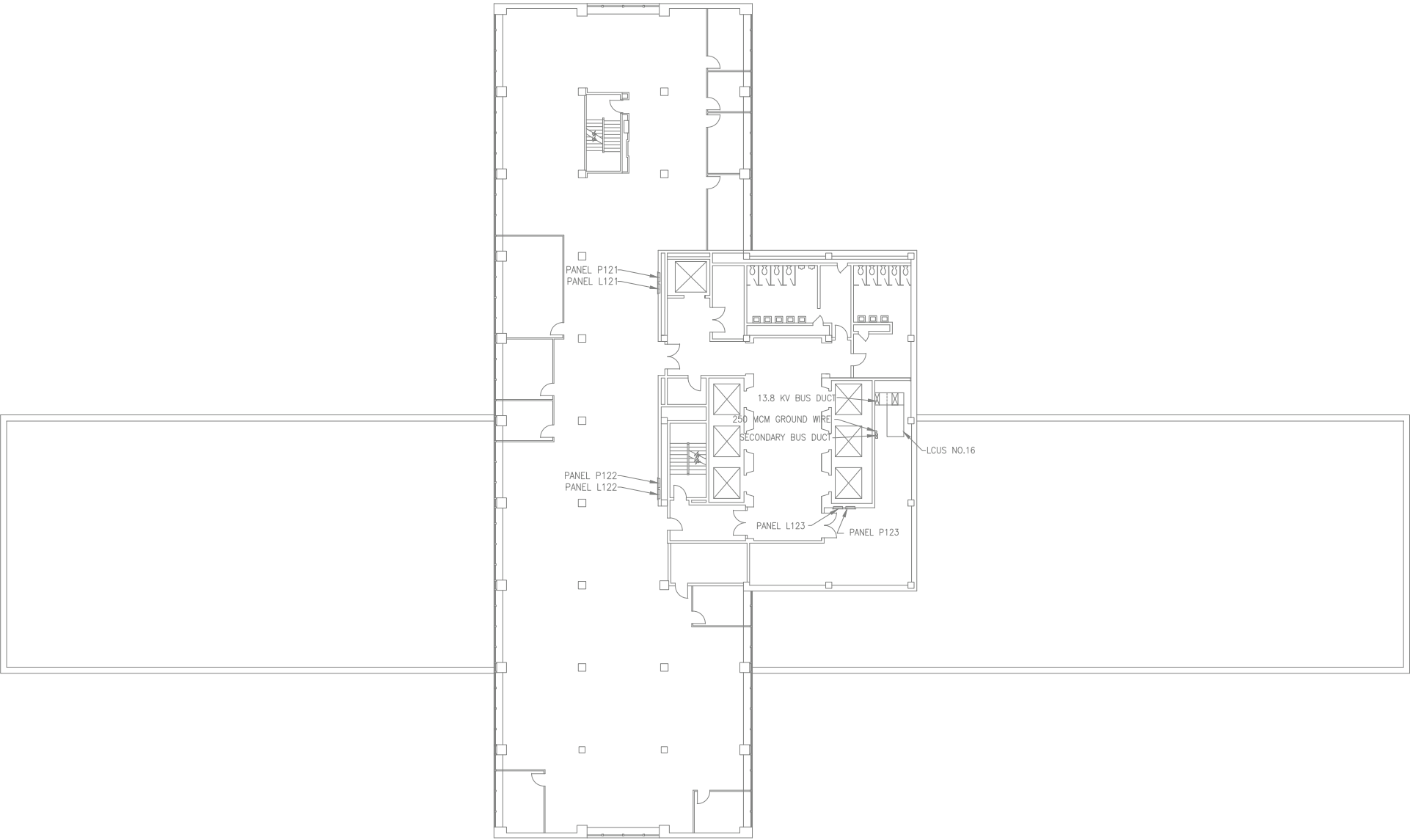
REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

LOCHNER
BWR Division
2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

Department of Administration
Division of Facilities Management
Landon State Office Building
900 SW Jackson, Suite 600
Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

ELEVENTH FLOOR
POWER PLAN
A-XXXXXX
E-114
ELECTRICAL
STUDY



1 TWELFTH FLOOR POWER PLAN
1/16" = 1'-0"
0 8 16 32 48
SCALE IN FEET



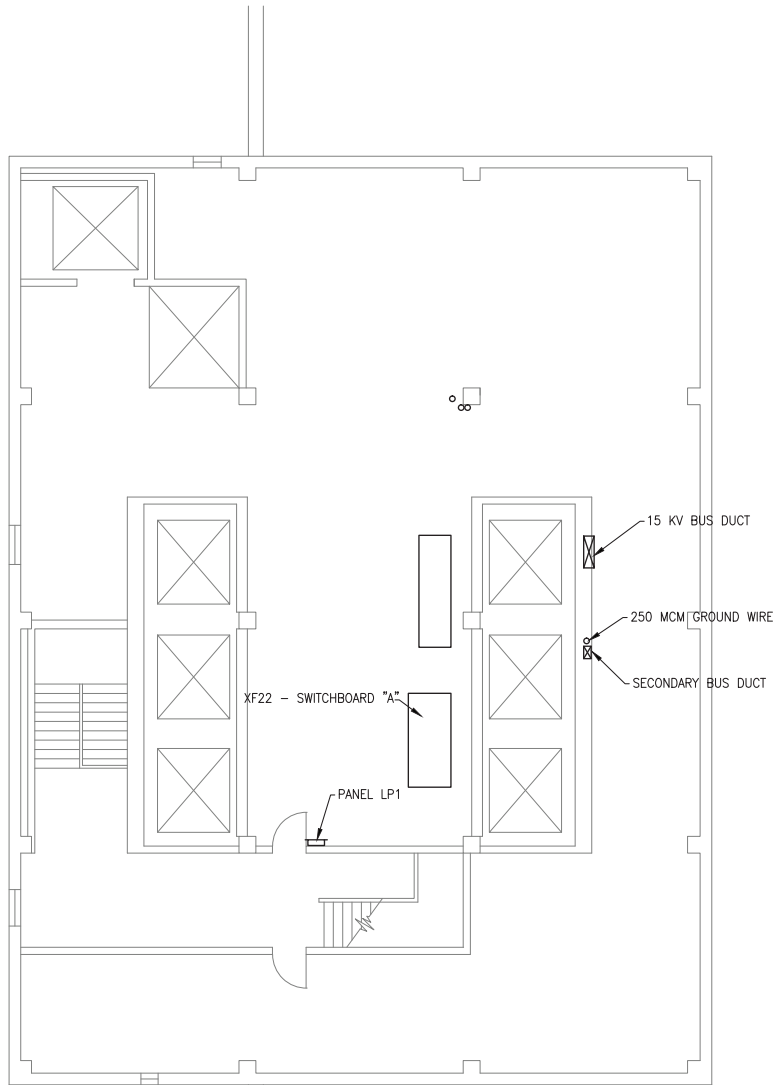
REVIEW SET
NOT TO BE
USED FOR
BIDDING OR
CONSTRUCTION

LOCHNER
BWR Division
2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

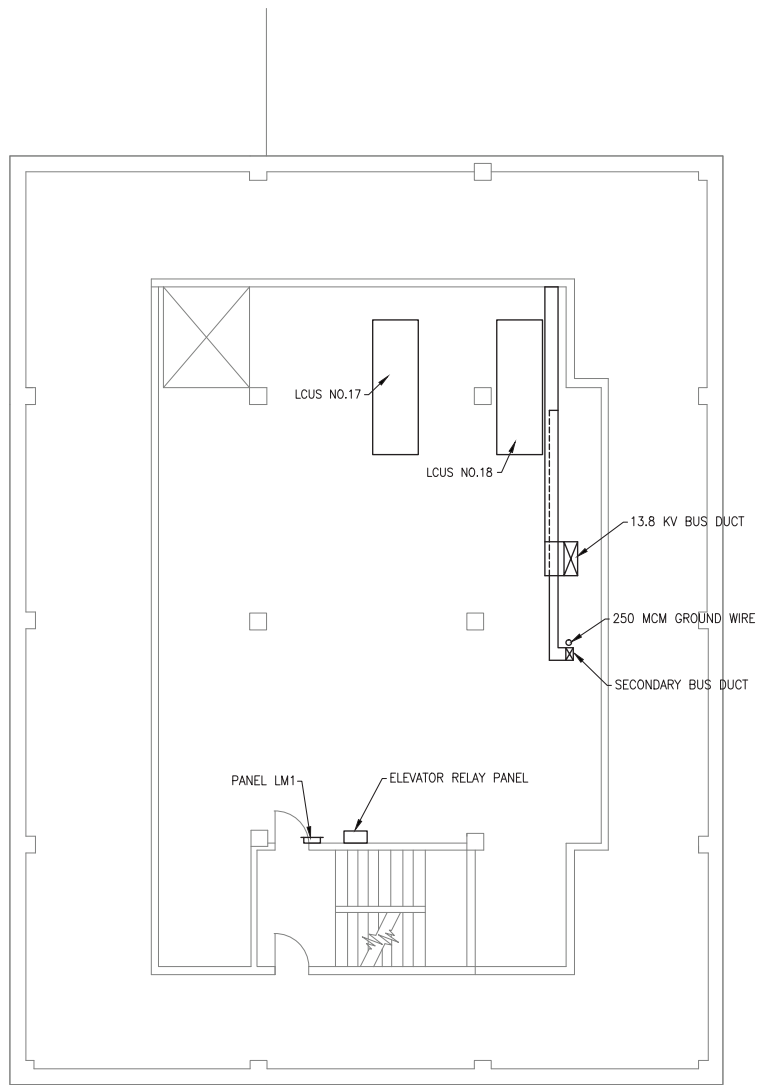
Department of Administration
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Landon State Office Building
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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11
DRAWN BY: CSS
CHECKED BY: LWS
REVISION:

TWELFTH FLOOR
POWER PLAN
A-XXXXXX
E-115
ELECTRICAL
STUDY



1 PENTHOUSE POWER PLAN
1/8" = 1'-0"



2 MACHINERY FLOOR POWER PLAN
1/8" = 1'-0"



REVIEW SET
NOT TO BE
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CONSTRUCTION

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Department of Administration
Division of Facilities Management
Landon State Office Building
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Topeka, Kansas 66612-1220
Telephone 785-296-8899 Fax 785-296-8898

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS
DATE: 1/17/11 DRAWN BY: CSS CHECKED BY: LWS REVISION:

PENTHOUSE AND
MACHINERY FLOOR
POWER PLANS

A-XXXXXX

E-116

ELECTRICAL
STUDY

ELECTRICAL
STUDY

APPENDIX D: AMPCALC

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations											
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas											
Program Serial Number: 203400552											
Single user license for Bucher, Willis & Ratliff, Kansas City, MO											

Filename: 0

Calculation Method:

Distinct AMPACITY calculated for each position in the system based on user specified conductor temperature.

Summary of Neher-McGrath Calculation Results:

No.	Identifier	System	x Coord	y Coord	Qty-Type	Cable Size	Sys kV	Temp	Amps	Rac	Watts/ft
1		1	0.000	0.000	4-1/c	500 kcmil	0.48	75.00	228.4	27.42	5.719
2		1	7.500	0.000	4-1/c	500 kcmil	0.48	75.00	188.4	27.42	3.893
3		1	15.000	0.000	4-1/c	500 kcmil	0.48	75.00	172.0	27.42	3.243
4		1	22.500	0.000	4-1/c	500 kcmil	0.48	75.00	164.2	27.42	2.956
5		1	30.000	0.000	4-1/c	500 kcmil	0.48	75.00	160.0	27.42	2.809
6		1	37.500	0.000	4-1/c	500 kcmil	0.48	75.00	157.7	27.42	2.726
7		1	45.000	0.000	4-1/c	500 kcmil	0.48	75.00	156.3	27.42	2.678
8		1	52.500	0.000	4-1/c	500 kcmil	0.48	75.00	155.4	27.42	2.648
9	C1	1	60.000	0.000	4-1/c	500 kcmil	0.48	75.00	154.9	27.42	2.630
10		1	67.500	0.000	4-1/c	500 kcmil	0.48	75.00	154.5	27.42	2.619
11		1	75.000	0.000	4-1/c	500 kcmil	0.48	75.00	154.4	27.42	2.615
12		1	82.500	0.000	4-1/c	500 kcmil	0.48	75.00	154.4	27.42	2.615
13		1	90.000	0.000	4-1/c	500 kcmil	0.48	75.00	154.5	27.42	2.619
14		1	97.500	0.000	4-1/c	500 kcmil	0.48	75.00	154.9	27.42	2.630
15		1	105.000	0.000	4-1/c	500 kcmil	0.48	75.00	155.4	27.42	2.648
16	C1	1	112.500	0.000	4-1/c	500 kcmil	0.48	75.00	156.3	27.42	2.678
17		1	120.000	0.000	4-1/c	500 kcmil	0.48	75.00	157.7	27.42	2.726
18		1	127.500	0.000	4-1/c	500 kcmil	0.48	75.00	160.0	27.42	2.809
19		1	135.000	0.000	4-1/c	500 kcmil	0.48	75.00	164.2	27.42	2.956
20		1	142.500	0.000	4-1/c	500 kcmil	0.48	75.00	172.0	27.42	3.243
21		1	150.000	0.000	4-1/c	500 kcmil	0.48	75.00	188.4	27.42	3.893
22		1	157.500	0.000	4-1/c	500 kcmil	0.48	75.00	228.4	27.42	5.719
23		1	0.000	-7.500	4-1/c	500 kcmil	0.48	75.00	207.5	27.42	4.722
24		1	7.500	-7.500	4-1/c	500 kcmil	0.48	75.00	162.8	27.42	2.908
25		1	15.000	-7.500	4-1/c	500 kcmil	0.48	75.00	142.6	27.42	2.230
26		1	22.500	-7.500	4-1/c	500 kcmil	0.48	75.00	132.0	27.42	1.910
27		1	30.000	-7.500	4-1/c	500 kcmil	0.48	75.00	125.7	27.42	1.734
28		1	37.500	-7.500	4-1/c	500 kcmil	0.48	75.00	121.8	27.42	1.626
29		1	45.000	-7.500	4-1/c	500 kcmil	0.48	75.00	119.1	27.42	1.556
30		1	52.500	-7.500	4-1/c	500 kcmil	0.48	75.00	117.3	27.42	1.510
31		1	60.000	-7.500	4-1/c	500 kcmil	0.48	75.00	116.2	27.42	1.480
32		1	67.500	-7.500	4-1/c	500 kcmil	0.48	75.00	115.4	27.42	1.462

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations											
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Program Serial Number: 203400552											
Single user license for Bucher, Willis & Ratliff, Kansas City, MO											

Filename: 0

Calculation Method:

Distinct AMPACITY calculated for each position in the system based on user specified conductor temperature.

Summary of Neher-McGrath Calculation Results:

No.	Identifier	System	x Coord	y Coord	Qty-Type	Cable Size	Sys kV	Temp	Amps	Rac	Watts/ft
33		1	75.000	-7.500	4-1/c	500 kcmil	0.48	75.00	115.1	27.42	1.453
34		1	82.500	-7.500	4-1/c	500 kcmil	0.48	75.00	115.1	27.42	1.453
35		1	90.000	-7.500	4-1/c	500 kcmil	0.48	75.00	115.4	27.42	1.462
36		1	97.500	-7.500	4-1/c	500 kcmil	0.48	75.00	116.2	27.42	1.480
37		1	105.000	-7.500	4-1/c	500 kcmil	0.48	75.00	117.3	27.42	1.510
38		1	112.500	-7.500	4-1/c	500 kcmil	0.48	75.00	119.1	27.42	1.556
39		1	120.000	-7.500	4-1/c	500 kcmil	0.48	75.00	121.8	27.42	1.626
40		1	127.500	-7.500	4-1/c	500 kcmil	0.48	75.00	125.7	27.42	1.734
41		1	135.000	-7.500	4-1/c	500 kcmil	0.48	75.00	132.0	27.42	1.910
42		1	142.500	-7.500	4-1/c	500 kcmil	0.48	75.00	142.6	27.42	2.230
43		1	150.000	-7.500	4-1/c	500 kcmil	0.48	75.00	162.8	27.42	2.908
44		1	157.500	-7.500	4-1/c	500 kcmil	0.48	75.00	207.5	27.42	4.722

User System Input Data**For System #1 of 1**

Underground system filename	0
Type of underground system	Direct Buried Conduits
Number of cable positions in system	44
Distance from earth's surface to origin (in.)	40.000
Earth thermal resistivity (RHO)	90
Earth temperature (degrees C)	20

Cable Position Input Data:

No.	Identifier	x Coord	# & Type	Cable Library	Cable Size	Shield	Sys kV	Duct Library	1/c Spc	Spec Temp
	System	y Coord	Cond.	Library Volume	Rated kV	Config	Sys Freq	Nom. Size	LF%	Spec Amps

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations										
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Program Serial Number: 203400552										
Single user license for Bucher, Willis & Ratliff, Kansas City, MO										

Filename: 0

Cable Position Input Data:

No.	Identifier System	x Coord y Coord	# & Type Cond.	Cable Library Library Volume	Cable Size Rated kV	Shield Config	Sys kV Sys Freq	Duct Library Nom. Size	1/c Spc LF%	Spec Temp Spec Amps
1	1	0.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
2	1	7.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
3	1	15.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
4	1	22.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
5	1	30.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
6	1	37.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
7	1	45.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
8	1	52.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
9	C1 1	60.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
10	1	67.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
11	1	75.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
12	1	82.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
13	1	90.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
14	1	97.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
15	1	105.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
16	C1 1	112.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
17	1	120.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
18	1	127.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations	
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Program Serial Number: 203400552	
Single user license for Bucher, Willis & Ratliff, Kansas City, MO	

Filename: 0

Cable Position Input Data:

No.	Identifier System	x Coord y Coord	# & Type Cond.	Cable Library Library Volume	Cable Size Rated kV	Shield Config	Sys kV Sys Freq	Duct Library Nom. Size	1/c Spc LF%	Spec Temp Spec Amps
19	1	135.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
20	1	142.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
21	1	150.000 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
22	1	157.500 0.000	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
23	1	0.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
24	1	7.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
25	1	15.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
26	1	22.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
27	1	30.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
28	1	37.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
29	1	45.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
30	1	52.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
31	1	60.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
32	1	67.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
33	1	75.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
34	1	82.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
35	1	90.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
36	1	97.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations	
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Filename: 0

Cable Position Input Data:

No.	Identifier System	x Coord y Coord	# & Type Cond.	Cable Library Library Volume	Cable Size Rated kV	Shield Config	Sys kV Sys Freq	Duct Library Nom. Size	1/c Spc LF%	Spec Temp Spec Amps
37	1	105.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
38	1	112.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
39	1	120.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
40	1	127.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
41	1	135.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
42	1	142.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
43	1	150.000 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0
44	1	157.500 -7.500	4-1/c Copper	NEC1_600 THHW	500 kcmil 0.60	None Equil.	0.48 60	NEC_PVC 6	- 100	[75.000] 5000.0

Caution - Specified Temp and Amps are user input setpoints and do not necessarily represent a correct solution.
Bracketed value is user specified input variable which may be held constant in optional calculation.

Voltage Drop Calculations:

No.	Identifier	Length (ft.)	Amps/Conductor	PF (%)	Ohms/1000 feet/Cond.		Volt Drop (+%) or Rise (-%)	
					Resistance	Reactance		
1		80	228.4	100.000	Lag	0.0274	0.0292	0.181 OK
2		80	188.4	100.000	Lag	0.0274	0.0292	0.149 OK
3		80	172.0	100.000	Lag	0.0274	0.0292	0.136 OK
4		80	164.2	100.000	Lag	0.0274	0.0292	0.130 OK
5		80	160.0	100.000	Lag	0.0274	0.0292	0.127 OK
6		80	157.7	100.000	Lag	0.0274	0.0292	0.125 OK
7		80	156.3	100.000	Lag	0.0274	0.0292	0.124 OK
8		80	155.4	100.000	Lag	0.0274	0.0292	0.123 OK
9	C1	80	154.9	100.000	Lag	0.0274	0.0292	0.123 OK
10		80	154.5	100.000	Lag	0.0274	0.0292	0.122 OK
11		80	154.4	100.000	Lag	0.0274	0.0292	0.122 OK
12		80	154.4	100.000	Lag	0.0274	0.0292	0.122 OK
13		80	154.5	100.000	Lag	0.0274	0.0292	0.122 OK

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations			
Version 4.00, Rev 16 (c) Copyright 1986-2011 Calcware Company Katy, Texas			
Program Serial Number: 203400552			
Single user license for Bucher, Willis & Ratliff, Kansas City, MO			

Filename: 0

Voltage Drop Calculations:

No.	Identifier	Length (ft.)	Amps/Conductor	PF (%)		Ohms/1000 feet/Cond.		Volt Drop (+%) or Rise (-%)	
						Resistance	Reactance		
14		80	154.9	100.000	Lag	0.0274	0.0292	0.123	OK
15		80	155.4	100.000	Lag	0.0274	0.0292	0.123	OK
16	C1	80	156.3	100.000	Lag	0.0274	0.0292	0.124	OK
17		80	157.7	100.000	Lag	0.0274	0.0292	0.125	OK
18		80	160.0	100.000	Lag	0.0274	0.0292	0.127	OK
19		80	164.2	100.000	Lag	0.0274	0.0292	0.130	OK
20		80	172.0	100.000	Lag	0.0274	0.0292	0.136	OK
21		80	188.4	100.000	Lag	0.0274	0.0292	0.149	OK
22		80	228.4	100.000	Lag	0.0274	0.0292	0.181	OK
23		80	207.5	100.000	Lag	0.0274	0.0292	0.164	OK
24		80	162.8	100.000	Lag	0.0274	0.0292	0.129	OK
25		80	142.6	100.000	Lag	0.0274	0.0292	0.113	OK
26		80	132.0	100.000	Lag	0.0274	0.0292	0.105	OK
27		80	125.7	100.000	Lag	0.0274	0.0292	0.100	OK
28		80	121.8	100.000	Lag	0.0274	0.0292	0.096	OK
29		80	119.1	100.000	Lag	0.0274	0.0292	0.094	OK
30		80	117.3	100.000	Lag	0.0274	0.0292	0.093	OK
31		80	116.2	100.000	Lag	0.0274	0.0292	0.092	OK
32		80	115.4	100.000	Lag	0.0274	0.0292	0.091	OK
33		80	115.1	100.000	Lag	0.0274	0.0292	0.091	OK
34		80	115.1	100.000	Lag	0.0274	0.0292	0.091	OK
35		80	115.4	100.000	Lag	0.0274	0.0292	0.091	OK
36		80	116.2	100.000	Lag	0.0274	0.0292	0.092	OK
37		80	117.3	100.000	Lag	0.0274	0.0292	0.093	OK
38		80	119.1	100.000	Lag	0.0274	0.0292	0.094	OK
39		80	121.8	100.000	Lag	0.0274	0.0292	0.096	OK
40		80	125.7	100.000	Lag	0.0274	0.0292	0.100	OK
41		80	132.0	100.000	Lag	0.0274	0.0292	0.105	OK
42		80	142.6	100.000	Lag	0.0274	0.0292	0.113	OK
43		80	162.8	100.000	Lag	0.0274	0.0292	0.129	OK
44		80	207.5	100.000	Lag	0.0274	0.0292	0.164	OK

Load Flow Calculations:

No.	Identifier System	Voltage		Current/Phase		PF (%)	Load Flow Power			kW Loss
		Mag	Deg	Amps	Deg		kVA	kW	kVAR	kVAR Loss

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Load Flow Calculations:

No.	Identifier System		Voltage		Current/Phase				Load Flow Power			kW Loss
			Mag	Deg	Amps	Deg			PF (%)	kVA	kW	kVAR
1	1	Source-->	480.0	0.00	228.4	-0.11	100.0	Unity	189.9	189.9	0.4	0.343
		Load-->	479.1	-0.11			100.0	Lag	189.5	189.5	0.0	0.365
2	1	Source-->	480.0	0.00	188.4	-0.09	100.0	Unity	156.6	156.6	0.2	0.234
		Load-->	479.3	-0.09			100.0	Lag	156.4	156.4	0.0	0.249
3	1	Source-->	480.0	0.00	172.0	-0.08	100.0	Unity	143.0	143.0	0.2	0.195
		Load-->	479.3	-0.08			100.0	Lag	142.8	142.8	0.0	0.207
4	1	Source-->	480.0	0.00	164.2	-0.08	100.0	Unity	136.5	136.5	0.2	0.177
		Load-->	479.4	-0.08			100.0	Lag	136.3	136.3	0.0	0.189
5	1	Source-->	480.0	0.00	160.0	-0.08	100.0	Unity	133.0	133.0	0.2	0.169
		Load-->	479.4	-0.08			100.0	Lag	132.9	132.9	0.0	0.179
6	1	Source-->	480.0	0.00	157.7	-0.08	100.0	Unity	131.1	131.1	0.2	0.164
		Load-->	479.4	-0.08			100.0	Lag	130.9	130.9	0.0	0.174
7	1	Source-->	480.0	0.00	156.3	-0.08	100.0	Unity	129.9	129.9	0.2	0.161
		Load-->	479.4	-0.08			100.0	Lag	129.7	129.7	0.0	0.171
8	1	Source-->	480.0	0.00	155.4	-0.07	100.0	Unity	129.2	129.2	0.2	0.159
		Load-->	479.4	-0.07			100.0	Lag	129.0	129.0	0.0	0.169
9	C1 1	Source-->	480.0	0.00	154.9	-0.07	100.0	Unity	128.7	128.7	0.2	0.158
		Load-->	479.4	-0.07			100.0	Lag	128.6	128.6	0.0	0.168
10	1	Source-->	480.0	0.00	154.5	-0.07	100.0	Unity	128.5	128.5	0.2	0.157
		Load-->	479.4	-0.07			100.0	Lag	128.3	128.3	0.0	0.167
11	1	Source-->	480.0	0.00	154.4	-0.07	100.0	Unity	128.4	128.4	0.2	0.157
		Load-->	479.4	-0.07			100.0	Lag	128.2	128.2	0.0	0.167
12	1	Source-->	480.0	0.00	154.4	-0.07	100.0	Unity	128.4	128.4	0.2	0.157
		Load-->	479.4	-0.07			100.0	Lag	128.2	128.2	0.0	0.167
13	1	Source-->	480.0	0.00	154.5	-0.07	100.0	Unity	128.5	128.5	0.2	0.157
		Load-->	479.4	-0.07			100.0	Lag	128.3	128.3	0.0	0.167
14	1	Source-->	480.0	0.00	154.9	-0.07	100.0	Unity	128.7	128.7	0.2	0.158
		Load-->	479.4	-0.07			100.0	Lag	128.6	128.6	0.0	0.168
15	1	Source-->	480.0	0.00	155.4	-0.07	100.0	Unity	129.2	129.2	0.2	0.159
		Load-->	479.4	-0.07			100.0	Lag	129.0	129.0	0.0	0.169
16	C1 1	Source-->	480.0	0.00	156.3	-0.08	100.0	Unity	129.9	129.9	0.2	0.161
		Load-->	479.4	-0.08			100.0	Lag	129.7	129.7	0.0	0.171
17	1	Source-->	480.0	0.00	157.7	-0.08	100.0	Unity	131.1	131.1	0.2	0.164
		Load-->	479.4	-0.08			100.0	Lag	130.9	130.9	0.0	0.174
18	1	Source-->	480.0	0.00	160.0	-0.08	100.0	Unity	133.0	133.0	0.2	0.169
		Load-->	479.4	-0.08			100.0	Lag	132.9	132.9	0.0	0.179

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Load Flow Calculations:

No.	Identifier System		Voltage		Current/Phase				Load Flow Power			kW Loss
			Mag	Deg	Amps	Deg			PF (%)	kVA	kW	kVAR
19	1	Source-->	480.0	0.00	164.2		100.0	Unity	136.5	136.5	0.2	0.177
		Load-->	479.4	-0.08			100.0	Lag	136.3	136.3	0.0	0.189
20	1	Source-->	480.0	0.00	172.0		100.0	Unity	143.0	143.0	0.2	0.195
		Load-->	479.3	-0.08			100.0	Lag	142.8	142.8	0.0	0.207
21	1	Source-->	480.0	0.00	188.4		100.0	Unity	156.6	156.6	0.2	0.234
		Load-->	479.3	-0.09			100.0	Lag	156.4	156.4	0.0	0.249
22	1	Source-->	480.0	0.00	228.4		100.0	Unity	189.9	189.9	0.4	0.343
		Load-->	479.1	-0.11			100.0	Lag	189.5	189.5	0.0	0.365
23	1	Source-->	480.0	0.00	207.5		100.0	Unity	172.5	172.5	0.3	0.283
		Load-->	479.2	-0.10			100.0	Lag	172.2	172.2	0.0	0.301
24	1	Source-->	480.0	0.00	162.8		100.0	Unity	135.4	135.4	0.2	0.174
		Load-->	479.4	-0.08			100.0	Lag	135.2	135.2	0.0	0.186
25	1	Source-->	480.0	0.00	142.6		100.0	Unity	118.5	118.5	0.1	0.134
		Load-->	479.5	-0.07			100.0	Lag	118.4	118.4	0.0	0.142
26	1	Source-->	480.0	0.00	132.0		100.0	Unity	109.7	109.7	0.1	0.115
		Load-->	479.5	-0.06			100.0	Lag	109.6	109.6	0.0	0.122
27	1	Source-->	480.0	0.00	125.7		100.0	Unity	104.5	104.5	0.1	0.104
		Load-->	479.5	-0.06			100.0	Lag	104.4	104.4	0.0	0.111
28	1	Source-->	480.0	0.00	121.8		100.0	Unity	101.2	101.2	0.1	0.098
		Load-->	479.5	-0.06			100.0	Lag	101.1	101.1	0.0	0.104
29	1	Source-->	480.0	0.00	119.1		100.0	Unity	99.0	99.0	0.1	0.093
		Load-->	479.5	-0.06			100.0	Lag	98.9	98.9	0.0	0.099
30	1	Source-->	480.0	0.00	117.3		100.0	Unity	97.6	97.6	0.1	0.091
		Load-->	479.6	-0.06			100.0	Lag	97.5	97.5	0.0	0.096
31	1	Source-->	480.0	0.00	116.2		100.0	Unity	96.6	96.6	0.1	0.089
		Load-->	479.6	-0.06			100.0	Lag	96.5	96.5	0.0	0.094
32	1	Source-->	480.0	0.00	115.4		100.0	Unity	96.0	96.0	0.1	0.088
		Load-->	479.6	-0.06			100.0	Lag	95.9	95.9	0.0	0.093
33	1	Source-->	480.0	0.00	115.1		100.0	Unity	95.7	95.7	0.1	0.087
		Load-->	479.6	-0.06			100.0	Lag	95.6	95.6	0.0	0.093
34	1	Source-->	480.0	0.00	115.1		100.0	Unity	95.7	95.7	0.1	0.087
		Load-->	479.6	-0.06			100.0	Lag	95.6	95.6	0.0	0.093
35	1	Source-->	480.0	0.00	115.4		100.0	Unity	96.0	96.0	0.1	0.088
		Load-->	479.6	-0.06			100.0	Lag	95.9	95.9	0.0	0.093
36	1	Source-->	480.0	0.00	116.2		100.0	Unity	96.6	96.6	0.1	0.089
		Load-->	479.6	-0.06			100.0	Lag	96.5	96.5	0.0	0.094

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Load Flow Calculations:

No.	Identifier System		Voltage		Current/Phase				Load Flow Power			kW Loss
			Mag	Deg	Amps	Deg			kVA	kW	kVAR	kVAR Loss
37	1	Source-->	480.0	0.00			100.0	Unity	97.6	97.6	0.1	0.091
		Load-->	479.6	-0.06	117.3	-0.06	100.0	Lag	97.5	97.5	0.0	0.096
38	1	Source-->	480.0	0.00			100.0	Unity	99.0	99.0	0.1	0.093
		Load-->	479.5	-0.06	119.1	-0.06	100.0	Lag	98.9	98.9	0.0	0.099
39	1	Source-->	480.0	0.00			100.0	Unity	101.2	101.2	0.1	0.098
		Load-->	479.5	-0.06	121.8	-0.06	100.0	Lag	101.1	101.1	0.0	0.104
40	1	Source-->	480.0	0.00			100.0	Unity	104.5	104.5	0.1	0.104
		Load-->	479.5	-0.06	125.7	-0.06	100.0	Lag	104.4	104.4	0.0	0.111
41	1	Source-->	480.0	0.00			100.0	Unity	109.7	109.7	0.1	0.115
		Load-->	479.5	-0.06	132.0	-0.06	100.0	Lag	109.6	109.6	0.0	0.122
42	1	Source-->	480.0	0.00			100.0	Unity	118.5	118.5	0.1	0.134
		Load-->	479.5	-0.07	142.6	-0.07	100.0	Lag	118.4	118.4	0.0	0.142
43	1	Source-->	480.0	0.00			100.0	Unity	135.4	135.4	0.2	0.174
		Load-->	479.4	-0.08	162.8	-0.08	100.0	Lag	135.2	135.2	0.0	0.186
44	1	Source-->	480.0	0.00			100.0	Unity	172.5	172.5	0.3	0.283
		Load-->	479.2	-0.10	207.5	-0.10	100.0	Lag	172.2	172.2	0.0	0.301

Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
1	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
2	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
3	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
4	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
5	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
6	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
7	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

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Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
8	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
9	C1 1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
10	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
11	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
12	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
13	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
14	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
15	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
16	C1 1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
17	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
18	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
19	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
20	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
21	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
22	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
23	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
24	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
25	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

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Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
26	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
27	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
28	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
29	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
30	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
31	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
32	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
33	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
34	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
35	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
36	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
37	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
38	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
39	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
40	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
41	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
42	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a
43	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

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Duct Fill Data and Calculations:

No.	Identifier System	Ph Qty	Ph Size Ph OD	Neut Qty	Neut Size Neut OD	Grd Qty Grd Type	Grd Size Grd OD	Duct ID	Allowable Fill %	Actual Fill %	Jam Ratio
44	1	4	500 kcmil 1.003	0	-	1 Insulated	3/0 AWG 2.620	6.000	40.0	30.2 OK	n/a

Cable Library Volume Data:

No.	Identifier System	Cable Library Lib Volume	Type kV	Temp Shield?	SIC SIC exp	DF DF exp	Ins RHO Jac RHO	CU res AL res	ks kp	3/c configuration
1	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
2	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
3	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
4	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
5	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
6	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
7	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
8	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
9	C1 1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
10	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
11	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
12	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
13	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
14	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations										
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Filename: 0

Cable Library Volume Data:

No.	Identifier System	Cable Library Lib Volume	Type kV	Temp Shield?	SIC SIC exp	DF DF exp	Ins RHO Jac RHO	CU res AL res	ks kp	3/c configuration
15	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
16	C1 1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
17	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
18	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
19	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
20	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
21	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
22	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
23	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
24	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
25	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
26	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
27	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
28	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
29	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
30	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
31	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
32	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-

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Filename: 0

Cable Library Volume Data:

No.	Identifier System	Cable Library Lib Volume	Type kV	Temp Shield?	SIC SIC exp	DF DF exp	Ins RHO Jac RHO	CU res AL res	ks kp	3/c configuration
33	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
34	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
35	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
36	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
37	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
38	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
39	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
40	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
41	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
42	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
43	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-
44	1	NEC1_600 THHW	1/c 0.600	75 No	0.000 0.0000	0.000 0.0000	500 0	10.371 17.002	1.000 1.000	-

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F AL lay F	Shield Th. Shield Dia.	Shield Rdc Calc Yse?
							kcmil	Diameter			
1	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
2	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
3	1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -

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Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F	Shield Th.	Shield Rdc
							kcmil	Diameter	AL lay F	Shield Dia.	Calc Yse?
4	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
5	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
6	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
7	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
8	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
9	C1----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
10	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
11	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
12	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
13	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
14	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
15	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
16	C1----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
17	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
18	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
19	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
20	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
21	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations											
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Filename: 0

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F	Shield Th.	Shield Rdc
							kcmil	Diameter	AL lay F	Shield Dia.	Calc Yse?
22	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
23	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
24	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
25	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
26	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
27	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
28	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
29	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
30	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
31	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
32	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
33	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
34	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
35	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
36	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
37	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
38	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
39	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations		
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Filename: 0

Cable Library Size Data - Basic Cable Data Format:

No.	Identifier System	Cable Size	Cable OD	1/c OD	Insulation thickness	Jacket thickness	Conductor		CU lay F	Shield Th.	Shield Rdc
							kcmil	Diameter	AL lay F	Shield Dia.	Calc Yse?
40	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
41	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
42	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
43	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -
44	----- 1	500 kcmil	1.003	-	0.0950	0.000	500.00	0.813	1.0228 1.0206	- -	- -

Duct Library Data

No.	Identifier	System	Duct Library	Duct					Covering	
				Type	RHO	Nominal Size	ID	Thickness	RHO	Thickness
1		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
2		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
3		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
4		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
5		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
6		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
7		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
8		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
9	C1	1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
10		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
11		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
12		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
13		1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
14		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
15		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
16	C1	1	NEC_PVC	Nmet	650	6.00	6.00	0.280	0	0.000
17		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
18		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
19		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
20		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
21		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000

AmpCalc - Cable Ampacity Calculations for Underground & Aerial Installations										
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Filename: 0

Duct Library Data

No.	Identifier	System	Duct Library	Duct					Covering	
				Type	RHO	Nominal Size	ID	Thickness	RHO	Thickness
22		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
23		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
24		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
25		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
26		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
27		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
28		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
29		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
30		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
31		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
32		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
33		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
34		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
35		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
36		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
37		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
38		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
39		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
40		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
41		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
42		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
43		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000
44		1	NEC_PVC	Nmet	650	0.00	6.00	0.280	0	0.000

CALCULATION RESULTS - Table 1 of 3

No.	Identifier	System	Temp	Amps	# Cond.	Loss Fac.	Watts/ft	Rac	Rdc	Wd	Dtd
1		1	75.000	228.4	4	1.000	5.719	27.419	25.800	0.0000	0.000
2		1	75.000	188.4	4	1.000	3.893	27.419	25.800	0.0000	0.000
3		1	75.000	172.0	4	1.000	3.243	27.419	25.800	0.0000	0.000
4		1	75.000	164.2	4	1.000	2.956	27.419	25.800	0.0000	0.000
5		1	75.000	160.0	4	1.000	2.809	27.419	25.800	0.0000	0.000
6		1	75.000	157.7	4	1.000	2.726	27.419	25.800	0.0000	0.000
7		1	75.000	156.3	4	1.000	2.678	27.419	25.800	0.0000	0.000
8		1	75.000	155.4	4	1.000	2.648	27.419	25.800	0.0000	0.000
9	C1	1	75.000	154.9	4	1.000	2.630	27.419	25.800	0.0000	0.000

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CALCULATION RESULTS - Table 1 of 3

No.	Identifier	System	Temp	Amps	# Cond.	Loss Fac.	Watts/ft	Rac	Rdc	Wd	Dtd
10		1	75.000	154.5	4	1.000	2.619	27.419	25.800	0.0000	0.000
11		1	75.000	154.4	4	1.000	2.615	27.419	25.800	0.0000	0.000
12		1	75.000	154.4	4	1.000	2.615	27.419	25.800	0.0000	0.000
13		1	75.000	154.5	4	1.000	2.619	27.419	25.800	0.0000	0.000
14		1	75.000	154.9	4	1.000	2.630	27.419	25.800	0.0000	0.000
15		1	75.000	155.4	4	1.000	2.648	27.419	25.800	0.0000	0.000
16	C1	1	75.000	156.3	4	1.000	2.678	27.419	25.800	0.0000	0.000
17		1	75.000	157.7	4	1.000	2.726	27.419	25.800	0.0000	0.000
18		1	75.000	160.0	4	1.000	2.809	27.419	25.800	0.0000	0.000
19		1	75.000	164.2	4	1.000	2.956	27.419	25.800	0.0000	0.000
20		1	75.000	172.0	4	1.000	3.243	27.419	25.800	0.0000	0.000
21		1	75.000	188.4	4	1.000	3.893	27.419	25.800	0.0000	0.000
22		1	75.000	228.4	4	1.000	5.719	27.419	25.800	0.0000	0.000
23		1	75.000	207.5	4	1.000	4.722	27.419	25.800	0.0000	0.000
24		1	75.000	162.8	4	1.000	2.908	27.419	25.800	0.0000	0.000
25		1	75.000	142.6	4	1.000	2.230	27.419	25.800	0.0000	0.000
26		1	75.000	132.0	4	1.000	1.910	27.419	25.800	0.0000	0.000
27		1	75.000	125.7	4	1.000	1.734	27.419	25.800	0.0000	0.000
28		1	75.000	121.8	4	1.000	1.626	27.419	25.800	0.0000	0.000
29		1	75.000	119.1	4	1.000	1.556	27.419	25.800	0.0000	0.000
30		1	75.000	117.3	4	1.000	1.510	27.419	25.800	0.0000	0.000
31		1	75.000	116.2	4	1.000	1.480	27.419	25.800	0.0000	0.000
32		1	75.000	115.4	4	1.000	1.462	27.419	25.800	0.0000	0.000
33		1	75.000	115.1	4	1.000	1.453	27.419	25.800	0.0000	0.000
34		1	75.000	115.1	4	1.000	1.453	27.419	25.800	0.0000	0.000
35		1	75.000	115.4	4	1.000	1.462	27.419	25.800	0.0000	0.000
36		1	75.000	116.2	4	1.000	1.480	27.419	25.800	0.0000	0.000
37		1	75.000	117.3	4	1.000	1.510	27.419	25.800	0.0000	0.000
38		1	75.000	119.1	4	1.000	1.556	27.419	25.800	0.0000	0.000
39		1	75.000	121.8	4	1.000	1.626	27.419	25.800	0.0000	0.000
40		1	75.000	125.7	4	1.000	1.734	27.419	25.800	0.0000	0.000
41		1	75.000	132.0	4	1.000	1.910	27.419	25.800	0.0000	0.000
42		1	75.000	142.6	4	1.000	2.230	27.419	25.800	0.0000	0.000
43		1	75.000	162.8	4	1.000	2.908	27.419	25.800	0.0000	0.000
44		1	75.000	207.5	4	1.000	4.722	27.419	25.800	0.0000	0.000

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Filename: 0

CALCULATION RESULTS - Table 2 of 3

No.	Identifier	System	Yp	Qp	Spacing	GF1	GF2	Ri	Rj	Rsd	Rcap	Rd
1		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
2		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
3		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
4		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
5		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
6		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
7		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
8		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
9	C1	1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
10		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
11		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
12		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
13		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
14		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
15		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
16	C1	1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
17		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
18		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
19		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
20		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
21		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
22		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.298	1.206
23		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
24		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
25		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
26		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
27		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
28		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
29		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
30		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
31		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
32		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
33		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
34		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
35		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
36		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206

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Filename: 0

CALCULATION RESULTS - Table 2 of 3

No.	Identifier	System	Yp	Qp	Spacing	GF1	GF2	Ri	Rj	Rsd	Rcap	Rd
37		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
38		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
39		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
40		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
41		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
42		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
43		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206
44		1	0.0000	1.0000	1.003	-	-	0.5473	0.0000	6.552	14.620	1.206

CALCULATION RESULTS - Table 3 of 3

No.	Identifier	System	Yc	Ycs	Ycp	Shld X	Ys	Ysc	Yse	Qs
1		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
2		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
3		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
4		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
5		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
6		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
7		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
8		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
9	C1	1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
10		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
11		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
12		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
13		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
14		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
15		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
16	C1	1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
17		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
18		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
19		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
20		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
21		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
22		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
23		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
24		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000

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CALCULATION RESULTS - Table 3 of 3

No.	Identifier	System	Yc	Ycs	Ycp	Shld X	Ys	Ysc	Yse	Qs
25		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
26		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
27		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
28		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
29		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
30		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
31		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
32		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
33		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
34		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
35		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
36		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
37		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
38		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
39		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
40		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
41		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
42		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
43		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000
44		1	0.0628	0.0163	0.0464	-	-	-	-	1.0000

Variable Definitions and Units:

Variable Label	Description	Units
# Cond	Number of conductors (not cables) at position	
1/c OD	For 3/c Cable, outside diameter of 1/c portion	Inches
1/c Spacing	Equivalent phase spacing for 1/c cables at different positions	Inches
3/c Configuration	Type of 3/c cable, round or sector	
Actual Fill %	Actual conduit fill	%
AL lay F	Lay factor for aluminum conductor	
AL Res	Aluminum electrical resistivity	Cir mils ohms/ft
Allowable Fill %	Allowable conduit fill according to limits set by user or NEC defaults	%
Amps	Calculated or specified current on a per conductor basis	Amperes
Cable Lib	Cable data library descriptor	
Cable OD	Cable overall outside diameter	Inches
Cable Size	Cable size designation	
Cable Type	Cable type, 1/c or 3/c	
Concrete thermal resistivity (RHO)	Concrete thermal resistivity	Deg C-cm/watt
Cond.	Conductor Material, Copper or Aluminum	
Conductor Diameter	Conductor diameter	Inches

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Variable Definitions and Units:

Variable Label	Description	Units
Config	Cable configuration, non-applicable, equilateral, cradled or mixed	
CU lay F	Lay factor for copper conductor	
CU Res	Copper electrical resistivity	Cir mils ohms/ft
Current Mag	Magnitude of current used in load flow calculations	Amps
Current Deg	Phase angle of current used in load flow calculations	Degrees
Dissipation Factor	Insulation dissipation factor, (DF), overall DF = DF x e ^(DF Exp x Temp)	
Dissipation Factor Exponent	Insulation dissipation factor exponent, overall DF = DF x e ^(DF Exp x Temp)	
Distance from earth's surface to origin	Vertical distance from earth's surface to origin of coordinate system	Inches
Dist. top of ductbank to earth's surface	Vertical distance from top of ductbank concrete envelope to earth's surface	Inches
Dtd	Increment of conductor temperature rise due to dielectric losses	Deg C
Duct ID	Duct Inner diameter	Inches
Duct Library	Duct data library descriptor	
Duct RHO	Duct material thermal resistivity	Deg C-cm/watt
Duct Thickness	Duct wall thickness	Inches
Duct Type	Whether duct material is Non-magnetic, Steel or Iron	
Ductbank Geometric Factor	Calculated ductbank geometric factor	
Ductbank Height	Height of ductbank concrete envelope	Inches
Ductbank Width	Width of ductbank concrete envelope	Inches
dx	Fictitious diameter at which the effect of loss factor commences	Inches
Earth temperature	Earth ambient temperature	Deg C
Earth thermal resistivity (RHO)	Earth thermal resistivity	Deg C-cm/watt
GF1	Geometric factor for 3/c cable applying to insulation resistance	
GF2	Geometric factor for 3/c cable applying to dielectric loss	
Grd OD	Overall outer diameter of ground cables at position	Inches
Grd Qty	Quantity of ground cables at position (needed only for conduit fill calculations)	
Grd Size	Size of ground cables at position	
Grd Type	Whether ground cables are Insulated or bare	
Identifier	Cable position identifier assigned by user	
Ins RHO	Thermal resistivity of insulation	Deg C-cm/watt
Insulation Thickness	Cable insulation thickness	Inches
IpF	Insulation power factor, overall IpF = IpF x e ^(IpF Exp x Temp)	
IpF Exp	Insulation power factor exponent, overall IpF = IpF x e ^(IpF Exp x Temp)	
Jac RHO	Cable jacket thermal resistivity	Deg C-cm/watt
Jacket Thickness	Cable jacket thickness	Inches
Jam Ratio	Ratio of duct ID to cable OD, to be OK for 3 cables must be < 2.8 or > 3.2	
kcmil	Conductor area	Thou. circ mils
kp	Conductor proximity effect factor	
ks	Conductor skin effect factor	
kV	Rated cable line-to-line kilovolts	kilovolts
kVA	Circuit three phase load flow kilovoltamperes for all cables at position	kVA
kVAR	Circuit three phase load flow kilovars for all cables at position	kVAR
kVAR Loss	Total Circuit three phase kilovars losses for all cables at position	kVAR
kW	Circuit three phase load flow kilowatt for all cables at position	kW
kW Loss	Total Circuit three phase kilowatt losses for all cables at position	kW
Length	Circuit length, (one-way distance for dc as well as ac)	Feet
LF%	Load factor	%
Lib Volume	Cable Library data volume tag	
LOG10(Fd)	Log (base 10) of distance product factor	
Loss Fac	Loss factor	
Neut OD	Overall outer diameter of neutral cables at position	Inches

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Filename: 0

Variable Definitions and Units:

Variable Label	Description	Units
Neut Qty	Quantity of neutral cables at position (needed only for conduit fill calculations)	
Neut Size	Size of neutral cables at position	
No.	Cable position number not including inactive positions	
Nom. Size	Nominal duct size	Inches
Number of cable positions in system	Number of active cable positions in system calculation	
PF %	Load Power Factor, (for voltage drop calcs)	%
Ph OD	Overall outer diameter of phase cables at position	Inches
Ph Qty	Quantity of phase cables at position	
Ph Size	Size of phase cables at position	
Qp	Loss ratio = Losses in (Conductor + Shield + Duct) / Conductor	
Qs	Loss ratio = Losses in (Conductor + Shield) / Conductor	
Qty-Type	Quantity and type (1/c or 3/c) of cables at position	
Rac	Conductor ac resistance at conductor specified or rated temperature	microhms/foot
Rated kV	Cable line-to-line kilovolt rating	kilovolts
Rcap	Overall thermal resistance between conductor & ambient	Thermal ohm-ft
Rd	Duct thermal resistance	Thermal ohm-ft
Rdc	Conductor dc resistance at conductor specified or rated temperature	microhms/foot
Reactance	Conductor ac reactance used for voltage drop calcs	ohms/1000 feet
Rep	Thermal resistance at interface zone between cable or conduit surface & ambient air	Thermal ohm-ft
Resistance	Conductor ac resistance used for voltage drop calcs	ohms/1000 feet
Ri	Insulation thermal resistance	Thermal ohm-ft
Rj	Cable Jacket thermal resistance	Thermal ohm-ft
Rsd	Thermal resistance between cable exterior and duct interior	Thermal ohm-ft
Shield	Cable shielded? Yes or No	
Shield	Shield grounding, No shield, Shield w/1 end grd or Shield w/2 end grd	
Shield Dia	Shield mean diameter	Inches
Shield Rdc	Shield dc resistance	microhms/foot
Shield Th	Shield thickness	Inches
Shld X	Mutual reactance conductor to shield	Microhms/foot
SIC	Insulation Specific Inductive capacitance (SIC), $SIC = SIC \times e^{(SIC \exp \times Temp)}$	
SIC Exp	Insulation SIC exponent, overall $SIC = SIC \times e^{(SIC \exp \times Temp)}$	
Size	Cable size designation	
Spacing	Spacing between conductors in the same phase group	Inches
Specified Amps	Specified conductor current	Amperes
Specified Temp	Specified conductor temperature	Deg C
Sys Freq	Applied power frequency in cable	Hertz
Sys kV	Applied cable line-to-line kilovolts	kilovolts
System	Number of system (assigned in order entered)	
Temp	Calculated or specified total conductor temperature	Deg C
Thermal Factor	Factor specifying relative heating at each cable position	
Type of underground system	Type of underground system, ductbank or direct buried	
Underground system filename	Path and *.ugs filename where underground system data stored	
Voltage Mag	Source or load voltage magnitude in load flow calcs	Volts
Voltage Deg	Source or load voltage phase angle in load flow calcs	Degrees
Volt Drop (+%) or Rise (-%)	Voltage drop or rise across circuit length, $= 100 \times (V_{source} - V_{load}) / V_{source}$	%
Watts/ft	Total cable watts loss per foot	Watts/foot
Wd	Cable dielectric loss	Watts/foot
x Coord	Position x coordinate	Inches
y Coord	Position y coordinate	Inches
Yc	Increment of Rac/Rdc ratio due to conductor effects = $Y_{cs} + Y_{cp}$	

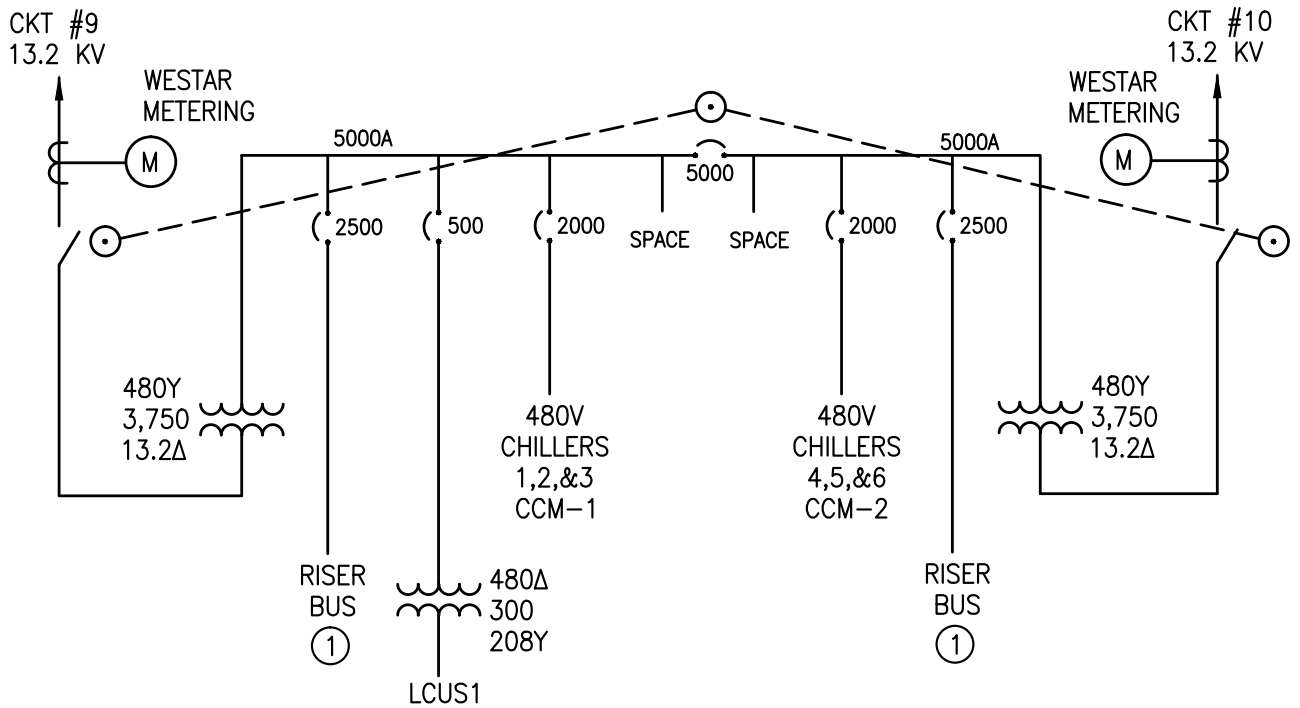
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Filename: 0

Variable Definitions and Units:

Variable Label	Description	Units
Ycp	Increment of Rac/Rdc ratio due to conductor proximity effect	
Ycs	Increment of Rac/Rdc ratio due to conductor skin effect	
Yp	Increment of Rac/Rdc ratio due to pipe or conduit losses	
Ys	Increment of Rac/Rdc ratio due to total shield losses = Ysc + Yse	
Ysc	Increment of Rac/Rdc ratio due to circulating currents in shield	
Yse	Increment of Rac/Rdc ratio due to eddy currents in the shield	

APPENDIX E: ONE-LINE/RISER DIAGRAMS



① RISER UP BLDG TO FEED 300 kVA XFMR, 480Δ-208Y POWER STATIONS.

PROPOSED LINE-UP (MAIN-TIE-MAIN)

NO SCALE

LOCHNER

BWR Division

2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

RISER DIAGRAM

NO SCALE

OPTION 1

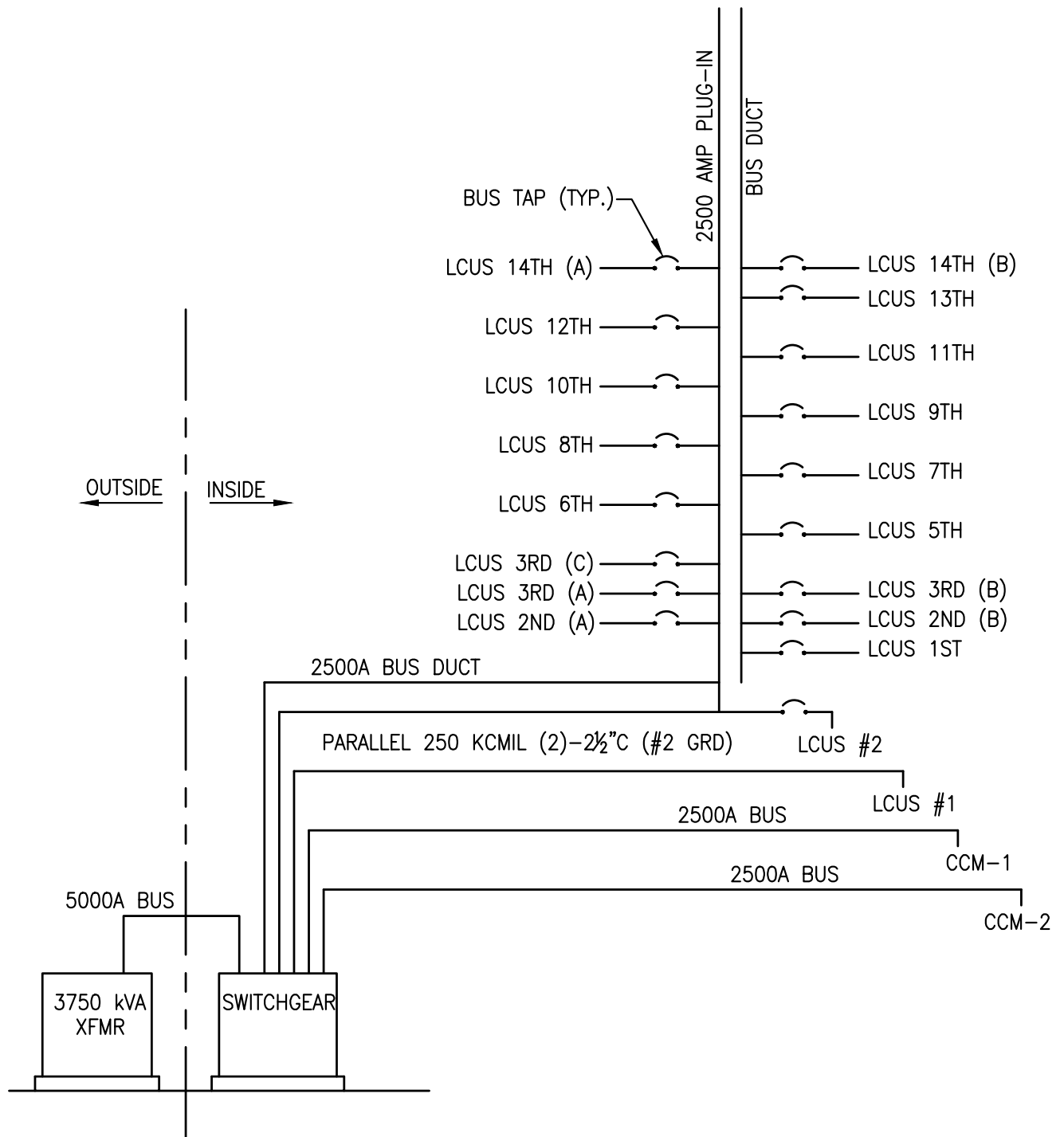
LOCHNER

BWR Division

2335 E. Crawford Street | Salina, Kansas 67401-3713
P 785.827.3603 | F 785.827.3029

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

Drawing Name: K:\2010-0343-KDFM-DockingElectrical\01\ACAD\DWG\RISER-OPTIONS.dwg Jan 18, 2011 - 8:13am



RISER DIAGRAM

NO SCALE

OPTION 2

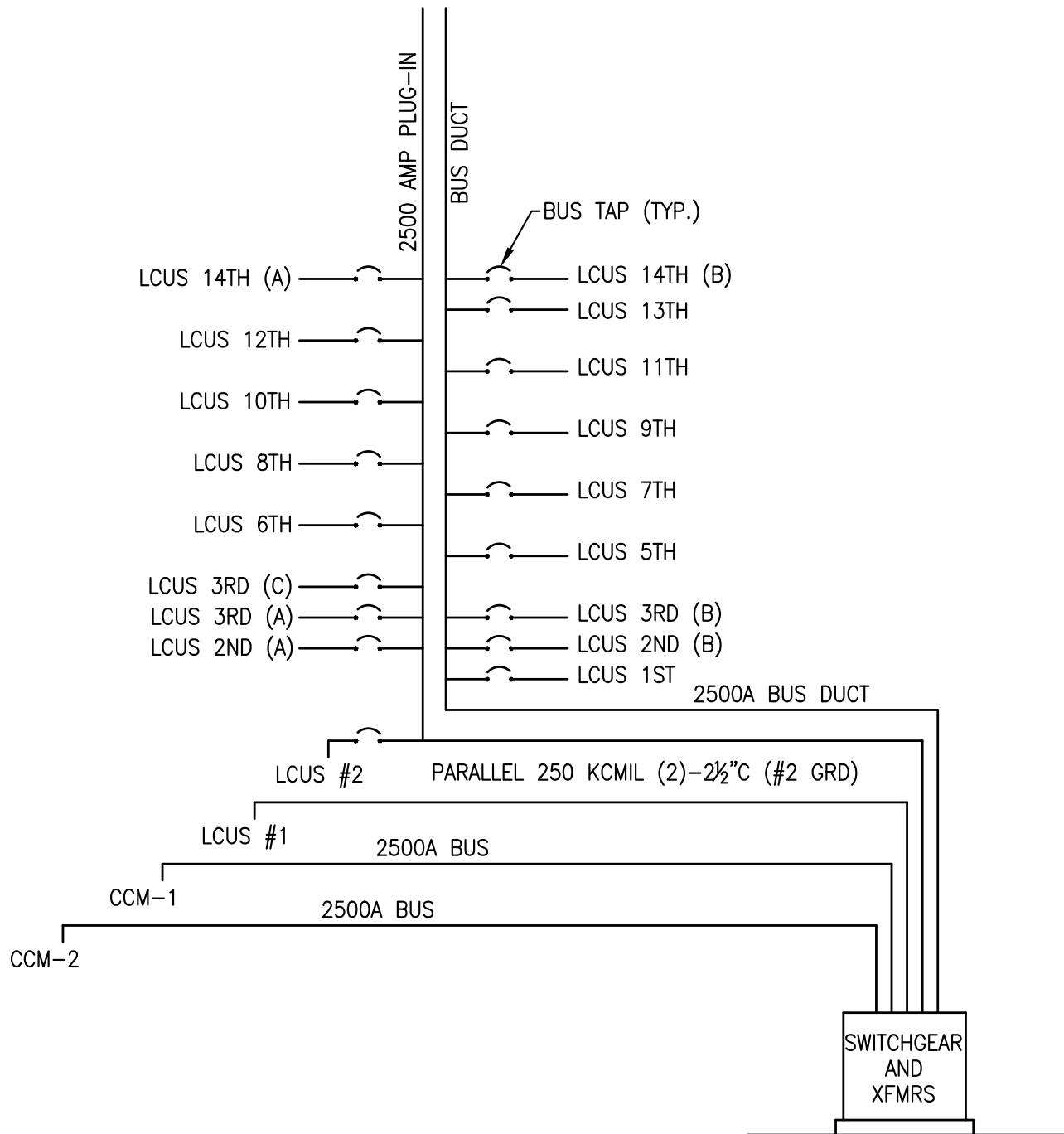
LOCHNER

BWR Division

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P 785.827.3603 | F 785.827.3029

DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

Drawing Name: K:\2010-0343-KDFM-DockingElectrical\01\ACAD\DWG\RISER-OPTIONS.dwg Jan 18, 2011 - 8:09am



RISER DIAGRAM

NO SCALE

OPTION 4

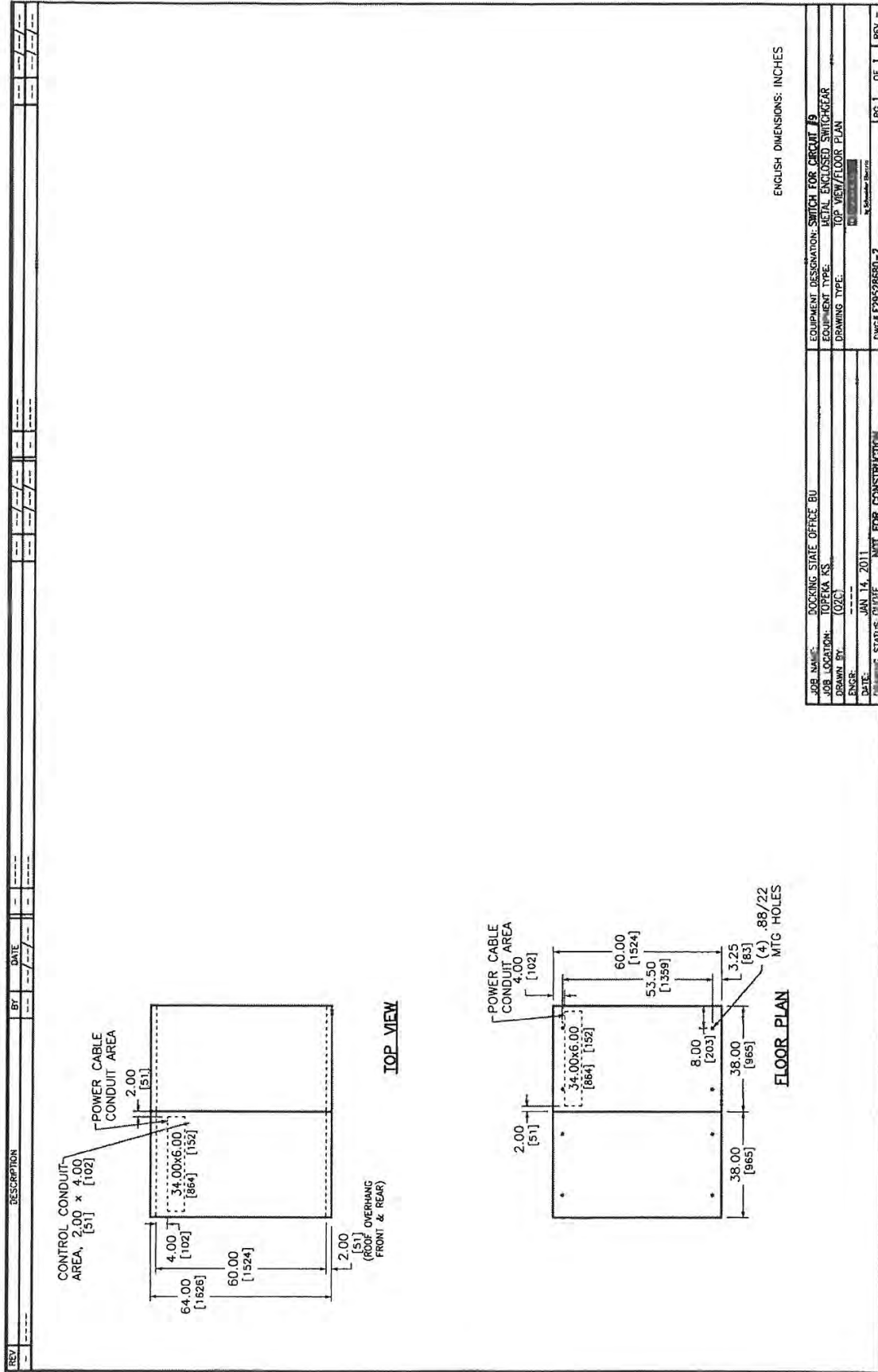
LOCHNER

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DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE
TOPEKA, KANSAS

APPENDIX F: OPTION 1 - TRANSFORMER AND SWITCHGEAR SHOP DRAWINGS



REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

GENERAL NOTES:

PRODUCT DESCRIPTION AND RATINGS:

13200 VOLTS, 3 PHASE, 3 WIRE WYE SOLIDLY GROUND
 15.0 KV MAXIMUM VOLTAGE RATING
 95 KV BIL, 60 HERTZ FREQUENCY
 1.5 KVA - 120 VAC CONTROL POWER

BUS SYSTEM DATA:

600A COPPER, SILVER PLATED MAIN BUS
 EPOXY BUS SUPPORTS
 SILVER PLATED COPPER GROUND BUS
 40 kA Asym (25 kA Sym) MAIN BUS BRACING

ENCLOSURE DATA:

TYPE 3R OUTDOOR NON-WALKIN CONSTRUCTION
 CATEGORY "B" ENCLOSURE
 ANSI #61 FINISH
 FRONT TYPE 3R REMOVED FOR CLARITY
 FRONT AND REAR ACCESS IS AVAILABLE

PAIDLOCK PROVISIONS:

TOP CABLE ENTRY: ENTRY THRU TOP TO BE PUNCHED DURING INSTALLATION
 IN GENERAL AREA SHOWN ON TOP VIEW IF APPLICABLE. RECOMMENDED POWER CABLE
 ENTRY AREA, 6" x 34" (152 x 864) AS SHOWN ON TOP VIEW.
 BOTTOM CABLE ENTRY: BOTTOMS ARE OPEN. RECOMMENDED POWER CABLE ENTRY AREA,
 6" x 34" (152 x 864) AS SHOWN ON FLOOR PLAN.

HANDLING:

SWITCHGEAR SECTIONS ARE FURNISHED WITH LIFTING ANGLES AND ARE SHIPPED ON SKIDS.
 ROLLERS OR FORKLIFT SHALL ONLY BE USED WITH SKID IN PLACE.
 APPROXIMATE WEIGHT: 2372 LBS 1078 KG
 SHIPPING SPLIT 1 WEIGHT: 2372 LBS 1078 KG

CODE STANDARDS:

THIS EQUIPMENT BEARS THE UL LISTING MARK FOR THE UNITED STATES.

PRODUCT INFORMATION:

CONTROL WIRING:

#14 AWG, TYPE SIS CONTROL WIRING, UNLESS OTHERWISE SPECIFIED
 #12 AWG, TYPE SIS HEATER CONTROL WIRING

WIRE LABELING:

WIRES SHALL BE LABELED WITH DESTINATION MARKING (ORIGIN-DESTINATION).

TERMINATIONS:

LOW VOLTAGE WIRE TERMINATIONS (WHERE REQUIRED) SHALL BE
 UNINSULATED RING TYPE LUGS (STYLE 2500S-XXXXX). TERMINAL

BLOCKS ARE SQUARE D COMPRESSION SOLDERLESS BOX LUG (TYPE 9080GR6),
 FUSE BLOCK (9080GFE6).

INSTRUCTION BULLETIN:

OPTIONS/ACCESSORIES:

LIST OF MISC. ACCESSORIES:

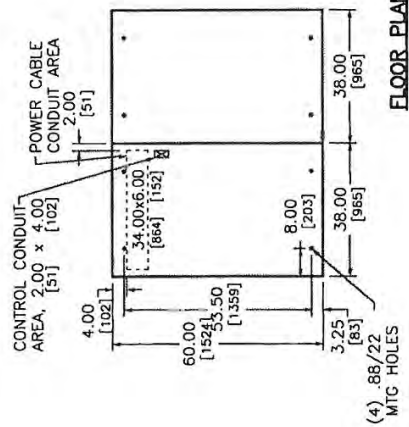
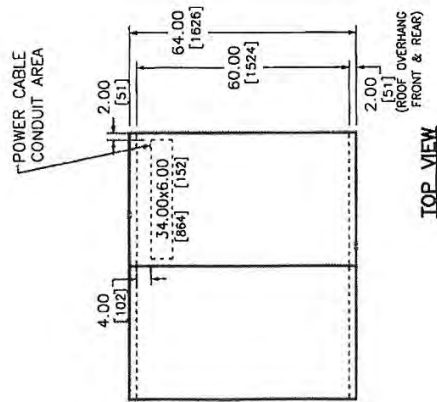
STRIP HEATERS

LIST OF MISC. STRUCTURE OPTIONS:

LIST OF MISC. GENERAL OPTIONS:

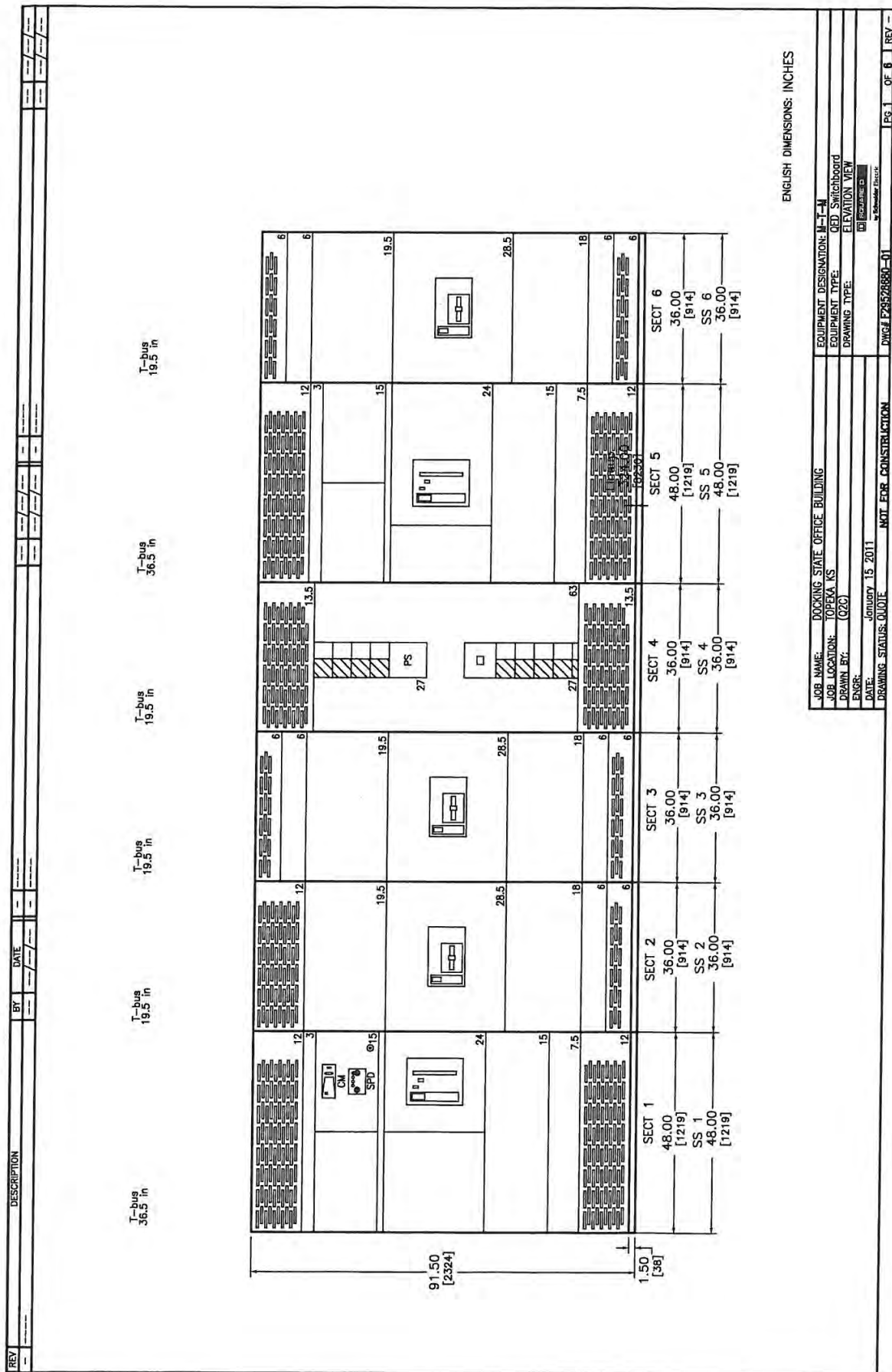
JOB NAME:	DODGING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUIT / 9
JOB LOCATION:	TOPEKA, KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	(020)	DRAWING TYPE:	GENERAL NOTES
DATE:	JAN 14, 2011	BY:	W. J. JONES
STATUS:	NOT FOR CONSTRUCTION	DWG #	2757650-3
PAGE	1	OF	1

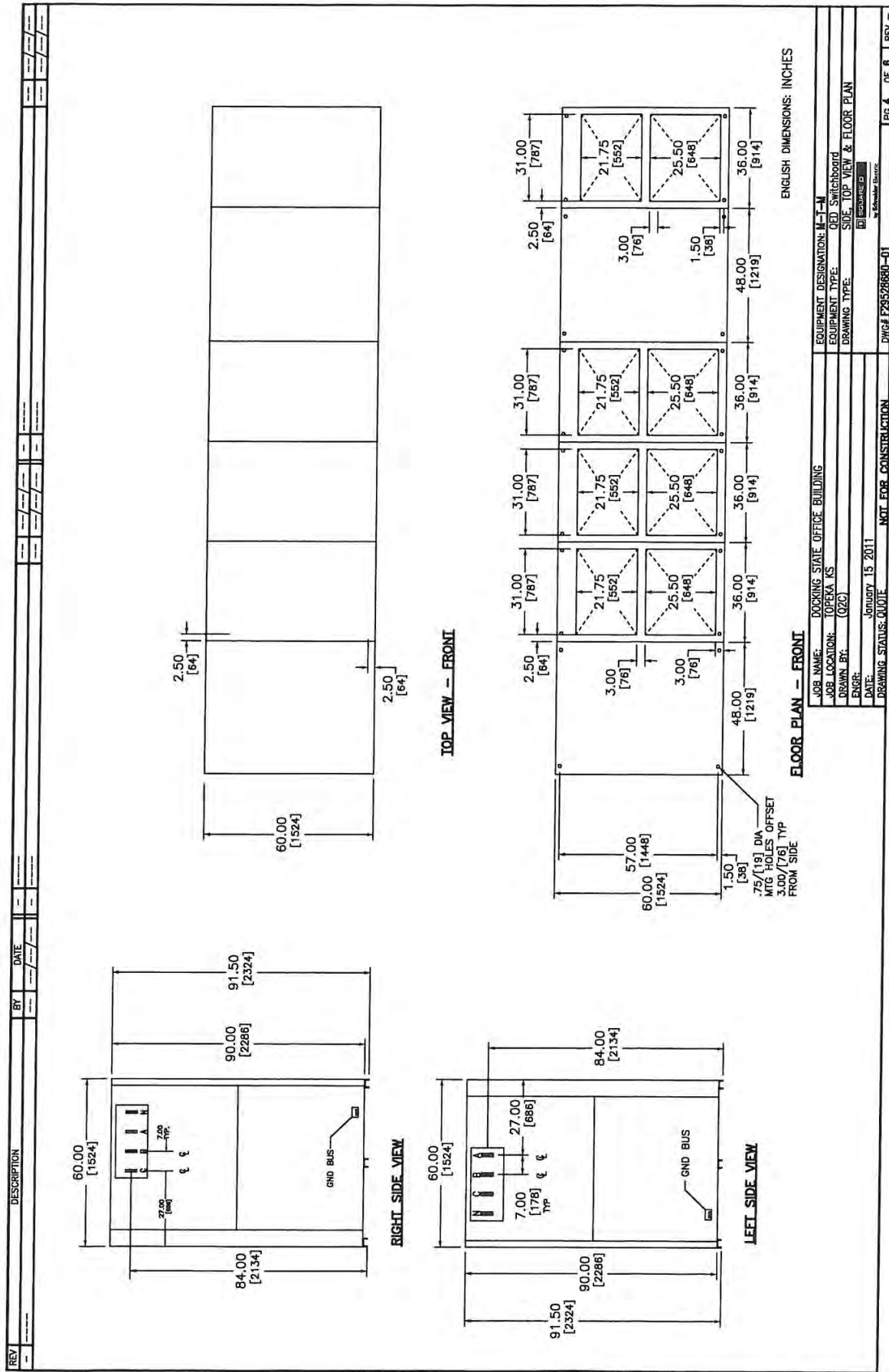
REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

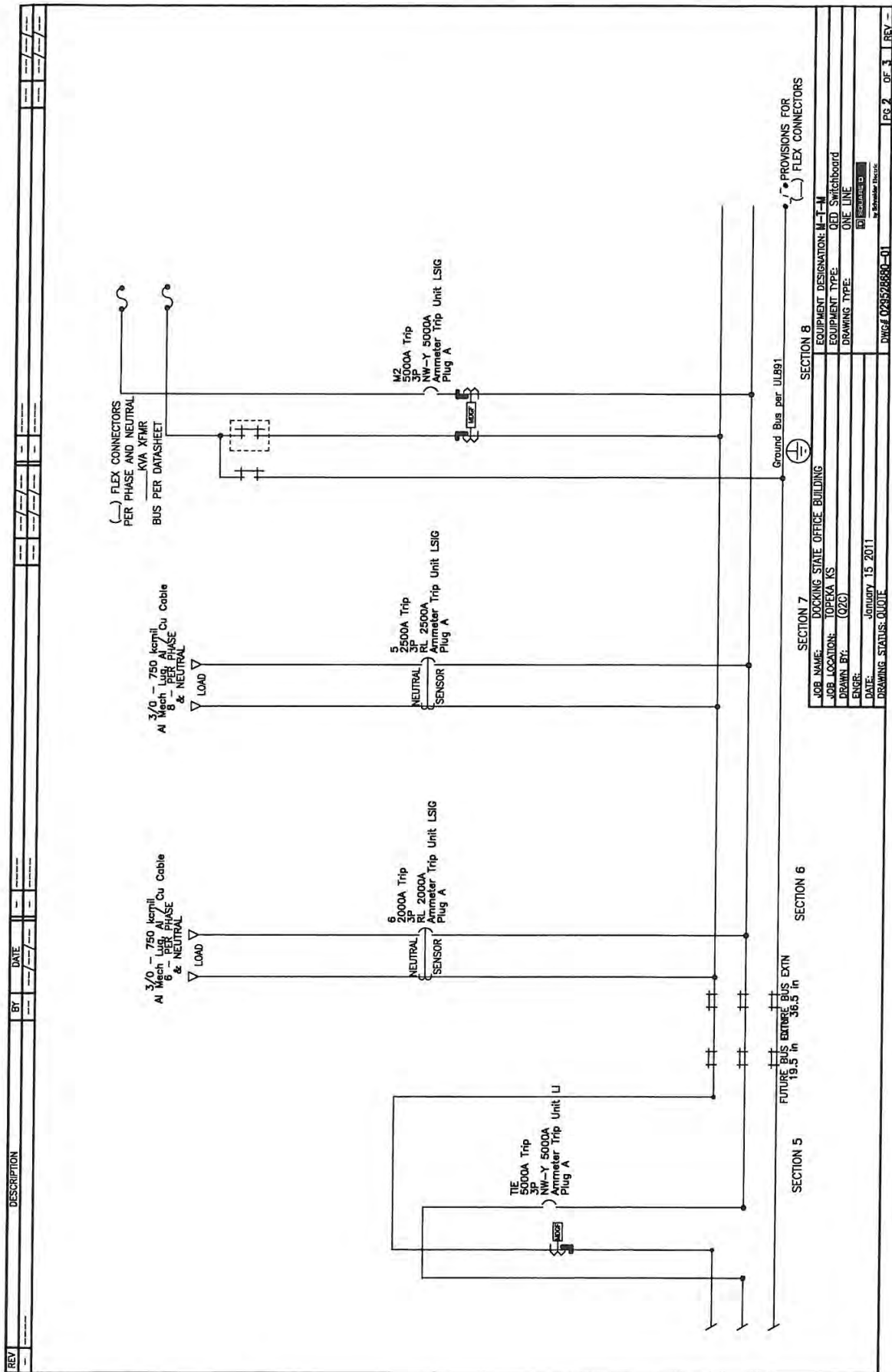


ENGLISH DIMENSIONS: INCHES

JOB NAME:	DOCKING STATE OFFICE BU	EQUIPMENT DESIGNATION:	SWITCH FOR CIRCUT #10
JOB LOCATION:	TOPEKA KS	EQUIPMENT TYPE:	METAL ENCLOSED SWITCHGEAR
DRAWN BY:	GZC	DRAWING TYPE:	TOP VIEW/FLOOR PLAN
DATE:	JAN 14, 2011	ENGINEER:	By: [Signature]
DRAWING STATUS:	QUOTE	NOT FOR CONSTRUCTION	FIG 1 OF 1 REV --







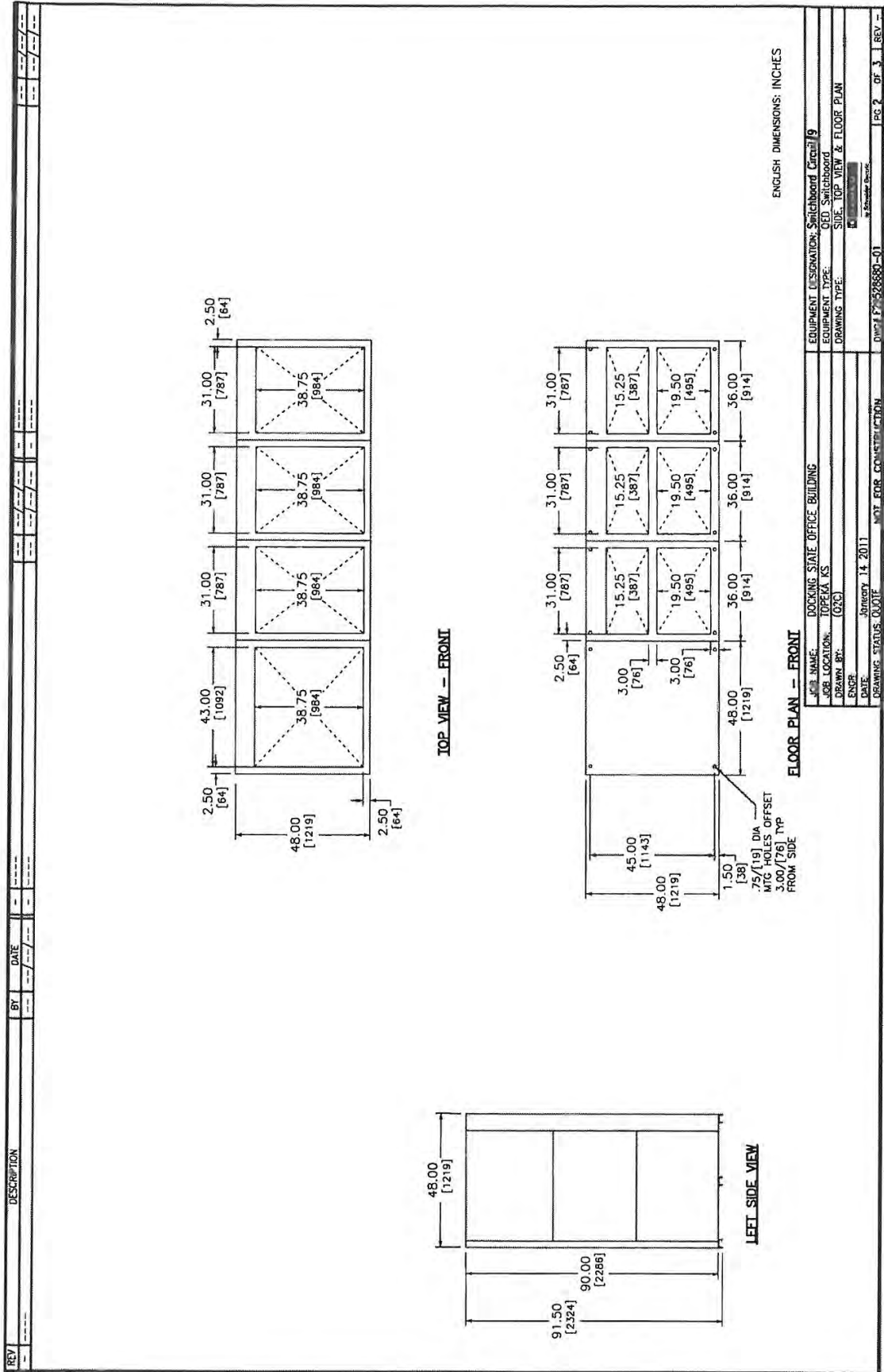
REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE
1															

POWER STYLE QED-2 SWITCHBOARD

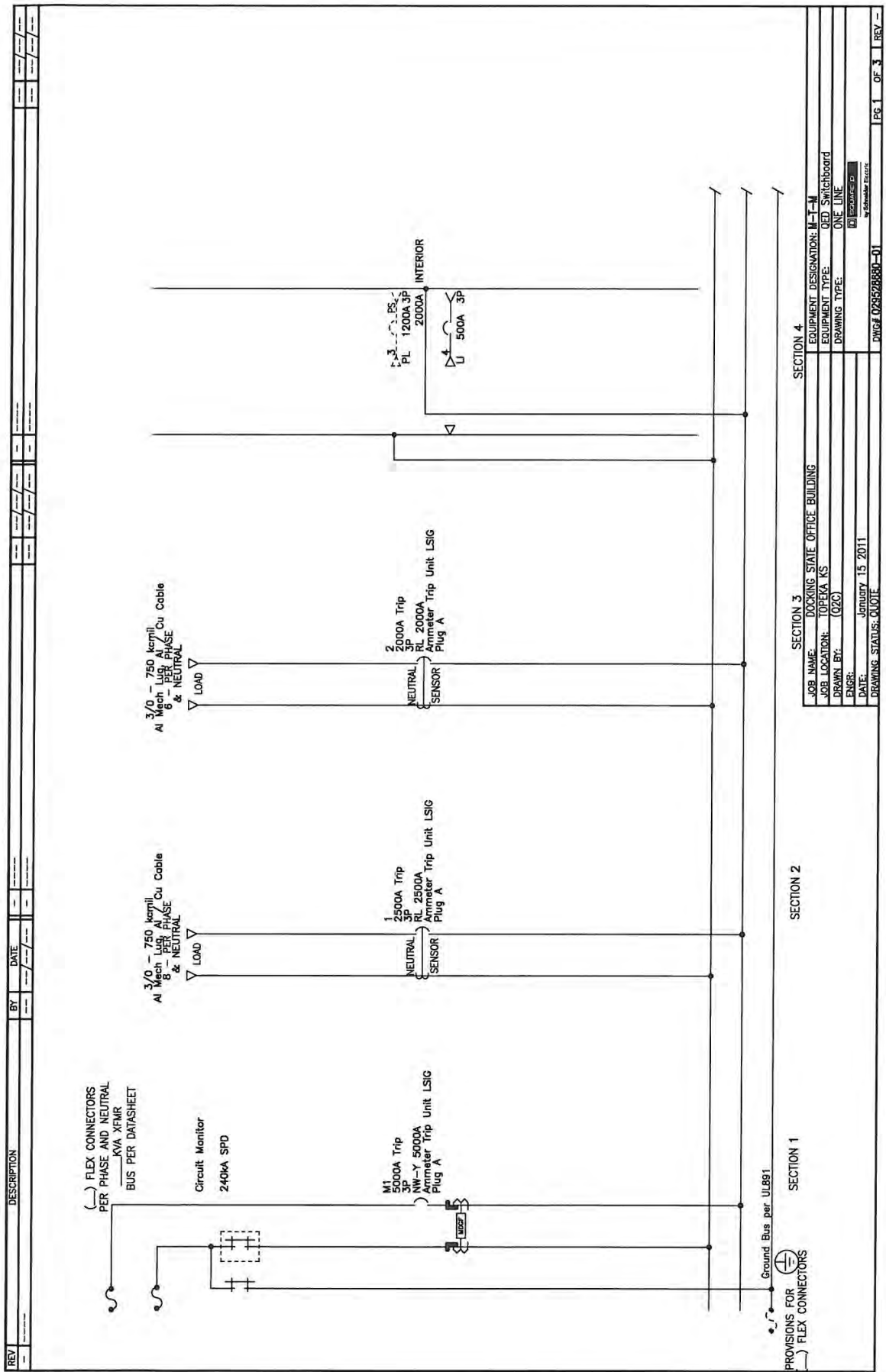
SECT	CKT	GMD HEIGHT	DEVICE /FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	N/P	LUG INFORMATION			ACCESSORIES		LEGEND		
									QTY	PHASE	WIRE RANGE	QTY	NEUT. WIRE RANGE			CM
1	1	—	Incoming Connection	—	—	—	—	—	—	XFMR	—	—	—	COM	Communications	
1	1	—	Circuit Monitor	—	—	—	—	—	—	—	—	—	—	GF	Ground Fault	
1	1	—	240kA SPD	—	—	—	—	—	—	—	—	—	—	MCH	Spring Charging Motor	
1	M1	—	NW 5000A Plug A	5000A	A-LSIG	3P	—	No	—	500 — 750 kcmil	—	500 — 750 kcmil	—	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA	MX1	Shunt Trip
2	1	—	RL 2500A Plug A	2500A	A-LSIG	3P	—	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	—	GF,COM,PLA	MX2	Shunt Trip Second
3	2	—	RL 2000A Plug A	2000A	A-LSIG	3P	—	No	6	3/0 — 750 kcmil	6	3/0 — 750 kcmil	—	GF,COM,PLA	OFB	B Form C Breaker Aux Contacts
4	3	9 In	PL (PS)	(1200A)	—	3P	—	No	4	3/0 — 500 kcmil	4	250 — 600 kcmil	—	—	PLA	Podlock Attachment—Fixed
4	4	7.5 in	LI	500A	—	3P	—	No	2	4/0 — 500kcmil	2	250 — 600 kcmil	—	—	PLC	PLC AutoTransfer Scheme
5	TIE	—	NW 5000A Plug A	5000A	A-LI	3P	—	No	—	—	—	—	—	PLC,COM,SDE1,OFB,UC2,MCH,MX1,MX2,XF,PLA	SDE1	Over Current Trip Switch
6	6	—	RL2000A Plug A 100%	2000A	A-LSIG	3P	—	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	—	GF,COM,PLA	SPD	Surge Protection Device
7	5	—	RL2500A Plug A 100%	2500A	A-LSIG	3P	—	No	8	3/0 — 750 kcmil	8	3/0 — 750 kcmil	—	GF,COM,PLA	UC2	Modified Differential Ground Fault
8	—	—	Incoming Connection	—	—	—	—	—	—	—	XFMR	—	—	—	XF	Closing Coil

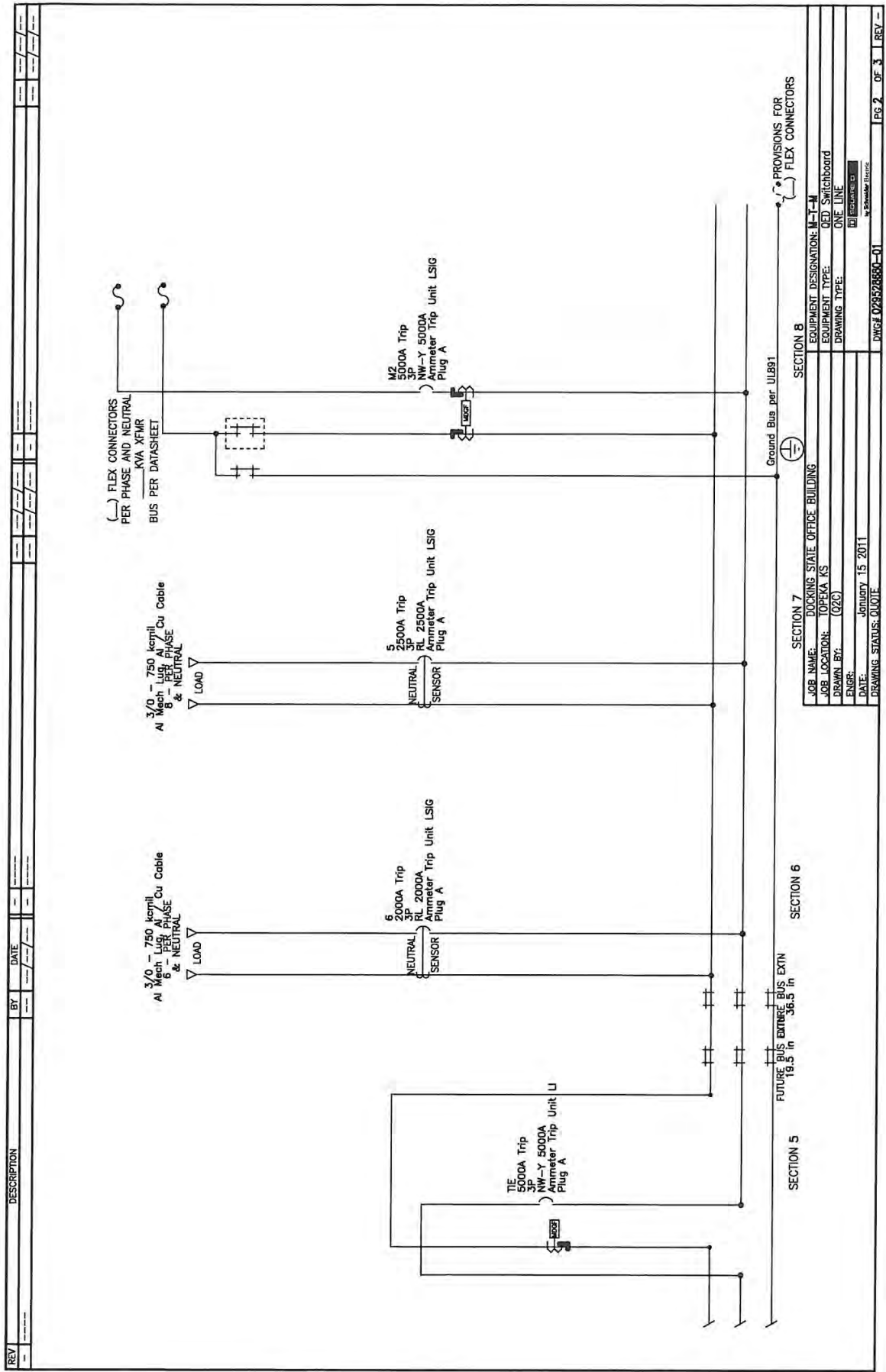
JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATION:	M-T-M
JOB LOCATION:	TOPEKA, KS	EQUIPMENT TYPE:	QED Switchboard
DRAWN BY:	QZC	DRAWING TYPE:	SCHEDULE
ENGR:		BY:	REDAKESD
DATE:	January 15 2011	BY:	REDAKESD
DRAWING STATUS:	QUOTE	DWG#	028528890-01
		PG#	OF 3
		REV	—

APPENDIX G: OPTION 2 - TRANSFORMER AND SWITCHGEAR SHOP DRAWINGS



REV	DESCRIPTION	BY	DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	121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SECTION 7		SECTION 8	
JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATION:	M-T-M
JOB LOCATION:	TOPFEKA KS	EQUIPMENT TYPE:	QED Switchboard
DRAWN BY:	(GZC)	DRAWING TYPE:	ONE LINE
ENGR:			
DATE:	January 15 2011		
DRAWING STATUS:	QUOTE		
		DWG# 023528880-01	
		Pg 2 OF 3	

REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE

POWER STYLE QED-2 SWITCHBOARD

SECT NO	CKT NO	GMD HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/ TRIP	#P	DESIGNATION	N/P	LUG INFORMATION			ACCESSORIES	LEGEND
									QTY	PHASE	WIRE RANGE	NEUT. WIRE RANGE	
1	1	—	Incoming Connection	—	—	—	—	—	—	—	—	—	CM
1	1	—	Circuit Monitor	—	—	—	—	—	—	—	—	—	CM
1	1	—	240kVA SPD	—	—	—	—	—	—	—	—	—	SPD
1	M1	—	NW 5000A Plug A	5000A	A-LSIG	3P	—	—	—	—	—	—	MCH
2	1	—	RL 2500A Plug A	2500A	A-LSIG	3P	—	—	—	—	—	—	MX1
3	2	—	RL 2000A Plug A	2000A	A-LSIG	3P	—	—	—	—	—	—	MX2
4	3	9 in	PL (PS)	(1200A)	—	3P	—	—	—	—	—	—	OFB
4	4	7.5 in	LI	500A	—	3P	—	—	—	—	—	—	PLA
5	TIE	—	NW 5000A Plug A	5000A	A-LI	3P	—	—	—	—	—	—	PLC
6	6	—	RL2000A Plug A 100%	2000A	A-LSIG	3P	—	—	—	—	—	—	SDE1
7	5	—	RL2500A Plug A 100%	2500A	A-LSIG	3P	—	—	—	—	—	—	SPD
8	—	—	Incoming Connection	—	—	—	—	—	—	—	—	—	UC2
8	M2	—	NW 5000A Plug A	5000A	A-LSIG	3P	—	—	—	—	—	—	XF

JOB NAME:	DOCKING STATE OFFICE BUILDING	EQUIPMENT DESIGNATION:	M-1-J
JOB LOCATION:	TOPERA KS	EQUIPMENT TYPE:	QED Switchboard
DRAWN BY:	QZC	DRAWING TYPE:	SCHEDULE
ENGR:			
DATE:	JANUARY 15 2011		
DRAWING STATUS:	QUOTE		
		DWG#	028526880-01
		PG	3 OF 3
		REV	—

APPENDIX H: ENGINEER'S OPINION OF PROBABLE PROJECT COSTS

STATEMENT OF PROBABLE CONSTRUCTION COSTS					DATE PREPARED 1-12-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade						BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase		
LOCATION Docking State Office Building								
ARCHITECT ENGINEER Lochner/BWR Division								
DRAWING NO. / SECTION: ELECTRICAL				ESTIMATOR LWS		CHECKED BY		
SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Demolition								
300 kVA Transformer	19	EA	0	\$0	1586	\$30,134	\$30,134	
15 kV Bus Duct	360	LF	0	\$0	100	\$36,000	\$36,000	
1,500 kVA Transformer	2	EA	0	\$0	3253	\$6,506	\$6,506	
15 kV Cable	1100	LF	0	\$0	0.785	\$864	\$864	
15 kV Switchgear	1	LS	0	\$0	10000	\$10,000	\$10,000	
Distribution Panel	19	EA	0	\$0	750	\$14,250	\$14,250	
Patch Floor Openings	13	EA	125	\$1,625	250	\$3,250	\$4,875	
Working in Occupied Building	1	LS	10000	\$10,000	50000	\$50,000	\$60,000	
Subtotal							\$162,629	
25% O'head & Profit							\$40,657	
Subtotal							\$203,286	
15% Contingency							\$30,493	
TOTAL							\$233,779	

Form BWR 2008

STATEMENT OF PROBABLE CONSTRUCTION COSTS					DATE PREPARED 1-14-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase			
LOCATION Docking State Office Building								
ARCHITECT ENGINEER Lochner/BWR Division								
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY			
SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Option 1								
Ductbank Construction	1	LS	500000	\$500,000		\$0	\$500,000	
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200	
Xfmr Pad	2	EA	800	\$1,600	200	\$400	\$2,000	
5,000 Amp Copper Bus	200	LF	1500	\$300,000	300	\$60,000	\$360,000	
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200	
Wall Penetration	2	EA	750	\$1,500	390	\$780	\$2,280	
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000	
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000	
LCUS No. 1 Feed	330	LF	70	\$23,100	52	\$17,160	\$40,260	
2,500 Amp Copper Bus	1300	LF	630	\$819,000	101	\$131,300	\$950,300	
2,500 Amp Elbow	19	EA	2550	\$48,450	445	\$8,455	\$56,905	
600 Amp Plug-in Unit	18	EA	3825	\$68,850	895	\$16,110	\$84,960	
Fire Stop Floor	26	EA	735	\$19,110	224	\$5,824	\$24,934	
300 kVA, 480V-208Y Dry Type	19	EA	24900	\$473,100	3500	\$66,500	\$539,600	
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000	
Rerouting of existing Circuits	19	LS	3000	\$57,000	1750	\$33,250	\$90,250	
Westar Charges	1	LS	100000	\$100,000	0	\$0	\$100,000	
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000	
Room Modifications	1	LS	50000	\$50,000	0	\$0	\$50,000	
Subtotal							\$3,848,889	
25% O'head & Profit							\$962,222	
Subtotal							\$4,811,111	
15% Contingency							\$721,667	
TOTAL							\$5,532,778	

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS				DATE PREPARED 1-12-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade				BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase			
LOCATION Docking State Office Building							
ARCHITECT ENGINEER Lochner/BWR Division							
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY		
SUMMARY Option 2	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Ductbank Construction	1	LS	1E+06	\$1,000,000	0	\$0	\$1,000,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Pad	2	EA	800	\$1,600	200	\$400	\$2,000
5,000 Amp Copper Bus	220	LF	1500	\$330,000	300	\$66,000	\$396,000
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200
Wall Penetration	2	EA	750	\$1,500	390	\$780	\$2,280
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	270	LF	70	\$18,900	52	\$14,040	\$32,940
2,500 Amp Copper Bus	1200	LF	630	\$756,000	101	\$121,200	\$877,200
2,500 Amp Elbow	20	EA	2550	\$51,000	445	\$8,900	\$59,900
600 Amp Plug-in Unit	18	EA	3825	\$68,850	895	\$16,110	\$84,960
Fire Stop Floor	26	EA	735	\$19,110	224	\$5,824	\$24,934
300 kVA, 480V-208Y Dry Type	19	EA	24900	\$473,100	3500	\$66,500	\$539,600
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	1750	\$33,250	\$90,250
Westar Charges	1	LS	200000	\$200,000	0	\$0	\$200,000
Room Addition	1	LS	60000	\$60,000	0	\$0	\$60,000
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000
Subtotal							\$4,417,464
25% O'head & Profit							\$1,104,366
Subtotal							\$5,521,830
15% Contingency							\$828,275
TOTAL							\$6,350,105

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS				DATE PREPARED 1-12-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade				BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase			
LOCATION Docking State Office Building							
ARCHITECT ENGINEER Lochner/BWR Division							
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS		CHECKED BY		
SUMMARY	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Option 3							
Ductbank Construction	1	LS	400000	\$400,000	0	\$0	\$400,000
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	7100	\$14,200	\$14,200
Xfmr Pad	2	EA	800	\$1,600	200	\$400	\$2,000
5,000 Amp Copper Bus	220	LF	1500	\$330,000	300	\$66,000	\$396,000
Bus Supports	6	EA	600	\$3,600	600	\$3,600	\$7,200
Wall Penetration	2	EA	750	\$1,500	390	\$780	\$2,280
5,000 Amp Elbow	8	EA	5000	\$40,000	625	\$5,000	\$45,000
5,000 Amp double-ended Swgr.	1	LS	700000	\$700,000	15000	\$15,000	\$715,000
LCUS No. 1 Feed	270	LF	70	\$18,900	52	\$14,040	\$32,940
2,500 Amp Copper Bus	1200	LF	630	\$756,000	101	\$121,200	\$877,200
2,500 Amp Elbow	20	EA	2550	\$51,000	445	\$8,900	\$59,900
600 Amp Plug-in Unit	18	EA	3825	\$68,850	895	\$16,110	\$84,960
Fire Stop Floor	26	EA	735	\$19,110	224	\$5,824	\$24,934
300 kVA, 480V-208Y Dry Type	19	EA	24900	\$473,100	3500	\$66,500	\$539,600
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000
Rerouting of existing Circuits	19	LS	3000	\$57,000	1750	\$33,250	\$90,250
Westar Charges	1	LS	800000	\$800,000	0	\$0	\$800,000
Room Addition	1	LS	60000	\$60,000	0	\$0	\$60,000
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000
Subtotal							\$4,417,464
25% O'head & Profit							\$1,104,366
Subtotal							\$5,521,830
15% Contingency							\$828,275
TOTAL							\$6,350,105

Form BWR 2008

* Material Price Included with Switchboard

STATEMENT OF PROBABLE CONSTRUCTION COSTS					DATE PREPARED 1-14-2011		SHEET 1 OF 1	
PROJECT Electrical Upgrade					BASIS FOR ESTIMATE ☐ CODE A (Preliminary design) - 35% ☐ CODE B (Preliminary design) - 65% ☐ CODE C (Final design) ☒ OTHER (Specify) - Study Phase			
LOCATION Docking State Office Building								
ARCHITECT ENGINEER Lochner/BWR Division								
DRAWING NO. / SECTION: ELECTRICAL			ESTIMATOR LWS			CHECKED BY		
SUMMARY Option 4	QUANTITY		MATERIAL		LABOR		TOTAL COST	
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL		
Ductbank Construction	1	LS	575000	\$575,000	0	\$0	\$575,000	
3,750 kVA, 13.2kV-480Y Xfmr*	2	EA	0	\$0	20000	\$40,000	\$40,000	
Floor Shoring	1	LS	500000	\$500,000	0	\$0	\$500,000	
Hallway Modifications	1	LS	150000	\$150,000	0	\$0	\$150,000	
Wall Penetration	2	EA	750	\$1,500	300	\$600	\$2,100	
5,000 Amp double-ended Swgr.	1	LS	800000	\$800,000	15000	\$15,000	\$815,000	
LCUS No. 1 Feed	330	LF	70	\$23,100	52	\$17,160	\$40,260	
2,500 Amp Copper Bus	1300	LF	630	\$819,000	101	\$131,300	\$950,300	
2,500 Amp Elbow	19	EA	2550	\$48,450	445	\$8,455	\$56,905	
600 Amp Plug-in Unit	18	EA	3825	\$68,850	895	\$16,110	\$84,960	
Fire Stop Floor	26	EA	735	\$19,110	224	\$5,824	\$24,934	
300 kVA, 480V-208Y Dry Type	19	EA	24900	\$473,100	3500	\$66,500	\$539,600	
Distribution Panelboard	19	EA	8000	\$152,000	1000	\$19,000	\$171,000	
Rerouting of existing Circuits	19	LS	3000	\$57,000	1750	\$33,250	\$90,250	
Westar Charges	1	LS	100000	\$100,000	0	\$0	\$100,000	
Load Switchover (After Hours)	19	EA	5000	\$95,000		\$0	\$95,000	
Room Modifications	1	LS	60000	\$60,000	0	\$0	\$60,000	
Subtotal							\$4,295,309	
25% O'head & Profit							\$1,073,827	
Subtotal							\$5,369,136	
15% Contingency							\$805,370	
TOTAL							\$6,174,507	

Form BWR 2008

* Material Price Included with Switchboard

LOCHNER

BWR Division

Study of:

Docking State Office Building Electrical Upgrade



Submitted to:

**Kansas Department of
Administration**

FOR REVIEW ONLY

January 18, 2011

KANSAS DEPARTMENT OF ADMINISTRATION

**DOCKING STATE OFFICE BUILDING
ELECTRICAL UPGRADE STUDY**

FOR REVIEW ONLY

Project No. 2010-0343.01

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engineering | planning | architecture

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FOR REVIEW ONLY

1. INTRODUCTION AND HISTORY

1.1 Purpose of Study

The purpose of this report is to determine the feasibility of upgrading the electrical distribution system within the Docking State Office Building. This upgrade would remove the existing 15 kV distribution system from within the facility and replace with a 480/277 Volt system. Various options to accomplish this task were investigated and are summarized in this report.

1.2 History

The existing electrical distribution system consists of electrical switchgear, rated for 15 kV, located in the northeast corner of the basement. Cabling, carrying 13.2 kV, is routed from a Westar Energy manhole in the northeast corner of Harrison and 9th Street. A recently constructed ductbank, containing three (3) 6-inch conduits, is routed from this manhole to the electrical room in the basement of the building. Two separate circuits (#9 and #10) are routed in this ductbank and supply electrical power to the 15 kV electrical switchgear. Of the two circuits, Circuit #10 is the preferred circuit and is normally utilized to supply power to the building.

Each of the electrical circuits feeds into the automatic throw-over switch in the switchgear. The automatic throw-over switch allows the switchgear to be fed from one of the two electrical feeder circuits. Typical operation is to have Circuit #10, from Westar Energy, supplying power to the switchgear through the automatic throw-over switch allows for energizing of the switchgear line-up.

If the preferred circuit is lost, the system is designed to automatically, if so selected, disconnect from the failed utility feeder and switch the “automatic throw-over switch” to energize the switchgear from the alternate source. With the current operation of operating only on Circuit #10, the loss of Circuit #10 would cause the system to disconnect from Circuit #10 and close the Circuit #9 switch to re-energize the switchgear from this source.

From the switchgear, which is operating at 13.2 kV, the electricity is distributed throughout the building with either 15 kV cable or 15 kV bus duct. Three of the electrical loads are fed with #2 AWG, 15 kV cable (CCM-1, CCM-2, and LCUS No. 1). The medium voltage switches, controlling these feeders, are contained in the medium voltage (15 kV) switchgear in the northeast corner of the basement. The remainder of the electrical loads is connected to a 15 kV electrical bus duct that is routed from the northeast corner of the basement, to the east of the north-south corridor, northeast of the bank of elevators, to the electrical room located north of the elevator banks, on the basement level. This 15 kV bus duct is then routed vertically through the building to the penthouse. At each floor, except at the sub-basement and fourth floor, at least one tap is made to this vertical bus. The tap is routed to a medium voltage switch which feeds a 300kVA step-down transformer to convert the 13.2 kV to 120/208 volt. The 120/208 volt is considered the utilization voltage of each floor. The chillers and other large electrical loads are operated on 480 volts and are supplied by a 13.2 kV to 480 volt step-down transformer.

2. EXISTING CONDITIONS

2.1 Site Investigation

During the period of November 24th to November 27th, 2010, Capital Electric was on site to perform routine maintenance on the 15 kV system in the facility. During this time, the electrical power to the building was turned “off” and the system was inspected, cleaned, and repaired. A copy of this report is included in Appendix A of this report. The findings of the report included excessive dust/dirt accumulation on the electrical gear and 15 kV bus duct, medium voltage switches not fully engaged, medium voltage fuses improperly installed, taped joints on the 15 kV bus duct needing repair, equipment out of adjustment and not fully engaged, transformer windings dangerously close to metal enclosures, and corrosion developing on insulators, just to name a few.

2.1.1 Dangers and Concerns

The dangers presented with the existing equipment include the possibility for an arc to be started with the displacement of the existing dust. The dust itself is explosive. If an electrical arc is started due to the conductivity of the dust particles, the addition of the fault electrical current, could lead to an explosion in the electrical bus duct, causing severe damage to the electrical equipment and harm to any personnel in the area.

In addition to the unsafe conditions discovered during the maintenance, the existing electrical distribution system is over 50 years old. The normal life of such electrical equipment is 20 – 30 years. Also, the existing equipment is now obsolete and finding parts is not only difficult and expensive, but in some instances may be impossible. This would require remanufacturing of some parts are substantial expense.

2.2 Present Building Electrical Loading

Historical loading information was provided by Westar Energy for the last three year’s usage on the Docking State Office Building. The peak demand electrical loading of this facility was 3,168 kW/kVA recorded in June of 2009. The data provided by Westar Energy is included in Appendix B. The demand loading for a building is defined as the maximum

electrical loading for a facility, over a 15 minute period. Based upon the rough square footage of the building, this equates to approximately 10 watts per square foot, which is typical for an office building loading.

This peak loading is used to determine the size of electrical equipment required to supply adequate power to the building. This value is used in developing options for possible upgrades.

Combining the existing electrical peak loading with the desire for a redundant electrical supply system, the step-down transformers to convert the incoming Westar Energy supplied 13.2 kV to 480/277 Volts will require a minimum of two (2) 3,750 kVA transformers. The maximum size of transformer that Westar Energy is able to provide is rated at only 2,500 kVA. Therefore, in order to meet the redundancy request, the state will be required to purchase and maintain the step-down transformers.

2.3 Building Layout

A site plan and the building floor plans are included in Appendix C to provide information on the existing building layout and electrical arrangement. Sheet E601 shows the existing one-line diagram of the 13.2kV distribution system and the major electrical loads.

3. ELECTRICAL UPGRADE OPTIONS

3.1 Option 1

Replace existing switchgear with new, exterior mounted pad mounted transformers on the north side of the building and new 480 volt switchgear in basement.



Photograph 1: North Side Docking State Office Building

This option involves the installation of two (2) new, 3,750 kVA, 13.2kV-480Y/277 Volt pad mounted transformers on the north side of the building. See Photograph 1 for approximate area for new transformers. The existing electrical, primary voltage feed is routed in a ductbank from a manhole at the northeast corner of Harrison and 9th Street. This ductbank consists of three (3) 6-inch conduits, concrete encased. To supply the new pad mounted transformers, a new ductbank, consisting of four (4) 6-inch conduits (two for conductors and two spares) would be routed from the existing manhole to the new transformers location.

The new primary conductors would be installed by Westar Energy from the manhole to the pad mounted transformers. Final electrical connections would also be performed by Westar Energy.

The secondary voltage of the transformers would be 480Y/277 Volts with a full load rating of 4,510 Amps, each. This would allow the entire load of the Docking State Office Building to be supplied by just one of the transformers, providing total redundancy. To carry the 4,510 full load amps, either conduit with conductors or weatherproof bus duct would be required, rated for a minimum of 5,000 Amps.

To place adequate raceway and conductors underground to carry the 5,000 Amps would require 44 conduits (Refer to calculations in Appendix D). The large number of conduits is required due to the derating effect from mutual heating from multiple conduits placed in a ductbank. A viable alternative is to install 5,000 Amp weatherproof ductbank from the transformers to the new electrical switchboard. Being that the electrical bus duct cannot be installed underground, an overhead routing from the secondary of the pad mounted transformers would be required. Support structures would be required to be placed along the route of the busduct from the pad mounted transformers to the underside of the second floor above the north drive.

Once routed to the exterior wall of the first floor, a penetration of the building exterior would be required to enter into the building and then the 5,000 Amp bus ducts would be routed vertically into the basement level and the new electrical switchgear room. This new electrical room would be created directly west across the hallway from the existing electrical room on the north end of the basement, next to the tunnel entrance. The new electrical room, the current auditorium, would need to be expanded to the west to allow for the installation of the electrical switchgear.

Photograph 2 shows the existing electrical room door to the right, the existing doors to the tunnel in the center, and the existing door to the auditorium on the left.



**Photograph 2: North End
Basement Hallway**

The new switchgear would be rated for 5,000 Amps at 480Y/277 Volts. This gear, placed on a housekeeping pad, would consist of metering cabinets on each end to allow for Westar Energy's use. Next to the metering cabinets would be the main, 5,000 Amp switch, one for each of the feeds from the pad mounted transformers. One would be identified Circuit #9 and one Circuit #10. The main switch on each end would then feed distribution panels, rated at 5,000 Amps. In the middle of the new switchgear would be an automated tie-breaker. This tie-breaker would allow for the automatic connection of the two halves of the switchgear, to allow it to be fed from either of the two feeder circuits. The existing switchgear is presently connected to Circuit #10 (preferred source). With the new switchgear, both of the circuits from Westar Energy would be energized to allow for heating of the pad mounted transformers and thereby preventing condensation in the transformer.

Upon the loss of one of the feeder circuits, the switchgear would open the lost feeder circuit and automatically close the tie-breaker to allow for the entire switchgear to be fed from the remaining feeder circuit. Upon restoration of service to the affected feeder circuit, a manual or automatic retransfer shall occur to separate the two halves of the switchgear and the restored feeder circuit reconnected to half of the switchgear.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, both located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 1.

3.2 Option 2

Replace existing switchgear with new, exterior mounted substation transformers on the south side of the building in the existing areaway and new 480 volt switchgear in



Photograph 3: South Side of DSOB Areaway

basement.

This option involves the installation of two (2) new, 3,750 kVA, 13.2 kV-480Y/277 Volt substation transformers in the existing areaway on the south side of the building. Photographs 3 and 4 show the existing areaway at the south end of the building. The existing electrical, primary voltage feed is routed in a ductbank from a manhole at the northeast corner of Harrison and 9th Street. This ductbank consists of three (3) 6-inch



Photograph 4: DSOB South Areaway

conduits, concrete encased. To supply the new pad mounted transformers, a new ductbank, consisting of four (4) 6-inch conduits (two for conductors and two spares) would be routed from the existing manhole to the new transformers location. A new manhole would also be required due to the length of the raceway routing.

The new primary conductors would be installed by Westar Energy from the manhole to the pad mounted transformers. Final electrical connections would also be performed by Westar Energy.

The secondary voltage of the transformers would be 480Y/277 Volts with a full load rating of 4,510 Amps, each. This would allow the entire load of the Docking State Office Building to be supplied by just one of the transformers, providing total redundancy. To carry the 4,510 full load amps, weatherproof bus duct would be required, rated for a minimum of 5,000 Amps.

With the transformers placed in the existing areaway, the primary conductors would be routed overhead to the transformers from the new ductbank. The secondary weatherproof bus duct would be routed overhead, into the subbasement level to the new 480 Volt switchgear. The new gear would be located in the subbasement level where existing chillers are being removed. The switchgear would be enclosed in a 2-hour enclosure with two exits.

The new switchgear would be rated for 5,000 Amps at 480Y/277 Volts. This gear, placed on a housekeeping pad, would consist of metering cabinets on each end to allow for Westar Energy's use. Next to the metering cabinets would be the main, 5,000 Amp switch, one for each of the feeds from the pad mounted transformers. One would be identified Circuit #9 and one Circuit #10. The main switch on each end would then feed distribution panels, rated at 5,000 Amps. In the middle of the new switchgear would be an automatic tie-breaker. This tie-breaker would allow for the automatic connection of the two halves of the switchgear, to allow it to be fed from either of the two feeder circuits. The existing switchgear is presently connected to Circuit #10 (preferred source). With the new switchgear, both of the circuits from Westar Energy would be energized to

allow for heating of the pad mounted transformers and thereby preventing condensation in the transformer.

Upon the loss of one of the feeder circuits, the switchgear would open the lost feeder circuit and automatically close the tie-breaker switch to allow for the entire switchgear to be fed from the remaining feeder circuit. Upon restoration of service to the affected feeder circuit, a manual or automatic retransfer shall occur to separate the two halves of the switchgear and the restored feeder circuit reconnected to half of the switchgear.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, both located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 2.

3.3 Option 3

Construct new Westar Energy Ductbank along the east side of Harrison Street to the intersection of 10th Street.

This option involves the extension of the Westar Energy ductbank along the east side of Harrison Street from the existing manhole at the intersection of 9th and Harrison to the 10th and Harrison intersection. At this location, a new manhole would be installed and a four (4) 6-inch conduit ductbank would be constructed to the west to feed the new exterior transformers in the existing south areaway.

The extension of the existing Westar Energy ductbank would allow for expanding of the Westar underground distribution system and allow the ability to serve future loads east of 10th and Harrison. The extension of the ductbank would be performed by Westar.

3.4 Option 4

Replace existing switchgear with new double-ended switchgear in basement at north end of building, including transformers.

This option involves the installation of the new 13.2kV to 480/277 Volt transformers in the basement. The transformers would be part of a new 5,000 Amp electrical line-up. A new ductbank with four (4) 6-inch conduits would be routed from the existing manhole at the intersection of 9th and Harrison. Two (2) of the conduits would be utilized for feeder circuits 9 and 10 from Westar Energy. The ductbank would extend to the exterior wall of the Docking State Office Building, at the basement level, on the north end of the building. The raceway would enter the building in the space that is currently the auditorium. This room would be converted into a new electrical room and would require some modifications.

The switchgear would consist of a medium voltage switch (15kV) on each end, feeding a 3,750 kVA step-down transformer to convert from 13.2kV to 480/277 Volt. On the secondary of the step-down transformer would be connected half of the 480 Volt switchgear. The gear would have an automatic tie-breaker switch in the middle. Each half of the switchgear would be fed with one of the feeder circuits (9 or 10) from Westar Energy. Upon the loss of one of the feeder circuits, the corresponding main switch would open and the automatic tie-breaker would close to allow for operation of the entire 480 Volt switchgear from one feeder circuit. Upon the restoration of the feeder circuit, the automatic tie-breaker would open and the corresponding main switch would close to restore power to each half of the switchgear. Normal operation would be to utilize both feeders to allow for energizing of the 13.2kV to 480/277 Volt transformers to prevent condensation buildup.

From the new electrical switchgear, 480 Volt feeders would be routed to the existing electrical loads within the facility. Connection to the existing CCM-1 and CCM-2, all located in the basement, shall each be fed with new 2,000 Amp, 480 Volt bus duct. LCUS No.1, also located in the basement, would be fed with conduit and wire adequate to supply 500 Amps to the LCUS. To supply the individual LCUS units located on the various floors, two (2) 2,500 Amp, 480 Volt bus ducts would be routed vertically through the building, with plug-in taps on each floor where existing loads exist. New 300 kVA step-down transformers would be installed on each floor to convert the voltage from 480 Volt to 120/208 Volts to allow for utilization on each floor. The secondary of the 300 kVA transformers would be connected to distribution panelboards. These distribution panelboards would be reconnected to existing building loads.

Refer to Appendix E for a Riser Diagram of Option 4.

3.5 Option 5

Replace existing 15kV switchgear with new at north end of basement.

This option consists of installing new 15kV switchgear in the existing auditorium. A new ductbank with four (4) 6-inch conduits would be routed from the existing manhole at the intersection of 9th and Harrison. Two (2) of the conduits would be utilized for feeder circuits 9 and 10 from Westar Energy. The other two (2) conduits would be spare for future use. The ductbank would extend to the exterior wall of the Docking State Office Building, at the basement level, on the north end of the building. The raceway would enter the building in the space that is currently the auditorium. This room would be converted into a new electrical room and would require some modifications.

The new gear would consist of 15kV switches for the two feeder circuits, 9 and 10, from Westar Energy. The switchgear would consist of four (4) 15kV switches to supply power to CCM-1, CCM-2, and LCUS No. 1, all located in the basement, and a 15kV bus duct to supply power to the other floors. New 15kV cable would be utilized to provide power to the basement level large electrical loads. A new 15kV bus duct would be routed from the new electrical room south to the existing electrical room to the north of the elevator

banks. To the north of the elevator banks, a new vertical 15kV bus duct would be routed up the building to supply power to the individual floors. At each floor, except fourth, the 15kV bus duct would be tapped and connected to a 300 kVA step-down transformers via a medium voltage switch. The 13.2kV to 120/208 Volt step-down transformer would feed a new distribution panelboard to supply utilization power to the corresponding floor of the building.

The new 15kV switchgear would contain an automatic transfer (throw-over) switch to allow one feeder to supply power to the entire switchgear. Normal operation would be to have the feeder circuit #10 switch closed and feeder circuit #9 open. Upon loss of feeder circuit #10, the automatic throw-over would disconnect from feeder circuit #10 and connect to feeder circuit #9 to re-energize the 15kV switchgear. Upon the restoration of feeder circuit #10, the automatic throw-over can automatically, or manually, be reconnected to feeder circuit #10 and disconnected from feeder circuit #9.

4. REVIEW OF OPTIONS

4.1 Option 1

Replace existing switchgear with new, exterior mounted pad mounted transformers on the north side of the building and new 480 volt switchgear in basement.

Refer to Site Plan, in Appendix C, for a proposed location for the pad mounted transformers. The ductbank would be routed parallel to the existing ductbank along the north side of 9th Street. The transformers would need to be placed on approximately 10-foot square concrete pads, for support. The primary conductors will be routed underground from the existing Westar Energy manhole at the northeast corner of 9th and Harrison.

On the secondary of the transformers, the use of conduit and wiring to route the 5,000 Amps, at 480 Volts, is not a viable option. Please refer to the Appendix D for calculations for a 44 duct underground ductbank. The mutual heating from adjacent conduits greatly limits the current carrying capacity of the ductbank conductors. Therefore, the only viable option is the use of 5,000 Amp weatherproof bus duct. The bus duct would need to be routed overhead as the bus duct cannot be installed underground. From the secondary of each transformer the bus duct would be routed on a support structure to allow the bus duct to get to the ceiling under the second floor overhang. At this point the bus duct could be supported from the structure above. The bus duct would need to penetrate the building exterior wall above grade. Therefore, the bus duct will enter the first floor interior space and a new chase would need to be built to enclose the bus duct until it reaches the floor level.

The existing auditorium in the basement is too small for the installation of the new electrical gear. The existing interior wall would need to be removed and a new wall, another column line west, would need to be constructed. Per the National Electrical Code (NEC) two emergency exits are required from this room. Some modifications may need to be made at the corridor door to allow for an outward swinging door into the

hallway. A second exit door could be installed either at the west end of the new room or into the room to the south.

The new transformers and overhead weatherproof bus duct will be exposed on the north side of the building which may not be an ascetically pleasing view from the Capitol.

4.2 Option 2

Replace existing switchgear with new, exterior mounted substation transformers on the south side of the building in the existing areaway and new 480 volt switchgear in basement.

Refer to Site Plan, in Appendix C, for a proposed location for the outdoor mounted transformers. The new ductbank will be routed from the existing manhole at the intersection of 9th and Harrison. From this location, a ductbank would be routed on the west side of Harrison Street, to the south end of the building. Here the ductbank would travel west to the existing areaway where cooling towers were originally housed. The primary conductors will be routed underground from the existing Westar Energy manhole at the northeast corner of 9th and Harrison to the south areaway.

There is a large amount of ductbank to be installed to get the underground electrical service to this location. Along Topeka Boulevard there is an existing 12.5kV overhead electrical line. The disadvantages to utilizing this circuit to supply power to the building are two fold. The first is that the line is overhead and is susceptible to squirrels, trees, and lightning strikes. The second is that there is only one circuit thereby not allow for a redundant feed.

Placing the transformers in the existing areaway allows for the transformers to be placed outside of the building, yet placing them in an area that is not visible at grade level. The heat from the transformers is kept out of the building so the building cooling load would be less than the existing.

Routing of the 5,000 Amp overhead weatherproof bus duct from the transformers into the building can also be contained below grade level. All supports are below grade and the exterior wall penetrations are below grade, but not underground.

The placement of the 480 Volt switchgear on the south end of the building puts the electrical gear closer to the larger loads, thereby eliminating the need to route 2,000 Amp bus duct from the north end of the building to the large electrical loads on the south end of the building.

4.3 Option 3

Construct new Westar Energy Ductbank along the east side of Harrison Street to the intersection of 10th Street.

The existing underground electrical network, around the Capitol complex, does not currently extend south to the 10th and Harrison intersection. As an option to installing a four (4) 6-inch conduit ductbank along the west side of Harrison from 9th to 10th, another possible option is to install a ductbank meeting Westar Energy's requirements, along the east side of Harrison, extending the existing underground network. This will allow for future load expansion to the east of this location.

With this option, a larger ductbank, than what is required to feed the new building transformers located in the south areaway, will be required to be built.

4.4 Option 4

Replace existing switchgear with new double-ended switchgear in basement at north end of building, including transformers.

As indicated in Option 1, the new switchgear could be installed in the area of the existing auditorium. This option, however, adds the new 13.2kV to 480/277 Volt transformers to this line-up. This allows the ductbank to be built along the north side of the Docking State Office Building and the ductbank would enter the building below grade, thereby not being visible and somewhat unsightly.

The transformers would add heat to this area and the need for cooling/ventilation would need to be addressed.

The biggest concern is being able to place the transformers in the basement room. The transformers are approximately 5-feet wide and 8-feet long. This becomes a problem to navigate the transformer through the building. The transformer is 102-inches tall and would require the removal of lighting fixtures, smoke detectors, and the opening of several doorways to allow for passage. Additionally, each transformer weighs approximately 10 tons. The existing floor design of the basement hallway will not support this great of a load without shoring up the floor from below. Photograph 5 shows one of the doorways that would need to be opened to make room for the transformers. Additionally, the existing lighting fixture, exit sign, and fire alarm annunciator would need to be removed to allow for passage of the 102-inch tall transformer.

4.5 Option 5

Replace existing 15kV switchgear with new at north end of basement.



Photograph 5: DSOB South Arealway

With this option, all new 15kV switchgear, cabling, and unit substations would be replaced with new. The existing ductbank would be modified to route the 15kV cables to the new electrical equipment location. The 13.2kV would be routed into the building underground from the existing manhole at 9th and Harrison to the building basement. The only transformers required in the building would be to step-down from 13.2kV to either 480 or 120/208 Volt for utilization. Due to the higher voltage level, the size of the cabling and bus duct would be smaller as they are routed through the building.

Unfortunately, the new 15kV bus duct construction is not much different now than it was 50 years ago. The bus duct, rather than being a “sandwiched” construction as it would be for 600 Volt, is a metal enclosed bus duct, very similar to the existing. The main difference is the that copper bus bars are insulated the entire length thereby eliminating the concern over contact with energized bus or the arcing and tracking that is currently a concern with the exposed copper bus bars in the 15kV bus duct.

A disadvantage is that 13.2kV will be routed through the building and the same concern that applies now with not having trained personnel to service and maintain this equipment, would still exist.

An estimated construction cost is not provided for this alternative.

5. ESTIMATED CONSTRUCTION COSTS

The costs for each option were assembled to provide a basic order of magnitude. A 15% contingency has been added to each option to cover any unforeseen construction expenses that will only become known during the design portion of the project. The source of the costs varies from Westar Energy, Square D Schneider Electric, to RSMeans Electrical Cost Data 2011. Backup information is available in the Appendix H. These estimates do not include expenses for design or construction administration.

Option 1 - \$5,850,000

Option 2 - \$6,650,000

Option 3 - \$6,650,000

Option 4 - \$6,450,000

Option 5 - Not Priced

6. CONCLUSION

6.1 Summary

Several options were identified and investigated to determine a general approach and basic order of magnitude cost for the electrical upgrade. The age of the existing equipment along with the potential operational hazards of routing metal enclosed, open copper bussing, through the building and vertically through the floors without firestopping at each floor necessitates the upgrade of the electrical distribution system with new, state-of-the-art equipment.

Refer to Appendix E for a Proposed Line-up of the new electrical distribution system. The placement of the transformers varies depending upon the option presented, but the basic system layout is represented.

The placing of pad mounted transformers on the front lawn (north side) of the building, along with overhead 5,000 Amp weatherproof bus duct makes for an unappealing visual arrangement. Additionally, the 5,000 Amp bus ducts would need to be supported from the bottom of the second floor deck over the drive area, and interior space would need to be occupied by the vertical bus duct run to the basement and concealed in a new utility chase.

Installing new 3,750 kVA, 13.2kV to 480/277 Volt transformers with main-tie-main 480 Volt switchgear allows for a confined electrical distribution system arrangement. However, physically installing the new transformers, with a weight of nearly 10 tons provides a structural obstacle as well as the physical dimensions of a 5-foot x 8-foot footprint, with a 102-inch overall height provides a maneuverability obstacle to bringing the transformers in the overhead door near the dock and then transporting down the hallways to the north end of the basement. At least three (3) hallway doorways will need to be modified to slip the transformer in the building and structural bracing will be required to roll the transformers on the basement floor. Additionally, permanent structural modifications will be required in the new electrical room to support the weight of the transformers.

Installing the new 3,750 kVA transformers in the south areaway, which originally housed cooling towers, allows for placement by crane from an exterior location. The transformers, while still outside of the building, are concealed below the grate cover from view. The new 480 Volt switchgear can be installed in a new electrical room in the south end of the building, closer to the larger electrical loads (CCM1 and CCM2) thereby reducing the required length, and cost, of 2,000 Amp, 480 Volt bus duct.

If the transformers and new switchgear are located in the south areaway, Westar has expressed the desire to extend their existing ductbank system to the corner of the 10th and Harrison. From this point, a new ductbank would be extended to the south areaway. This approach varies from Option 2 in the fact that the north-south ductbank will be built by Westar to Westar standards on the east side of the Harrison and the state would only build the ductbank from the 10th Street and Harrison Street intersection manhole, to the west. The state would not need to build the ductbank on the west side of Harrison Street. This approach allows the utility to extend its underground network and the new transformers can be hidden from sight. This also keeps the electrical and mechanical equipment in the utility part of the building and frees up space for storage, meeting, or office space.

LOCHNER

BWR Division

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Page 1

10th. Floor Mech.

Tag ID 1480 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
Serial # 997326	Manufacturer square d	Model U/O	

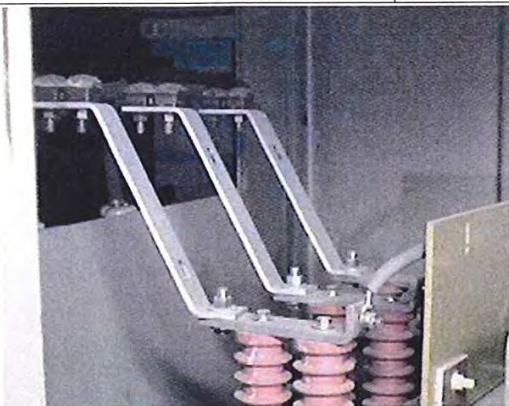


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Tag ID 1481 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
# J	Manufacturer Federal Pacific	Model 50662-001	



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Equipment Inventory - Short Form with Images

Page 2

11th. Floor Mech.

Tag ID 1482 Distribution Panel Single Front (≥ 400 amp)		Equipment Type Distribution Panel Single Front (≥ 400 amp)	
Serial # 997326	Manufacturer square d	Model U/O	



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Tag ID 1483 5-15kV Dry Transformers ≤ 500 kVA		Equipment Type 5-15kV Dry Transformers ≤ 500 kVA	
# .0	Manufacturer Federal Pacific	Model 50662-003	



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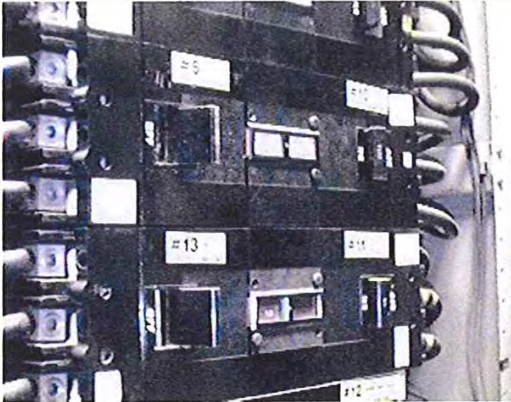
02, 2009

Equipment Inventory - Short Form with Images

Page 3

12th. Floor Mech.

Tag ID 1484 Distribution Panel Single Front (≥ 400 amp)		Equipment Type Distribution Panel Single Front (≥ 400 amp)
Serial # 997319	Manufacturer square d	Model U/O

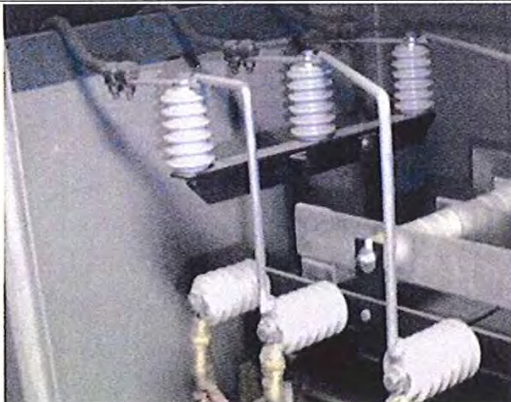


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Tag ID 1485 5-15kV Dry Transformers ≤ 500 kVA		Equipment Type 5-15kV Dry Transformers ≤ 500 kVA
Inst # .0	Manufacturer niagra	Model 49951



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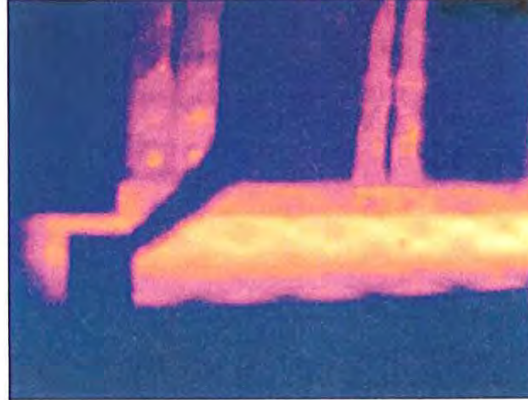
Page 4

13th Floor Mech.

Tag ID 1486-A Phase 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # gm238446	Manufacturer sola basic	Model 1755406t00



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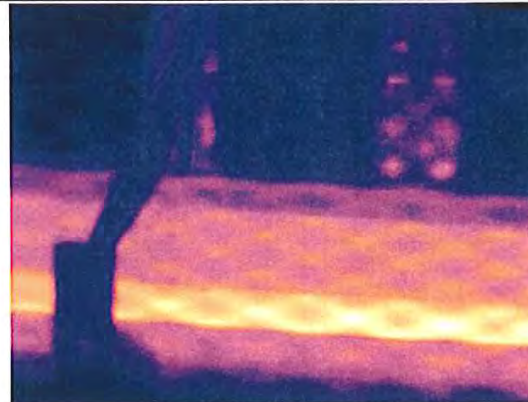


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Tag ID 1486-B Phase 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # n238446	Manufacturer sola basic	Model 1755406t00



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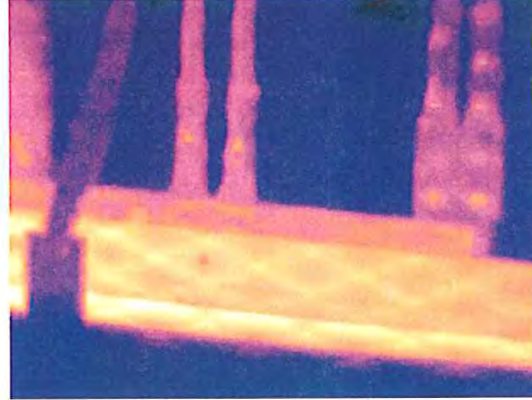
Page 5

13th Floor Mech.

Tag ID 1486-C Phase 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # gm238446	Manufacturer sola basic	Model 1755406t00

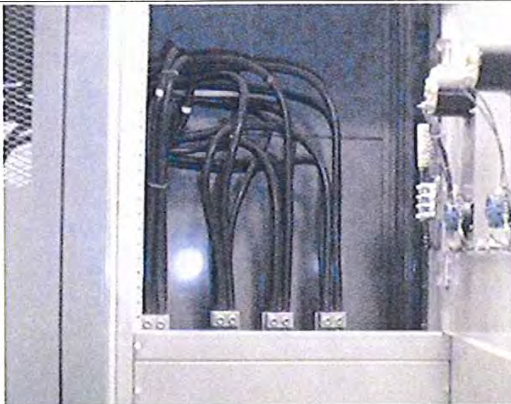


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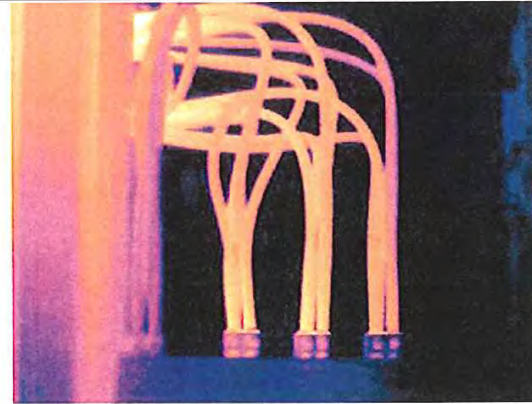


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Tag ID 1487 DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)		Equipment Type DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)
I #	Manufacturer ITE	Model 17-41220-1



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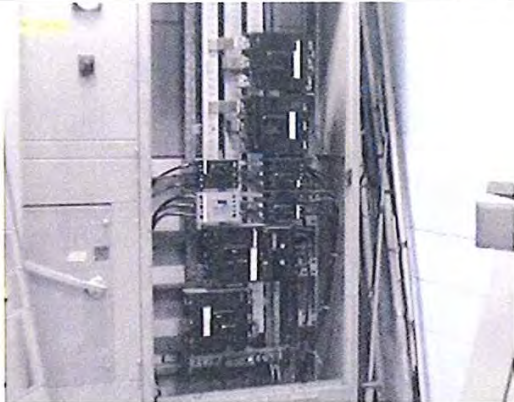
72, 2009

Equipment Inventory - Short Form with Images

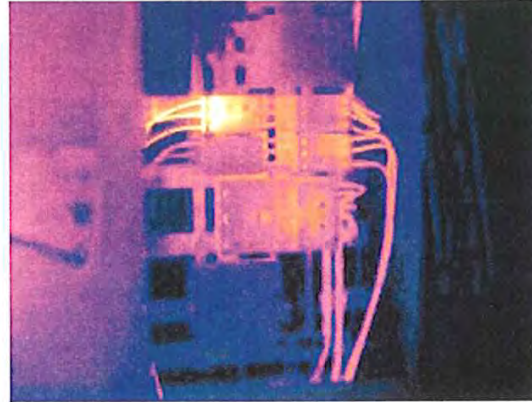
Page 6

13th Floor Mech.

Tag ID 1488 DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)		Equipment Type DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
Serial # 6	Manufacturer ITE	Model 17-41220-1	



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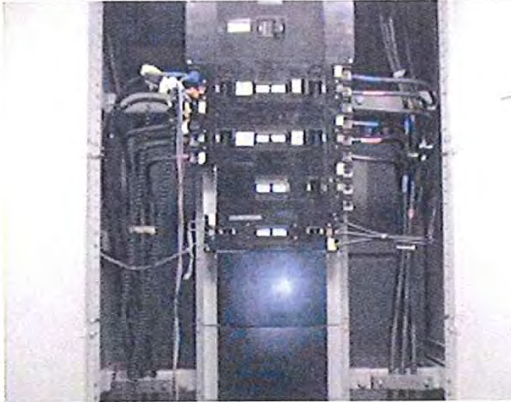
2, 2009

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Page 7

14th Floor Mech.

Tag ID 1489 Distribution Panel Single Front (≥ 400 amp)		Equipment Type Distribution Panel Single Front (≥ 400 amp)	
Serial # 997318	Manufacturer square d	Model U/O	

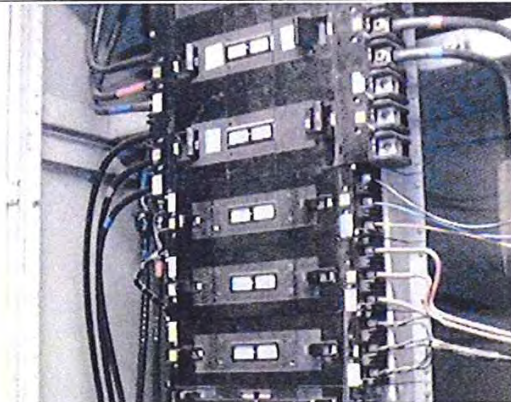


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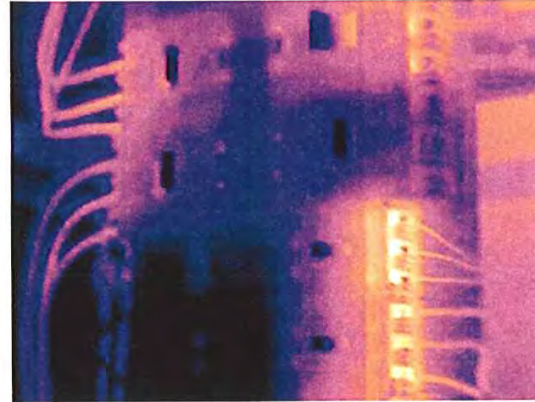


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Tag ID 1490 Distribution Panel Single Front (≥ 400 amp)		Equipment Type Distribution Panel Single Front (≥ 400 amp)	
I # J9350	Manufacturer square d	Model U/O	



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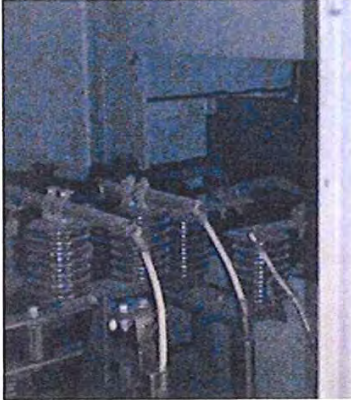
2, 2009

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Page 8

14th Floor Mech.

Tag ID 1491 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # u/o	Manufacturer allis chalmers	Model 2887380



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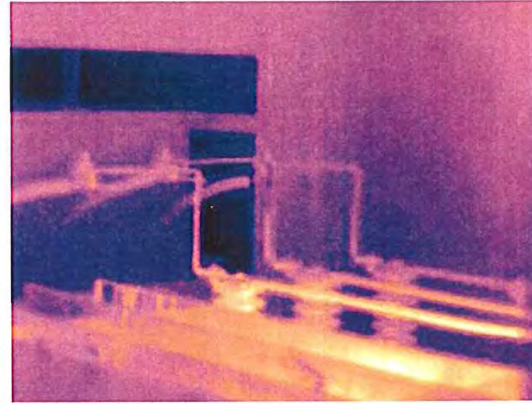


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Tag ID 1492 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
I # 0	Manufacturer allis chalmers	Model 2887379



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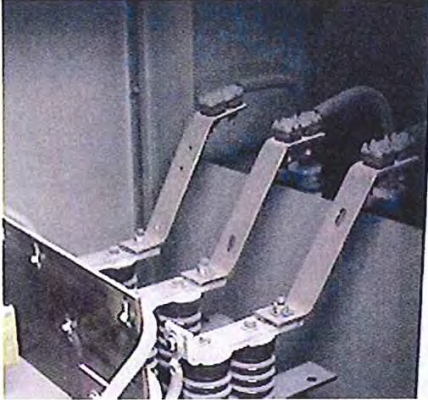
12, 2009

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Page 9

2nd Floor Mech.

Tag ID 1459 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # u/o	Manufacturer Federal Pacific	Model 50150-003



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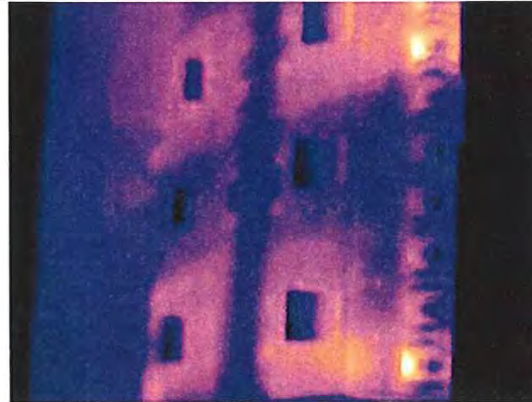


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Tag ID 1460 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)
Serial # 37326	Manufacturer square d	Model U/O



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2nd Floor Mech.

Tag ID 1461 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # u/o	Manufacturer Federal Pacific	Model 50150-002

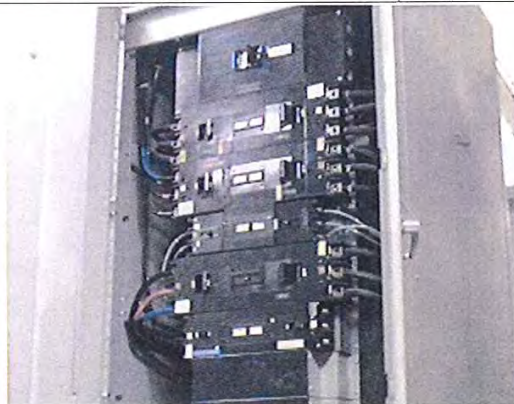


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Tag ID 1462 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)
I # J7326	Manufacturer square d	Model U/O



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3rd. Floor Mech.

Tag ID 1463 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
Serial # u/o	Manufacturer Federal Pacific	Model 50662-005	

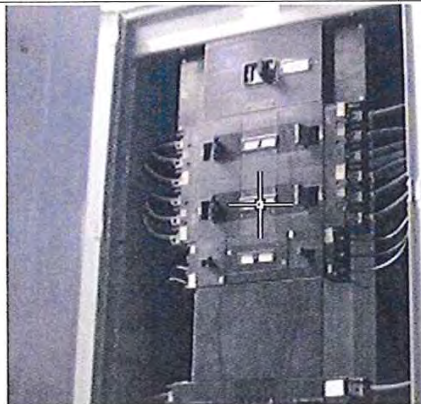


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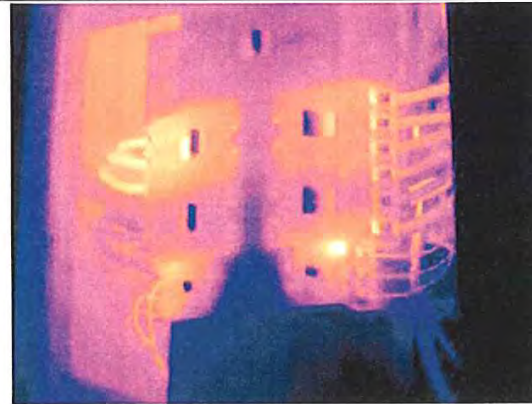


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Tag ID 1464 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
Serial # 99370	Manufacturer square d	Model U/O	



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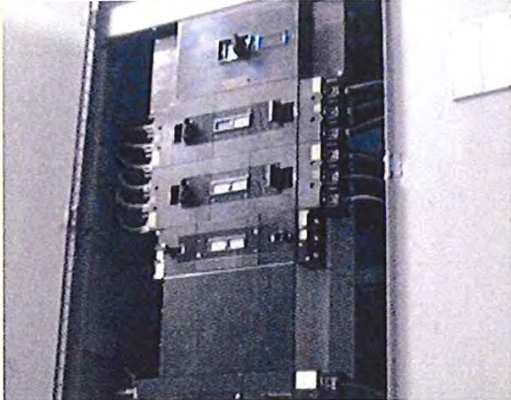
2, 2009

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3rd. Floor Mech.

Tag ID 1465 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)
Serial # 997318	Manufacturer square d	Model U/O



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Tag ID 1466 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
# 0	Manufacturer niagra	Model 51131



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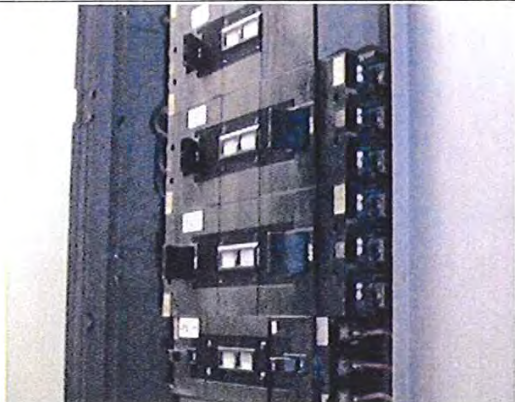
2, 2009

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3rd. Floor Mech.

Tag ID 1467 Distribution Panel Single Front (≥ 400 amp)		Equipment Type Distribution Panel Single Front (≥ 400 amp)
Serial # 997318	Manufacturer square d	Model U/O

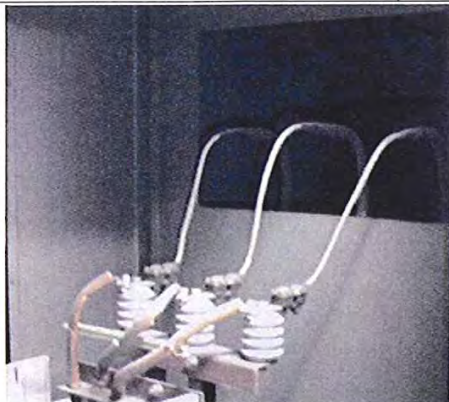


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Tag ID 1468 5-15kV Dry Transformers ≤ 500 kVA		Equipment Type 5-15kV Dry Transformers ≤ 500 kVA
Tag # ...0	Manufacturer niagra	Model 51132



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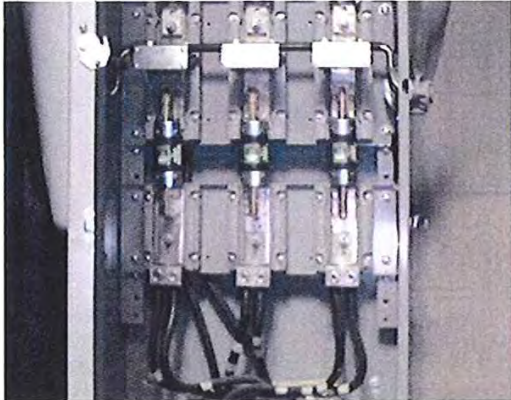
12, 2009

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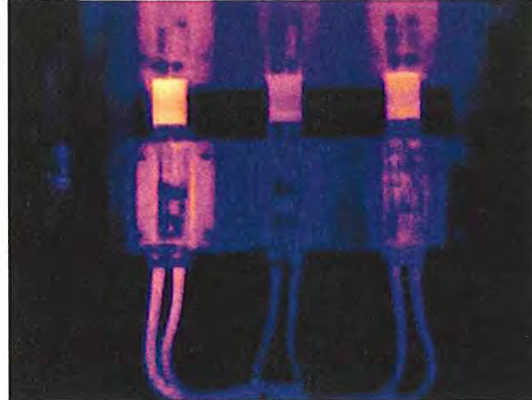
Page 14

3rd. Floor Mech.

Tag ID 1469 Individual Disconnect Switch		Equipment Type Individual Disconnect Switch
Serial # u/o	Manufacturer ITE	Model jn-425



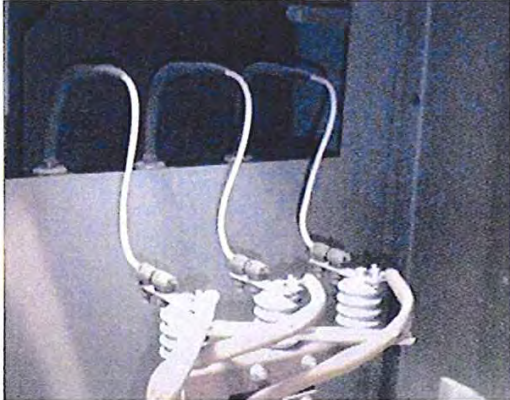
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5th. Floor Mech.

Tag ID 1470 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # u/o	Manufacturer niagra	Model 51134

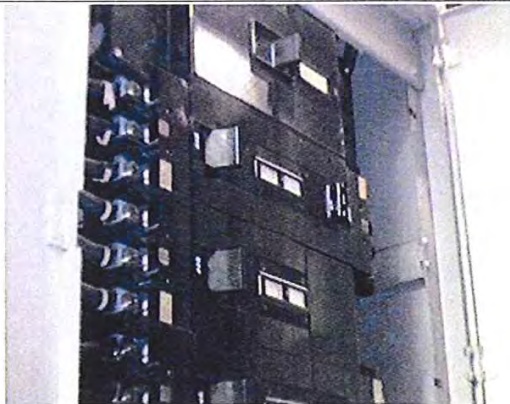


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Tag ID 1471 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)
I # J7326	Manufacturer square d	Model U/O



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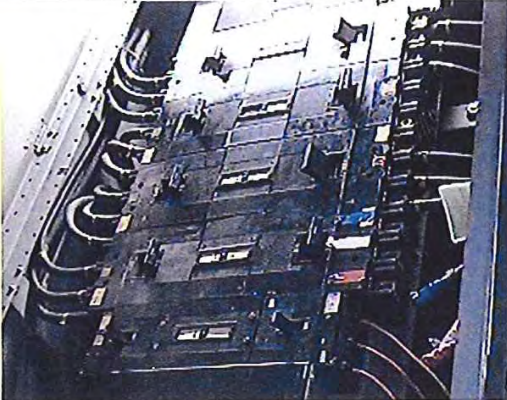
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6th. Floor Mech.

Tag ID 1472 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
Serial # 997318	Manufacturer square d	Model U/O	

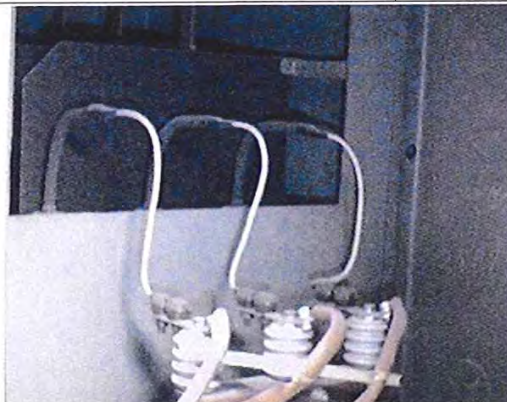


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Tag ID 1473 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
Serial # U/O	Manufacturer niagra	Model 51130	



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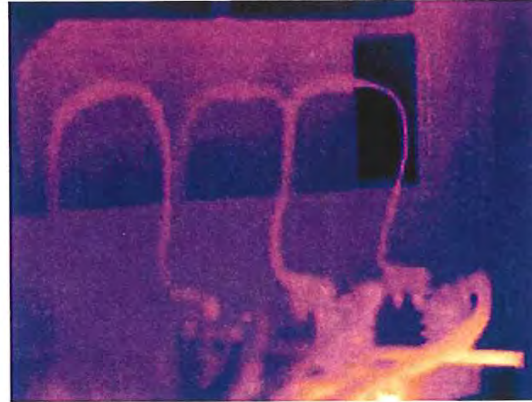
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7th. Floor Mech.

Tag ID 1474 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # u/o	Manufacturer niagra	Model 51133

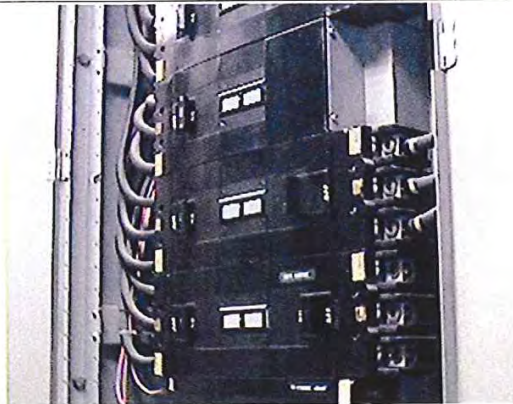


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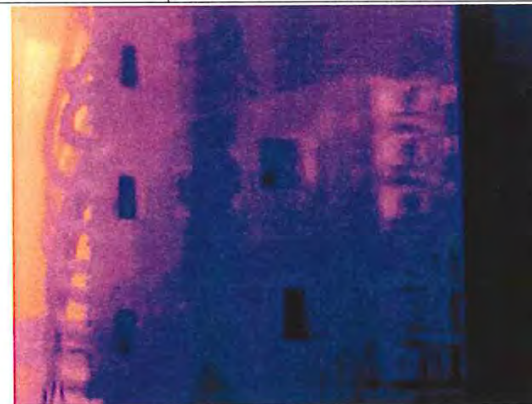


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Tag ID 1475 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)
Serial # 97318	Manufacturer square d	Model U/O



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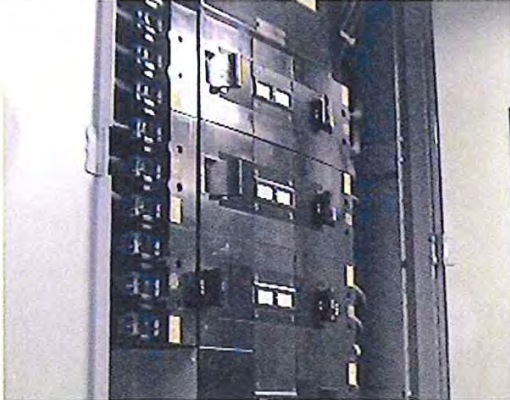
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8th. Floor Mech.

Tag ID 1476 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
Serial # 997318	Manufacturer square d	Model U/O	



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Tag ID 1477 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
Serial # U/O	Manufacturer niagra	Model 51129	



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9th. Floor Mech.

Tag ID 1478 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
Serial # 997326	Manufacturer square d	Model U/O	

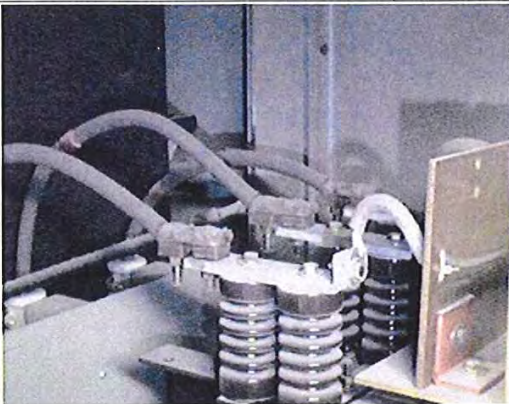


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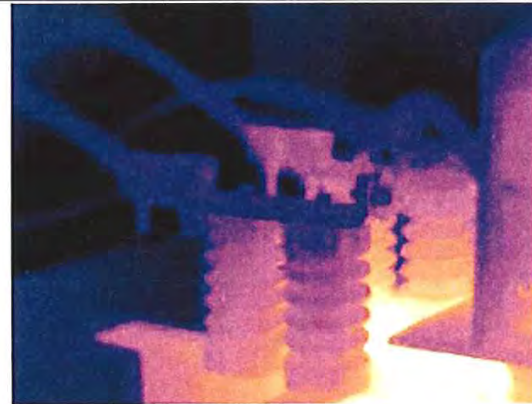


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Tag ID 1479 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
I # .0	Manufacturer Federal Pacific	Model 50150-001	



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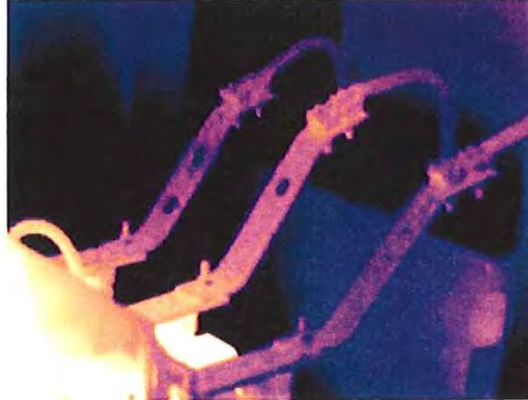
Page 20

1st Floor Air Handler Room

Tag ID 1457 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA
Serial # u/o	Manufacturer Federal Pacific	Model 50150-004

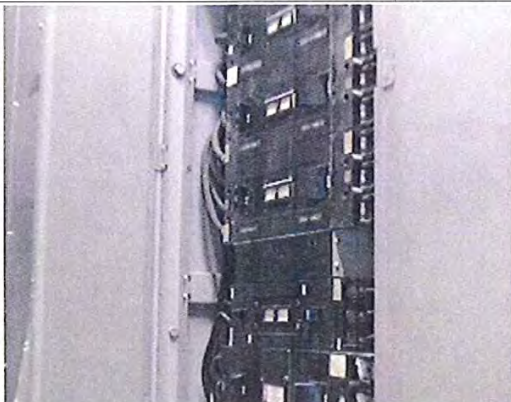


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Tag ID 1458 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)
I # 0	Manufacturer square d	Model 999370



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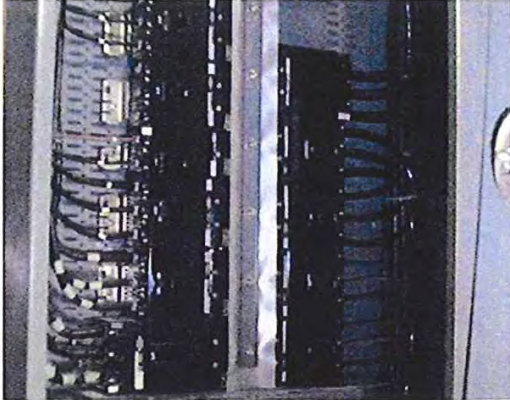
12, 2009

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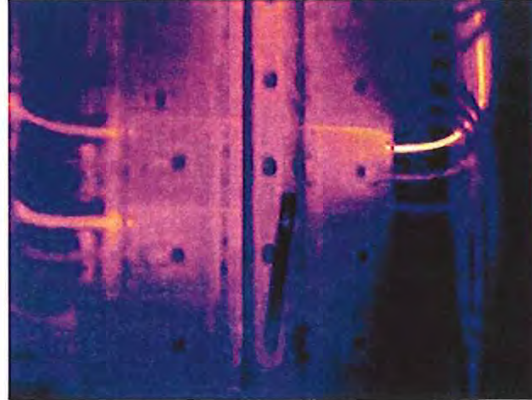
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Basement Air Handler Room

Tag ID 1445 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
Serial # 3	Manufacturer square d	Model 3256-4	



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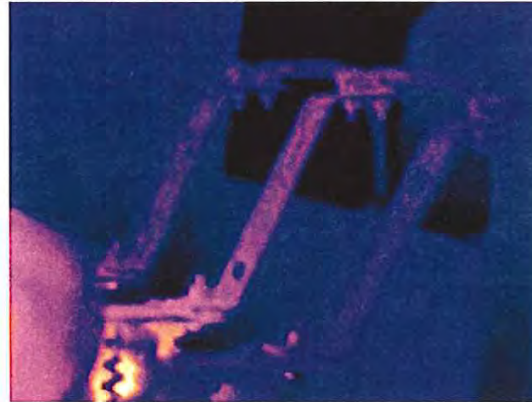


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Tag ID 1446 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
I # 0	Manufacturer Federal Pacific	Model 50662-004	



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Equipment Inventory - Short Form with Images

Page 22

Basement Air Handler Room

Tag ID 1447 Distribution Panel Single Front (≥ 400 amp)		Equipment Type Distribution Panel Single Front (≥ 400 amp)	
Serial # u/o	Manufacturer square d	Model U/O	



S37\EI19953.jpg



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12/22/2009

Equipment Inventory - Short Form with Images

Page 23

Main Switch Gear

Tag ID 1448 5-15kV Switchgear		Equipment Type 5-15kV Switchgear	
Serial # cd-109102	Manufacturer S & C Electric Company	Model cd-389002	



S37\EI19930.jpg

Tag ID 1449 5-15kV Switchgear		Equipment Type 5-15kV Switchgear	
Serial # J-109102	Manufacturer S & C Electric Company	Model cd-389002	



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02, 2009

Equipment Inventory - Short Form with Images

Page 24

Main Switch Gear

Tag ID 1450 5-15kV Switchgear		Equipment Type 5-15kV Switchgear	
Serial # cd-109102	Manufacturer S & C Electric Company	Model cd-389002	



S37\EI19928.jpg

Tag ID 1451 5-15kV Switchgear		Equipment Type 5-15kV Switchgear	
Serial # cd-109102	Manufacturer S & C Electric Company	Model cd-389002	



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12, 2009

Equipment Inventory - Short Form with Images

Page 25

Main Switch Gear

<i>Tag ID</i> 1452 5-15kV Switchgear		<i>Equipment Type</i> 5-15kV Switchgear	
<i>Serial #</i> cd-109102	<i>Manufacturer</i> S & C Electric Company	<i>Model</i> cd-389002	



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<i>Tag ID</i> 1453 5-15kV Switchgear		<i>Equipment Type</i> 5-15kV Switchgear	
<i>Serial #</i> J-109102	<i>Manufacturer</i> S & C Electric Company	<i>Model</i> cd-389002	



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12, 2009

Equipment Inventory - Short Form with Images

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Main Switch Gear

Tag ID 1454 5-15kV Switchgear		Equipment Type 5-15kV Switchgear	
Serial # cd-109102	Manufacturer S & C Electric Company	Model cd-389002	



S37\EI19924.jpg

Tag ID 1455 5-15kV Switchgear		Equipment Type 5-15kV Switchgear	
I# J-109102	Manufacturer S & C Electric Company	Model cd-389002	



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Main Switch Gear

<i>Tag ID</i> 1456 5-15kV Switchgear		<i>Equipment Type</i> 5-15kV Switchgear	
<i>Serial #</i> cd-109102	<i>Manufacturer</i> S & C Electric Company	<i>Model</i> cd-389002	



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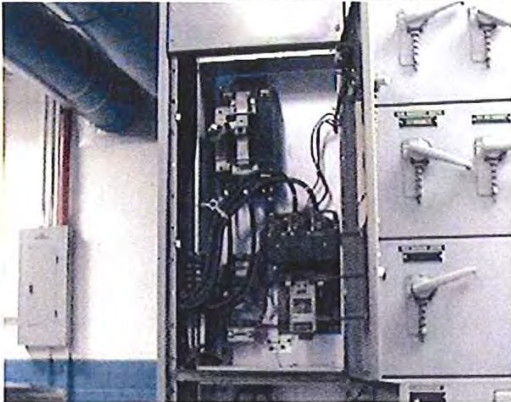
2, 2009

Equipment Inventory - Short Form with Images

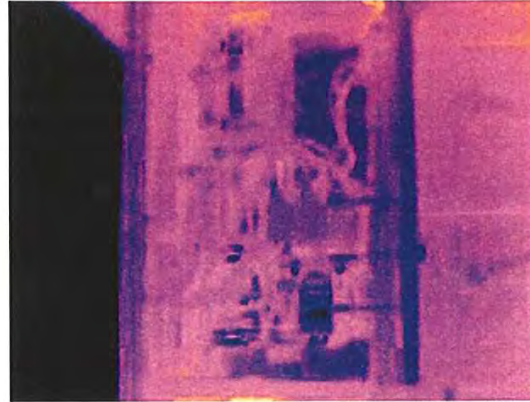
Page 28

Mezzanine

Tag ID 1427 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # 306097-a1	Manufacturer square d	Model wk122fa2166

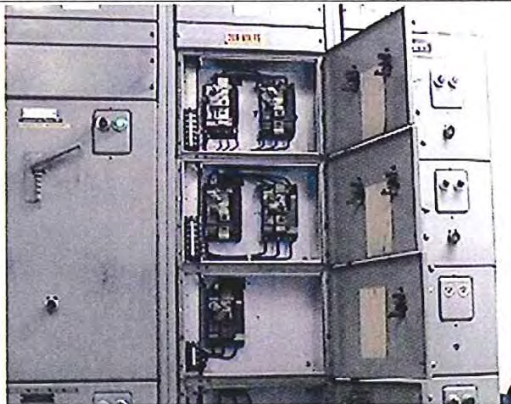


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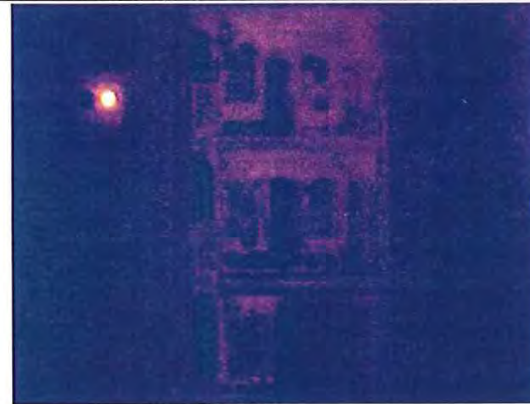


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Tag ID 1428 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
I# J6097-a1	Manufacturer square d	Model wk122fa2166



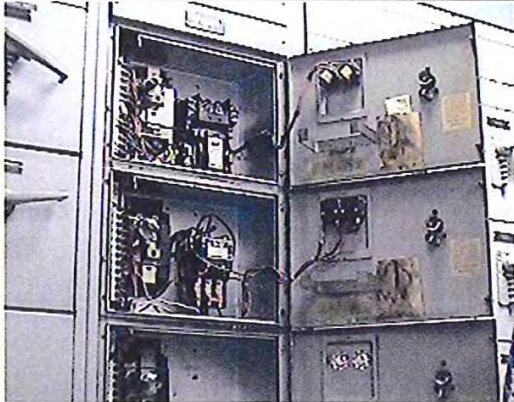
S37\EI19946.jpg



S37\BIR19946.jpg

Mezzanine

Tag ID 1429 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # 306097-a1	Manufacturer square d	Model wk122fa2166



S37\EI19947.jpg



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Tag ID 1430 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # J6097-a1	Manufacturer square d	Model wk122fa2166



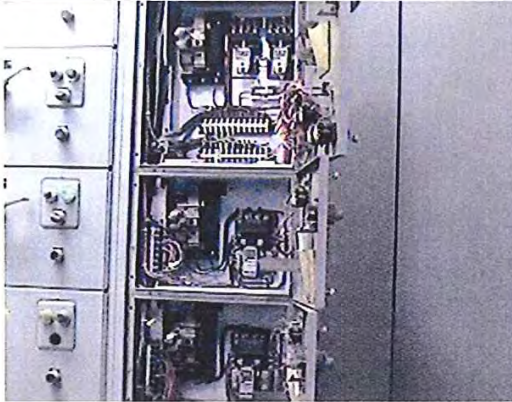
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Mezzanine

Tag ID 1431 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)	
Serial # 306097-a1	Manufacturer square d	Model wk122fa2166	

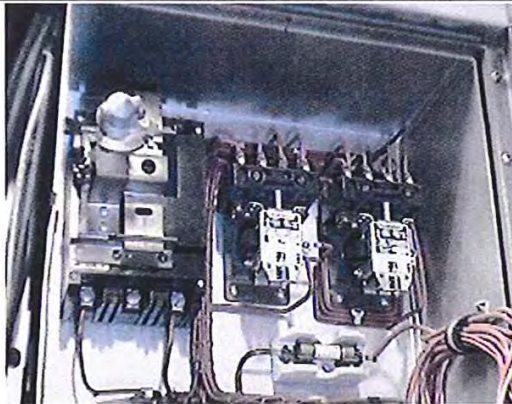


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Tag ID 1432 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)	
Serial # J6097-a1	Manufacturer square d	Model wk122fa2166	



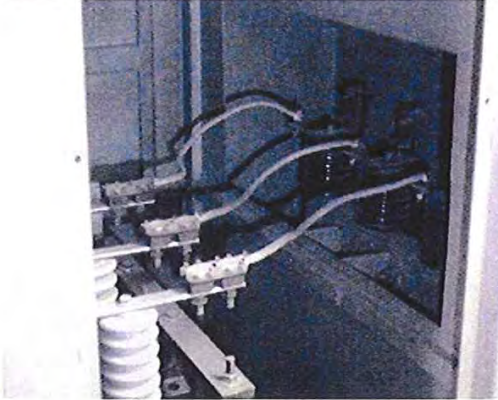
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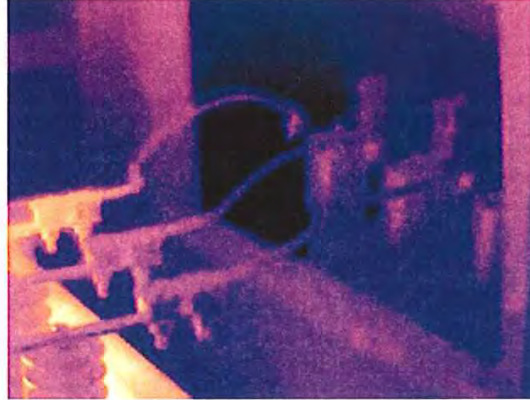
S37\BIR19939.jpg

Mezzanine

Tag ID 1433 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
Serial # t862853606-2	Manufacturer allis chalmers	Model 10873	

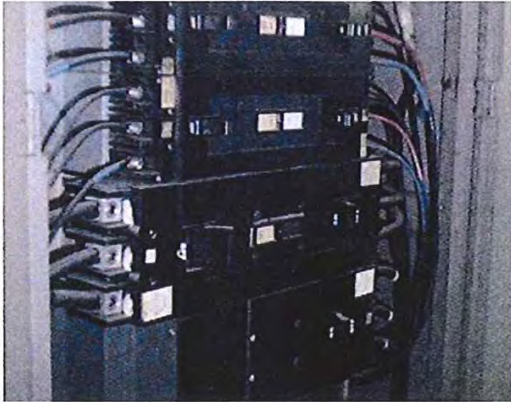


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Tag ID 1434 Distribution Panel Single Front (>= 400 amp)		Equipment Type Distribution Panel Single Front (>= 400 amp)	
I # .62853606-2	Manufacturer square d	Model U/O	



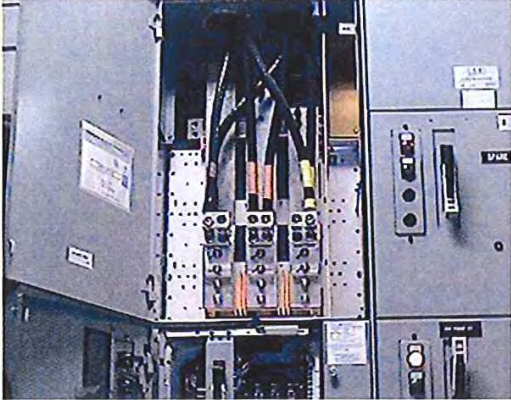
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Mezzanine

Tag ID 1435 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # u/o	Manufacturer sieman	Model 89bfu2g9q001

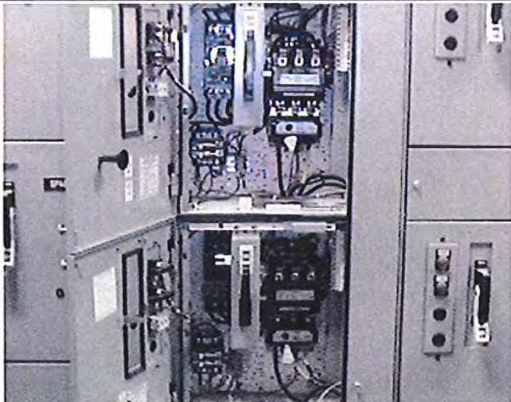


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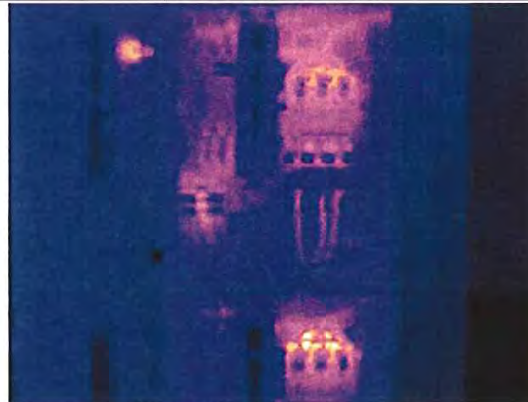


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Tag ID 1436 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # u/o	Manufacturer sieman	Model 89bfu2g9q001



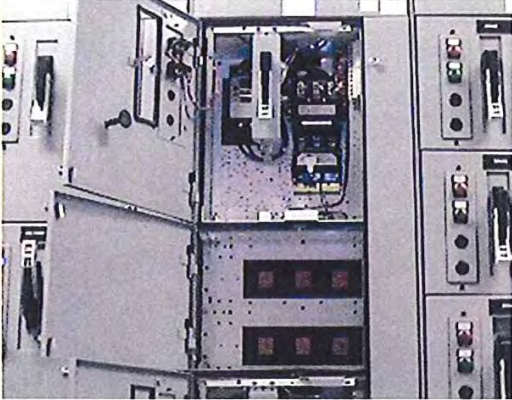
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Mezzanine

Tag ID 1437 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # u/o	Manufacturer sieman	Model 89bfu2g9q001

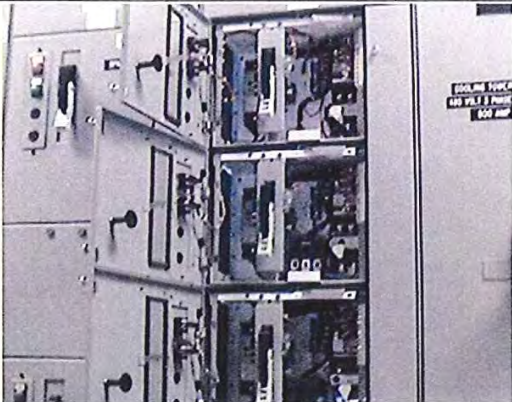


S37\EI19942.jpg



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Tag ID 1438 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)
Serial # J	Manufacturer sieman	Model 89bfu2g9q001



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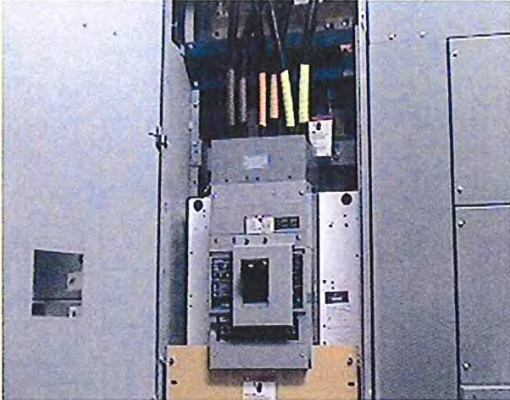
2, 2009

Equipment Inventory - Short Form with Images

Page 34

Mezzanine

Tag ID 1439 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)	
Serial # u/o	Manufacturer sieman	Model 89bfu2g9q001	

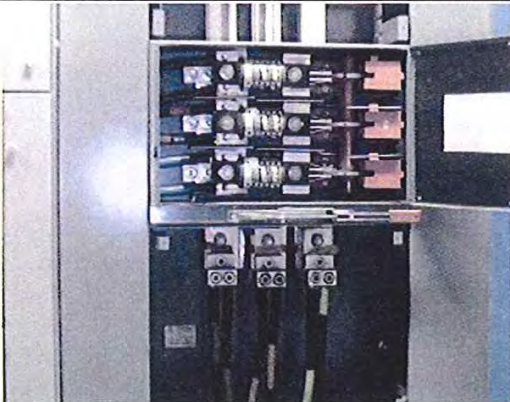


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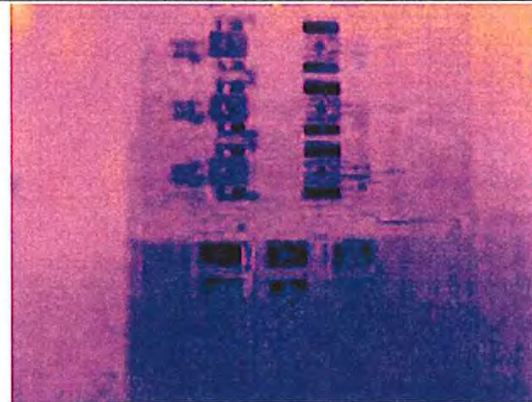


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Tag ID 1440 Motor Control Center (Per vertical section)		Equipment Type Motor Control Center (Per vertical section)	
I# 1	Manufacturer square d	Model 4590-8	



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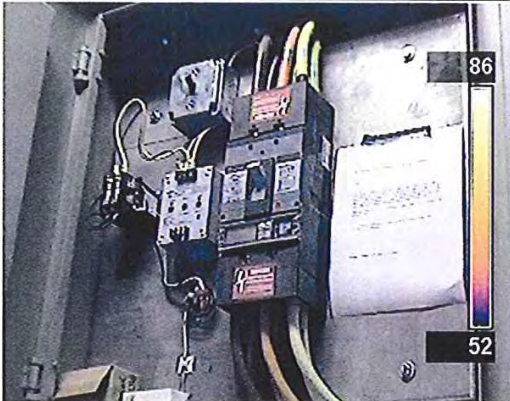
2, 2009

Equipment Inventory - Short Form with Images

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Mezzanine

Tag ID 1441 Switchgear - Incoming Main Service (Per Section)	Equipment Type Switchgear - Incoming Main Service (Per Section)	
Serial # 2-1468-24540	Manufacturer allis chalmers	Model arc-216b

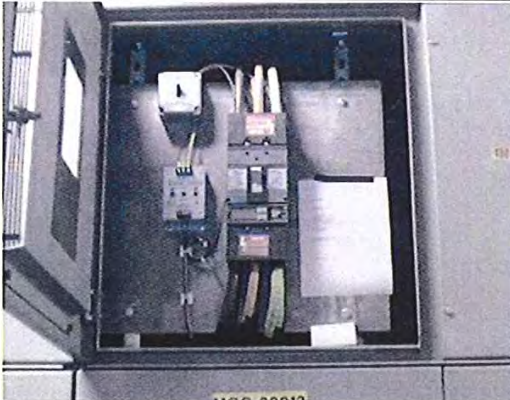


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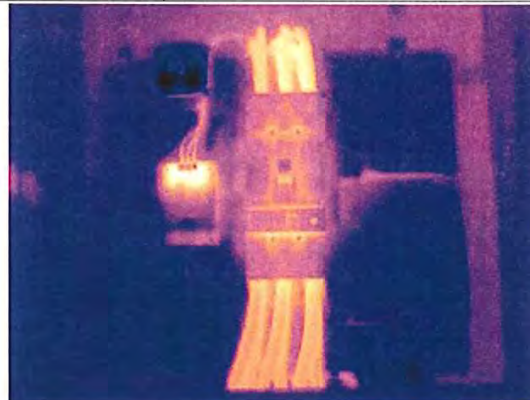


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Tag ID 1442 Switchgear - Incoming Main Service (Per Section)	Equipment Type Switchgear - Incoming Main Service (Per Section)	
Serial # 1468-24540	Manufacturer allis chalmers	Model arc-216b



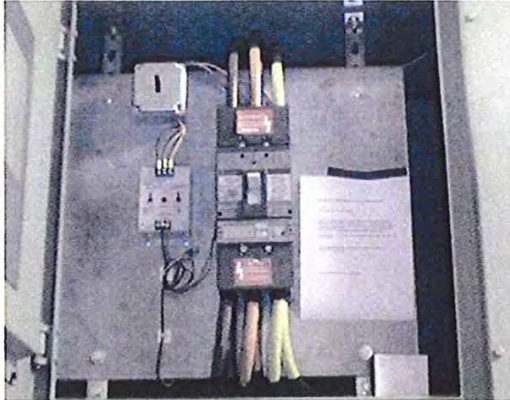
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Mezzanine

Tag ID 1443 Switchgear - Incoming Main Service (Per Section)		Equipment Type Switchgear - Incoming Main Service (Per Section)	
Serial # 2-1468-24540	Manufacturer allis chalmers	Model arc-216b	

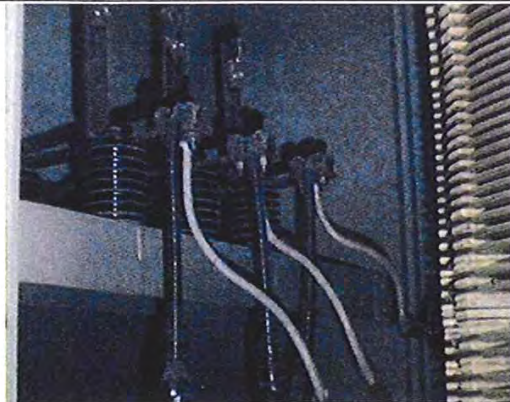


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Tag ID 1444 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA	
U# .0	Manufacturer allis chalmers	Model 2887383	



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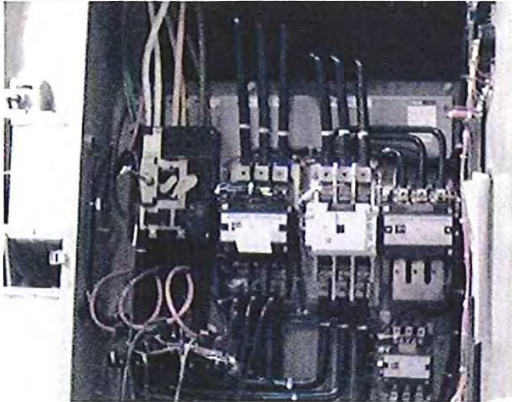
22, 2009

Equipment Inventory - Short Form with Images

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Mezzanine

Tag ID chiller 1 MCC: Motor Starters		Equipment Type MCC: Motor Starters	
Serial # U/O	Manufacturer Cutler Hammer	Model U/O	

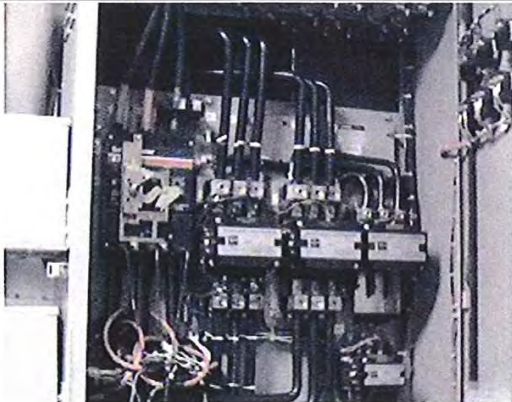


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Tag ID chiller 2 MCC: Motor Starters		Equipment Type MCC: Motor Starters	
Serial # U/O	Manufacturer Cutler Hammer	Model U/O	



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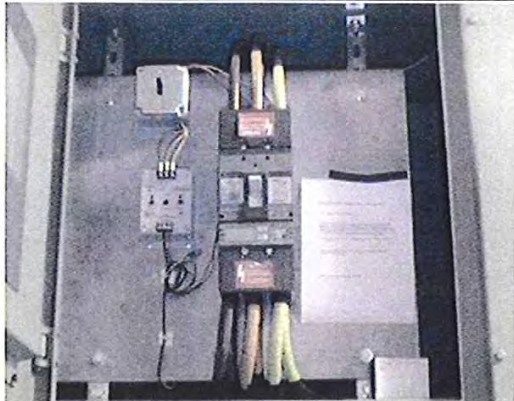
12, 2009

Equipment Inventory - Short Form with Images

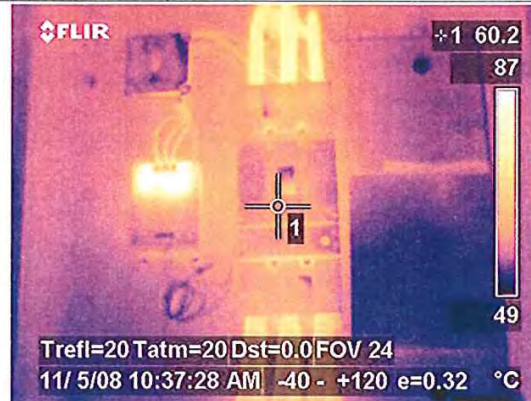
Page 38

Mezzanine

<i>Tag ID</i> chiller 3 MCC: Motor Starters		<i>Equipment Type</i> MCC: Motor Starters	
<i>Serial #</i> U/O	<i>Manufacturer</i> Cutler Hammer	<i>Model</i> U/O	



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03/2008

Infrared Inspection Report Sheet

Page 2A

Technician

Clint Gottschalk

Location

10th. Floor Mech.

Tag ID

1480 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
51.6C	86.8C	35.2C

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 11	70	16	6	.323
Phase B	breaker 11	70	23	7	.010
Phase C	breaker 11	70	22	7	.002

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_a_" Phase breaker contact is displaying abnormal thermal pattern compared to "_b_" and "_c_" Phase contacts and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

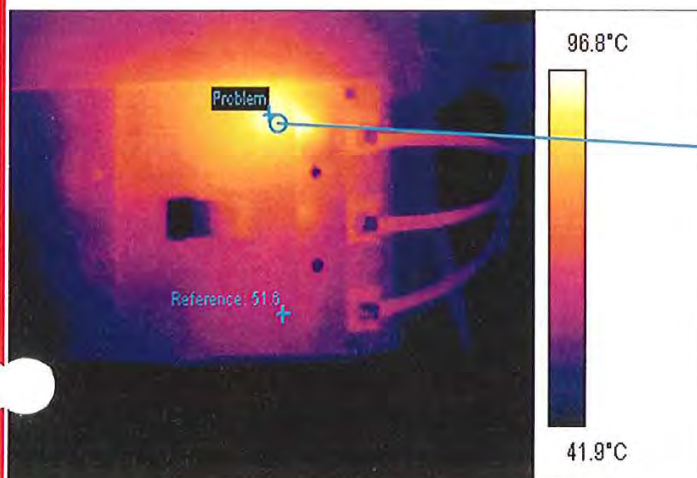
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

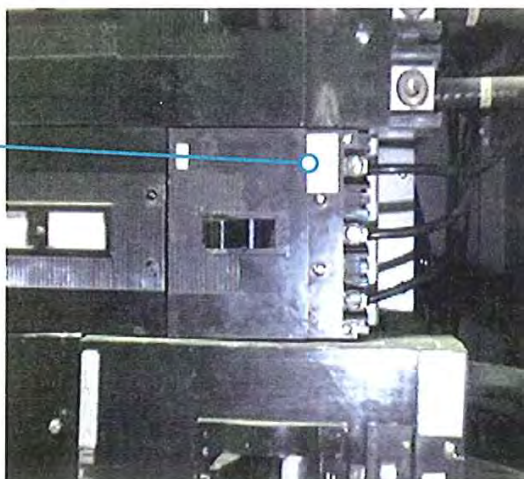
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62\IR_2961.jpg



62\DC_2962.jpg



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Infrared Inspection Report Sheet

Page 2B

7/3/2008

Technician

Clint Gottschalk

Location

10th. Floor Mech.

Tag ID

1480 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

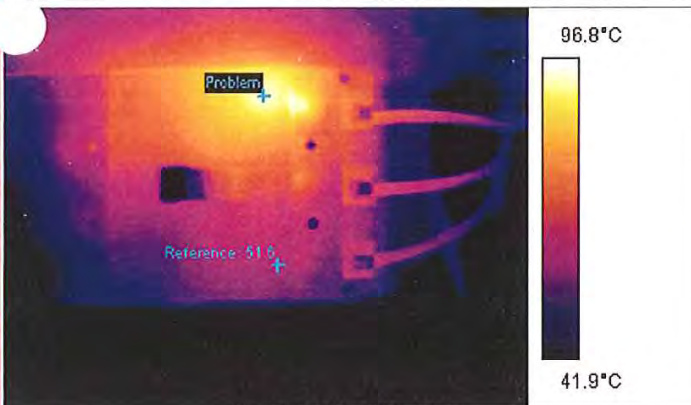
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



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621DC_2962.jpg



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3/2008

Infrared Inspection Report Sheet

Page 3A

Technician

Clint Gottschalk

Location

11th. Floor Mech.

Tag ID

1482 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
33.9C	40.4C	6.4C

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 9	150	30	34	.002
Phase B	breaker 9	150	48	14	.009
Phase C	breaker 9	150	32	32	.008

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_b_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_c_" Phase contacts.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Properly torque connections on a preventative basis. ☐ ☐

☒ Problem Corrected

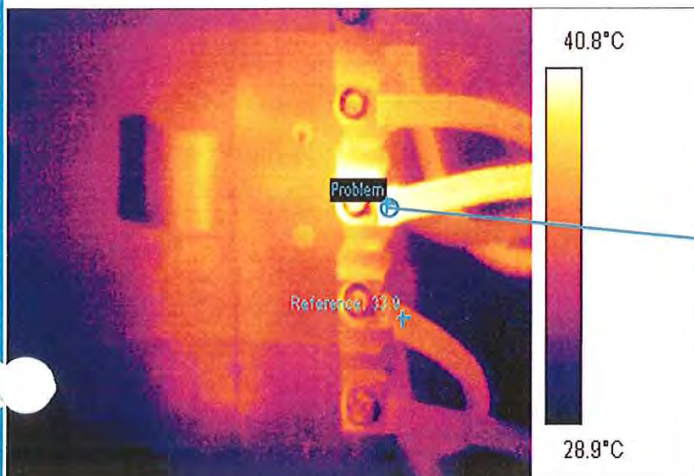
☒ Tightened/Torqued Connection

☐ Corroded/Discolored

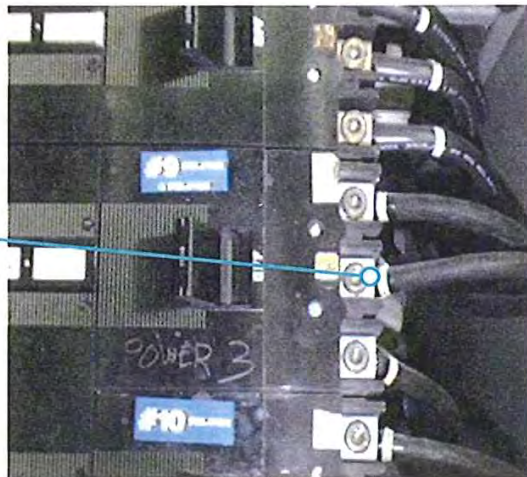
☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62VR_2967.jpg



62IDC_2968.jpg



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03/2008

Infrared Inspection Report Sheet

Page 3B

Technician

Clint Gottschalk

Location

11th. Floor Mech.

Tag ID

1482 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

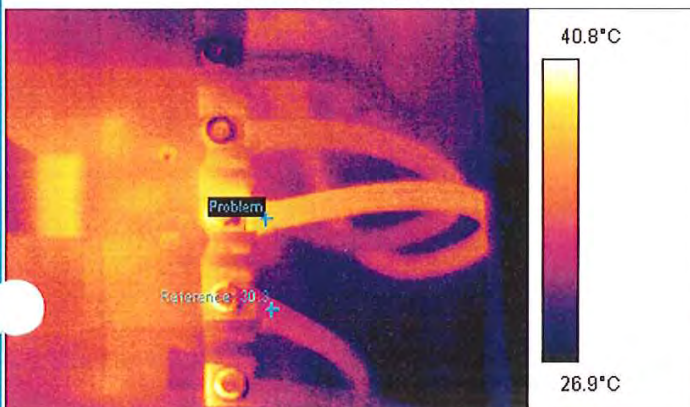
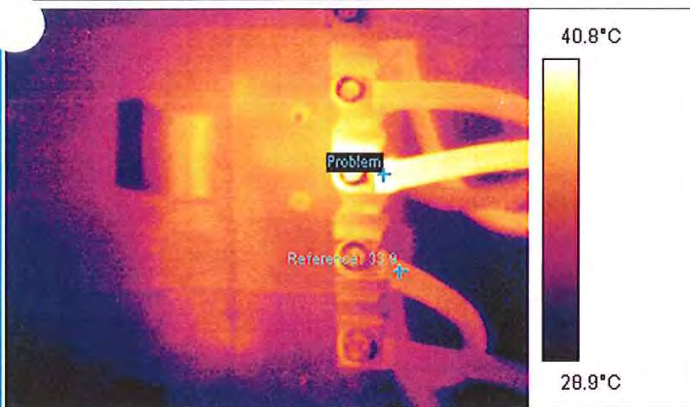
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☒ Fixed During Visit ☐ Contractor Will Correct ☐ Customer Will Correct ☐ Estimate Required





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3/2008

Infrared Inspection Report Sheet

Page 4A

Technician Clint Gottschalk	Location 12th. Floor Mech.
Tag ID 1484 Distribution Panel Single Front (≥ 400 amp)	Equipment Type Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
38.1C	44.0C	5.9C

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 11	175	37	14	.002
Phase B	breaker 11	175	46	21	.014
Phase C	breaker 11	175	40	17	.002

Problem Description

☐ Immediate Hazard

☒ Customer Notified Immediately

"_b_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_c_" Phase contacts.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

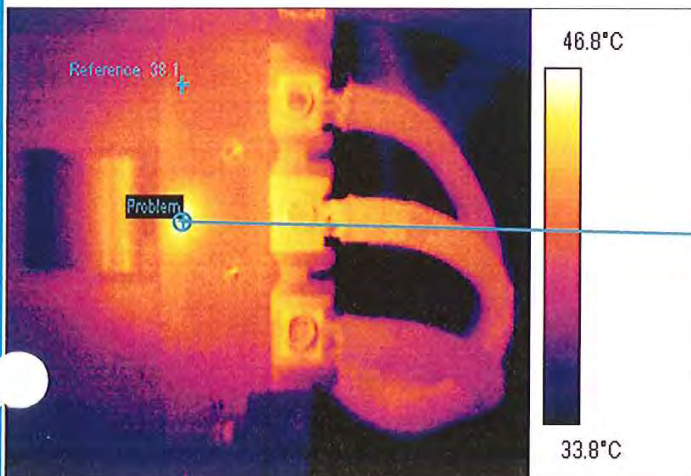
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

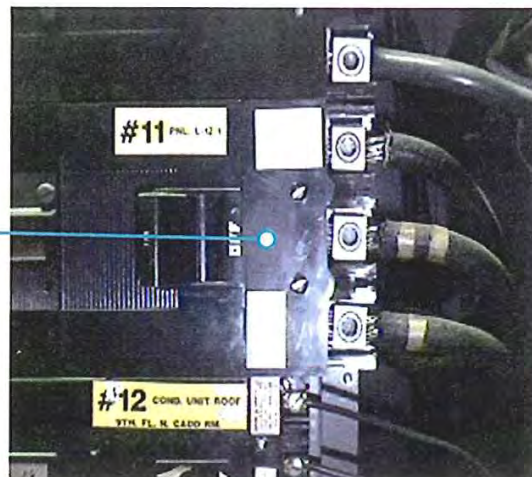
☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



621IR_2974.jpg



621DC_2975.jpg



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03/2008

Infrared Inspection Report Sheet

Page 4B

Technician

Clint Gottschalk

Location

12th. Floor Mech.

Tag ID

1484 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

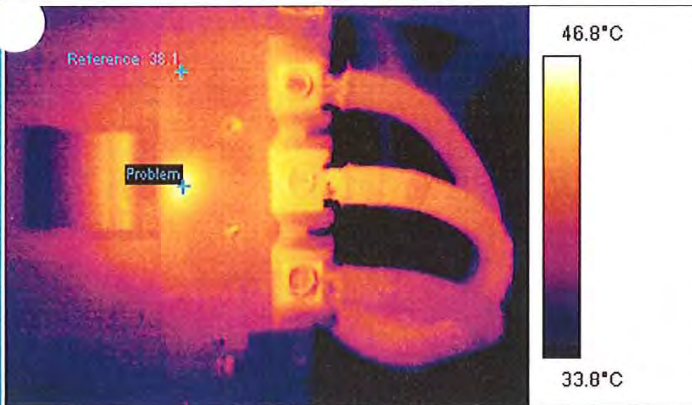
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

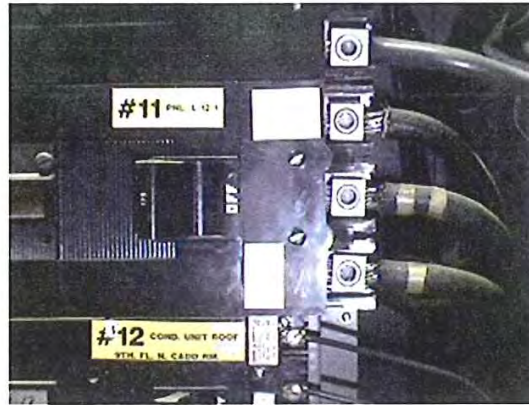
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



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62\DC_2975.jpg



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State of Kansas Docking Building - BAS207472JW

3/2008

Infrared Inspection Report Sheet

Page 5A

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
82.1C	99.0C	16.9C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 5	200	83	18.6	.059
Phase B	breaker 5	200	88.6	20	.039
Phase C	breaker 5	200	117.3	17.9	.055

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem. Total Current Harmonic Distortion levels are at a high percent on each phase.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

install harmonic filtering to reduce heating.

☐ Problem Corrected

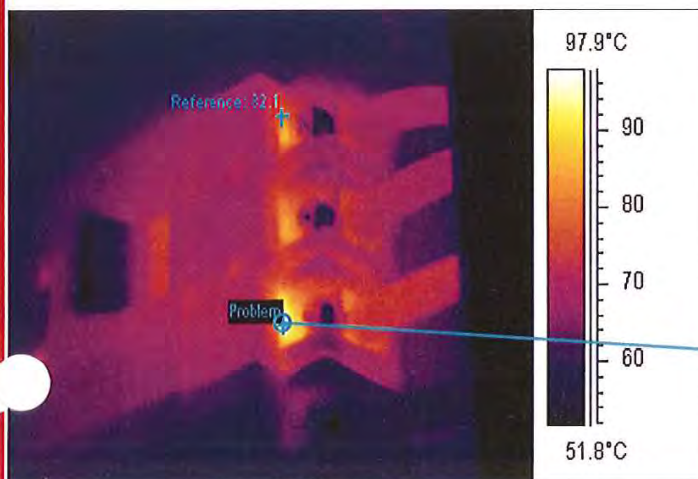
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

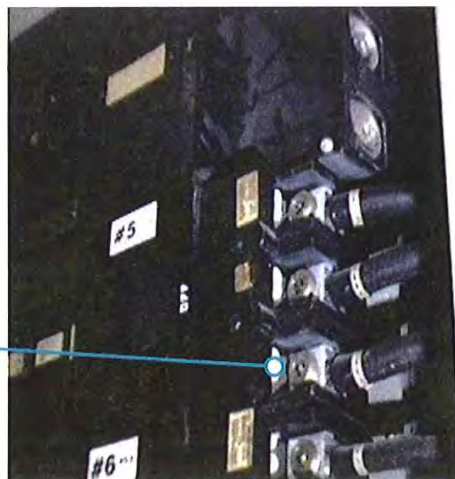
☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



621R_2898.jpg



621C_2899.jpg



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03/2008

Infrared Inspection Report Sheet

Page 5B

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

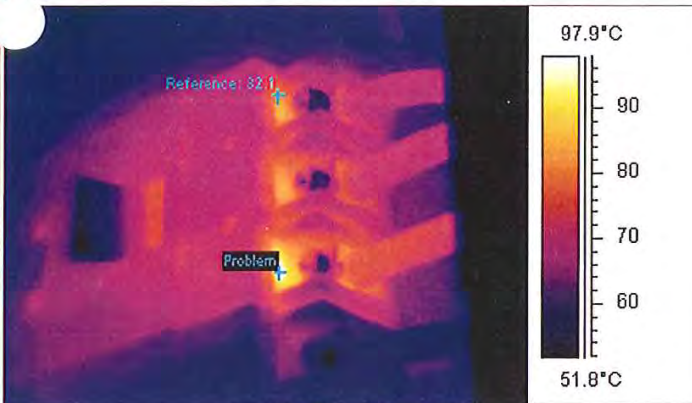
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Advanced heat stress could occur on all electrical equipment, conductors and transformers.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^{\text{PROBLEM}}^ - 62\IR_2898.jpg



62\DC_2899.jpg



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03/2008

Infrared Inspection Report Sheet

Page 6A

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
69.7C	95.0C	25.3C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 4	200	25.9	20.4	.304
Phase B	breaker 4	200	15.4	25.9	.005
Phase C	breaker 4	200	29.4	10.8	.436

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_a_" and "_c_" Phase breaker contacts are displaying abnormal thermal patterns compared to "_b_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☐ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

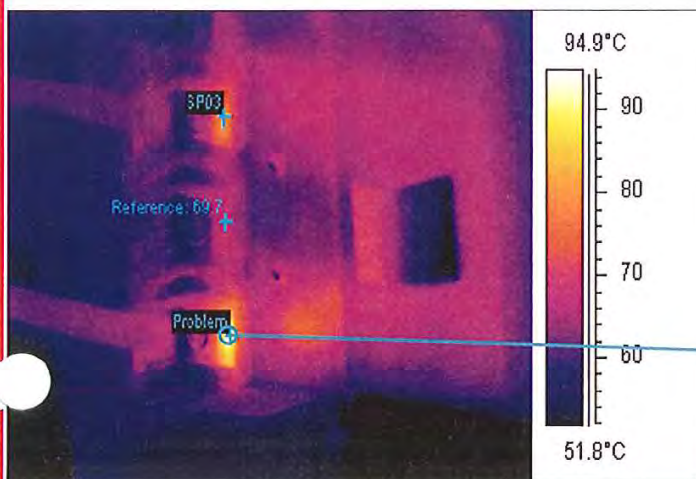
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware





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Infrared Inspection Report Sheet

Page 6B

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

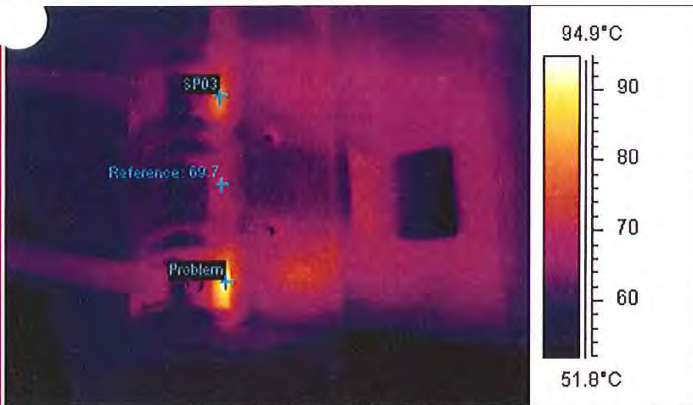
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

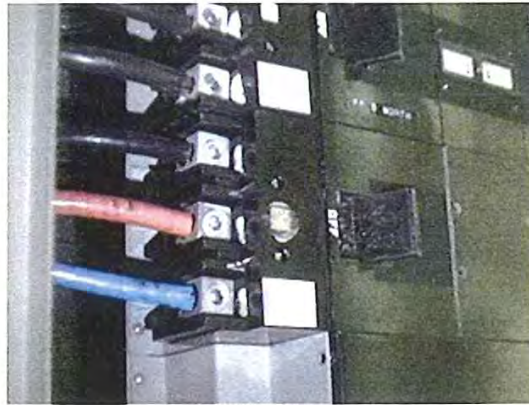
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



62\IR_2900.jpg



62\DC_2901.jpg



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03/2008

Infrared Inspection Report Sheet

Page 7A

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
66.2C	101.0C	34.8C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 7	150	26.6	21.5	.002
Phase B	breaker 7	150	28	18	.01
Phase C	breaker 7	150	33	29	.238

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_c_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_b_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☐ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

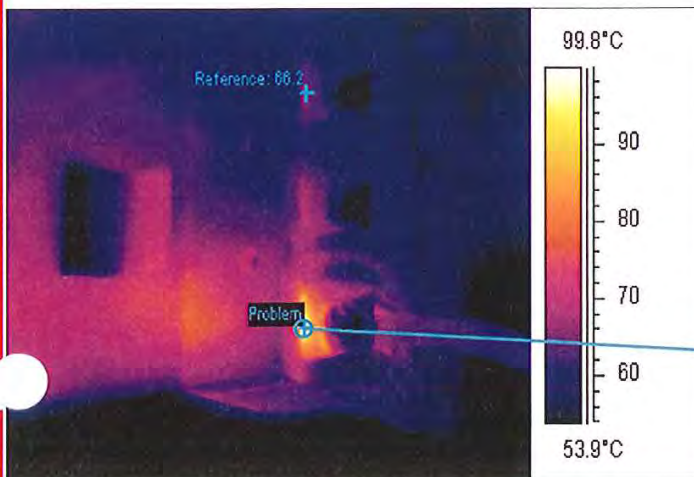
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

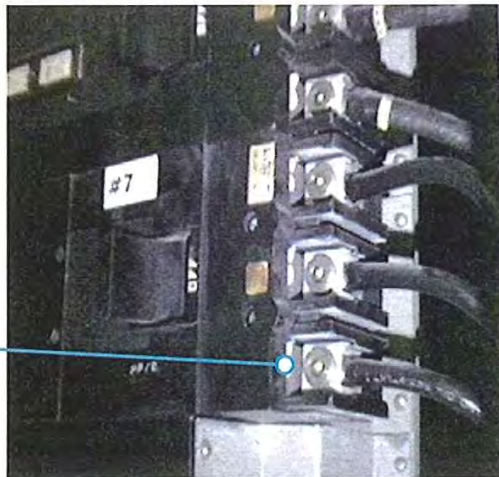
☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62\IR_2902.jpg



62\DC_2903.jpg



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Infrared Inspection Report Sheet

Page 7B

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

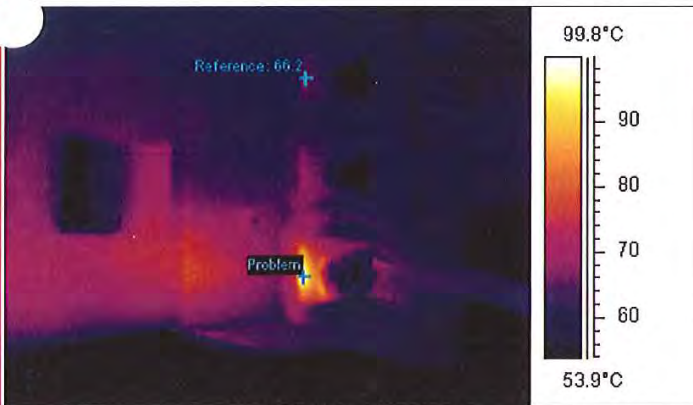
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



4[PROBLEM]^ - 62\IR_2902.jpg



62\DC_2903.jpg



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Infrared Inspection Report Sheet

Page 8A

Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1462 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
73.1C	78.1C	5.0C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 2	200	106	17	.042
Phase B	breaker 2	200	104	16	.037
Phase C	breaker 2	200	105	18	.01

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem. High total current harmonic distortion percentage.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Install Harmonic Filtering.

☐ Problem Corrected

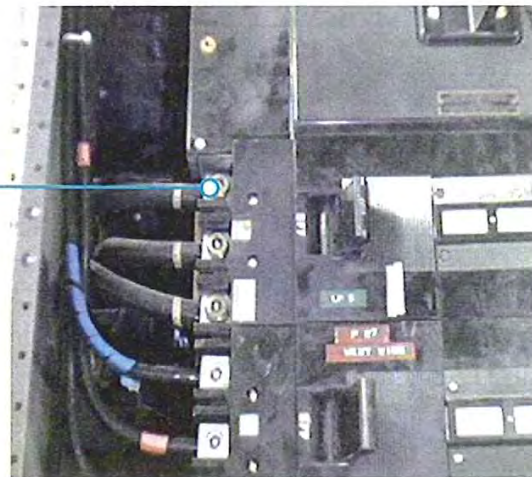
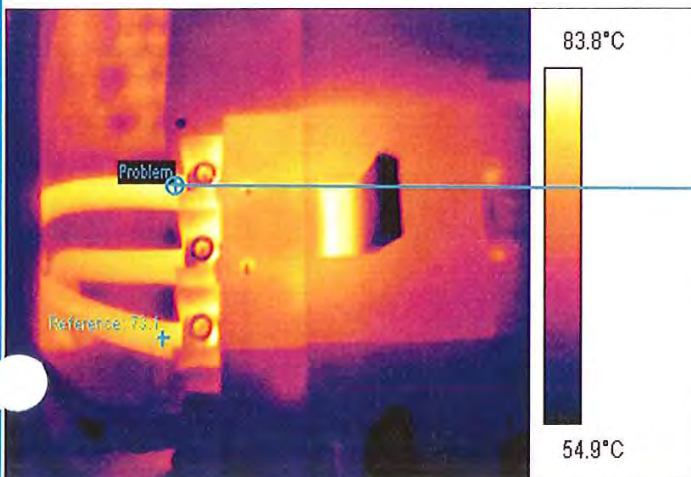
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware





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Infrared Inspection Report Sheet

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Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1462 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

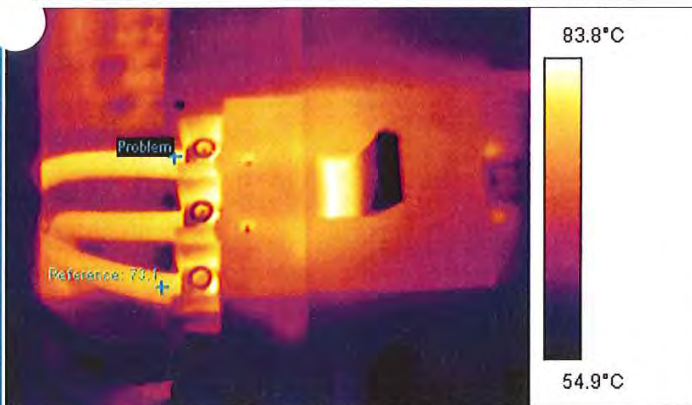
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

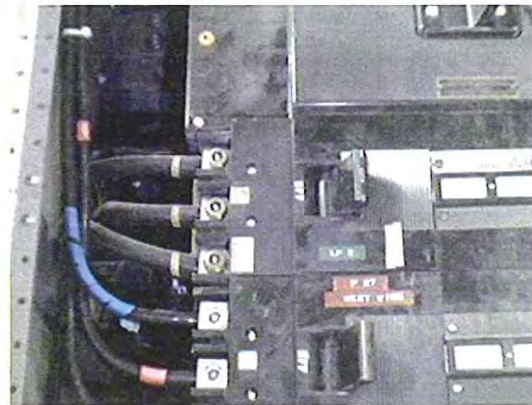
Harmonic distortion can cause heat stress on electrical equipment, conductors, and transformers.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^{\text{PROBLEM}}^{\wedge} - 62\text{IIR}_2906.jpg



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Infrared Inspection Report Sheet

Page 9A

Technician: Clint Gottschalk Location: 2nd Floor Mech.

Tag ID: 1462 Distribution Panel Single Front (≥ 400 amp) Equipment Type: Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
66.1C	75.3C	9.2C

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 5	225	91	17	.024
Phase B	breaker 5	225	80	20	.048
Phase C	breaker 5	225	74	18	.001

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem, The total harmonic current distortion is at a high percentage.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Install harmonic filtering. Repair or find a replacement breaker do to pitting contacts. Millivolt measurements have confirmed failure of the contacts.

☐ Problem Corrected

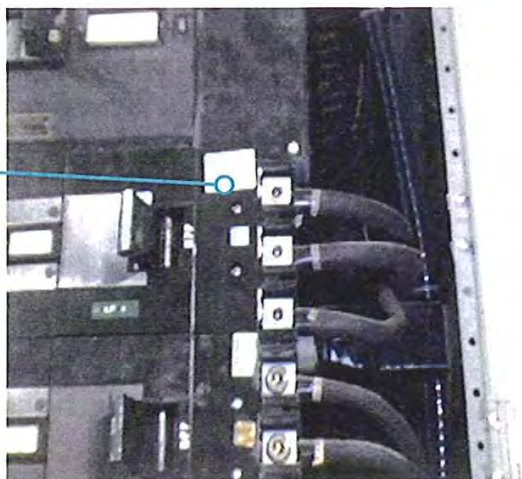
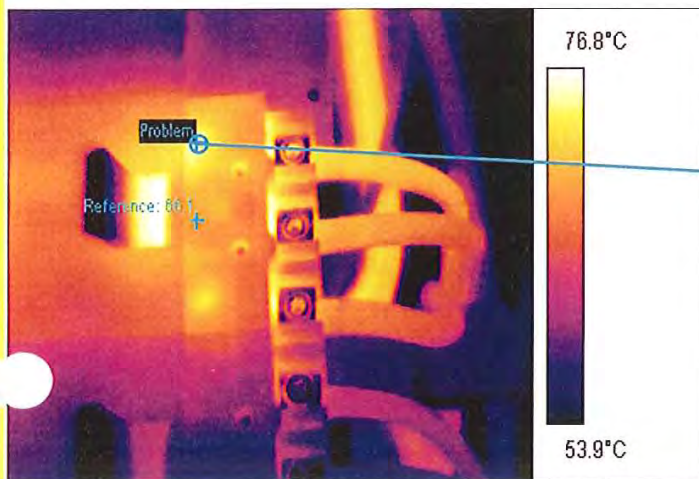
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware





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Infrared Inspection Report Sheet

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Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1462 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

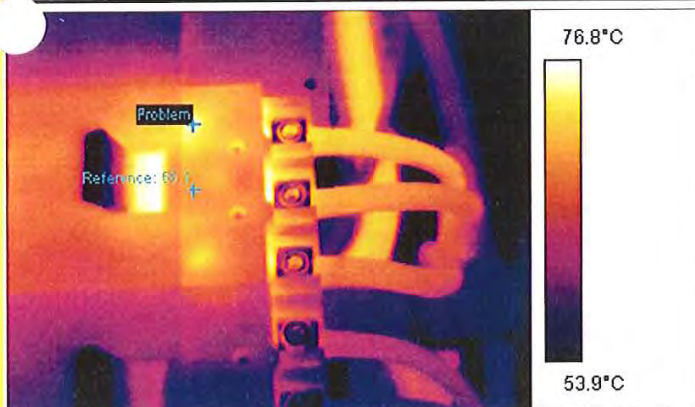
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Unwanted heat stress could occur in electrical equipment, conductors, and transformers.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



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62\DC_2909.jpg



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Infrared Inspection Report Sheet

Page 10A

Technician Clint Gottschalk	Location 3rd. Floor Mech.
Tag ID 1464 Distribution Panel Single Front (>= 400 amp)	Equipment Type Distribution Panel Single Front (>= 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature 55.0C	Problem Temperature 75.5C	Difference Temperature 20.5C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	7	70	22	8	.172
Phase B	7	70	20	9	.033
Phase C	7	70	21	9	.04

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_a_" Phase breaker contact is displaying abnormal thermal pattern compared to "_b_" and "_c_" Phase contacts and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

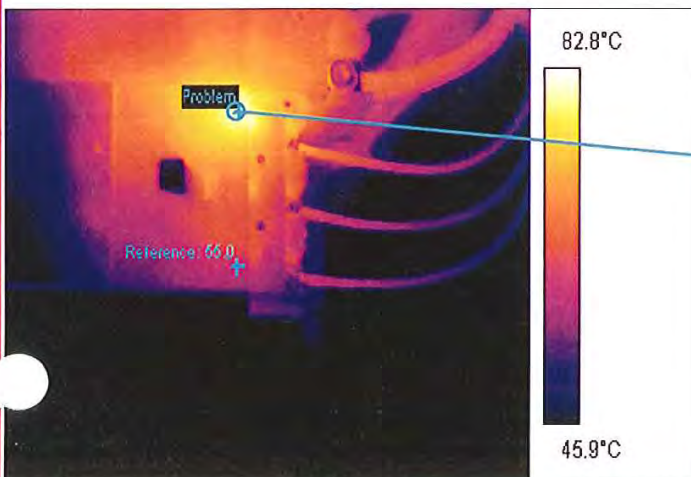
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

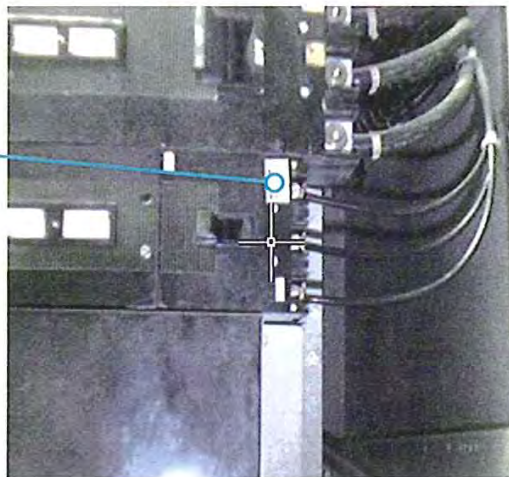
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



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62\DC_2917.jpg



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Infrared Inspection Report Sheet

Page 10B

Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1464 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

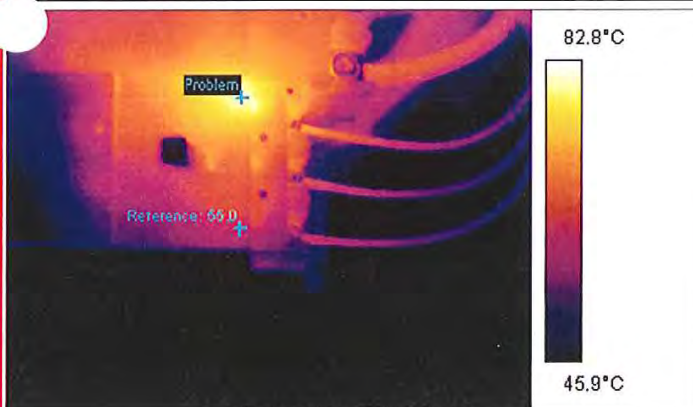
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

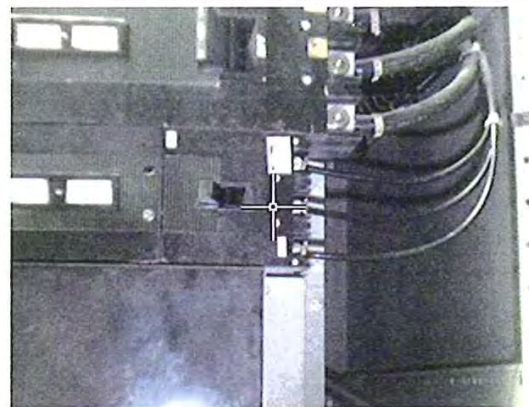
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



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Infrared Inspection Report Sheet

Page 11A

Technician Clint Gottschalk	Location 3rd. Floor Mech.
Tag ID 1465 Distribution Panel Single Front (≥ 400 amp)	Equipment Type Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature 65.2C	Problem Temperature 75.2C	Difference Temperature 10.0C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 5	200	104	18	.045
Phase B	breaker 5	200	81	19	.031
Phase C	breaker 5	200	86	18	.023

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem, Unbalanced loads are occurring. Harmonics are also at near to high percentage levels

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Balance loads that are subfed from this breaker.

☐ Problem Corrected

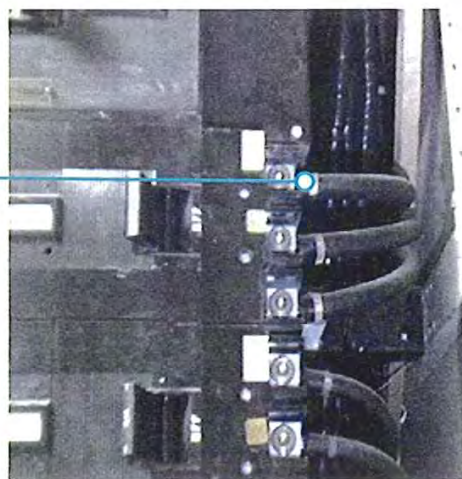
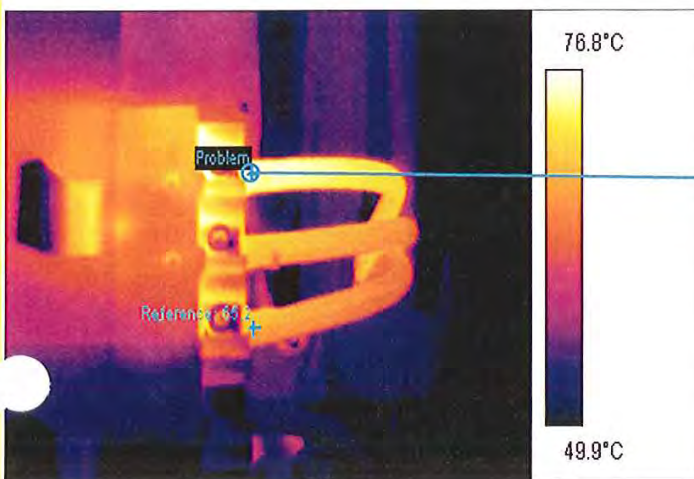
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware





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Infrared Inspection Report Sheet

Page 11B

Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1465 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

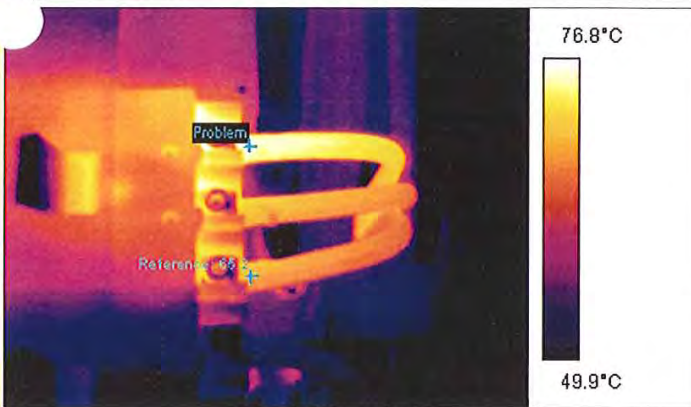
Distribution Panel Single Front (≥ 400 amp)

Consequences if Not Corrected

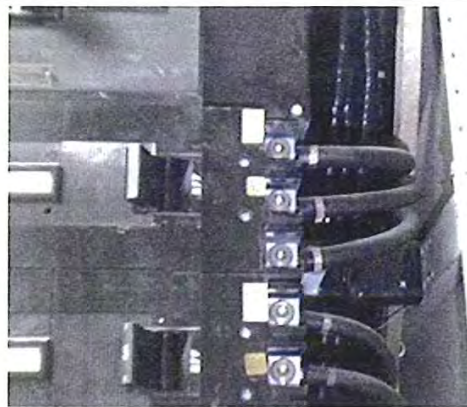
☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



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62\DC_2921.jpg



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Infrared Inspection Report Sheet

Page 12A

Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1467 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
53.1C	60.2C	7.0C

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 11	50	22	4	.038
Phase B	breaker 11	50	21	4	.042
Phase C	breaker 11	50	22	4	.047

Problem Description

☐ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem. Pitting inside the breaker is forming do to the age and constant load on this breaker.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Excercise breaker #11 to prevent pitting from producing internally. Inspect contacts to see if they need replaced.

☐ Problem Corrected

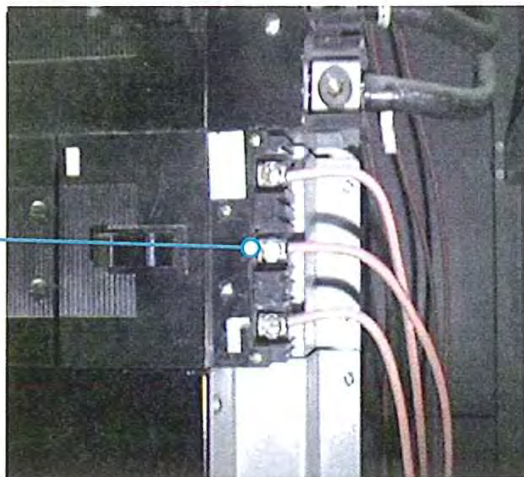
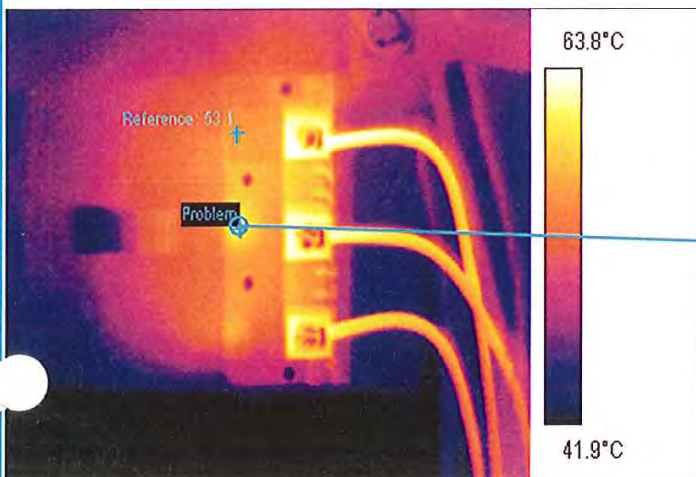
☒ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware





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Infrared Inspection Report Sheet

Page 12B

Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1467 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

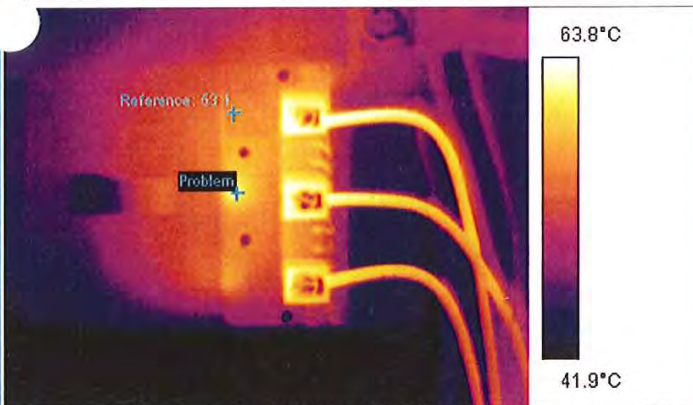
Distribution Panel Single Front (≥ 400 amp)

Consequences if Not Corrected

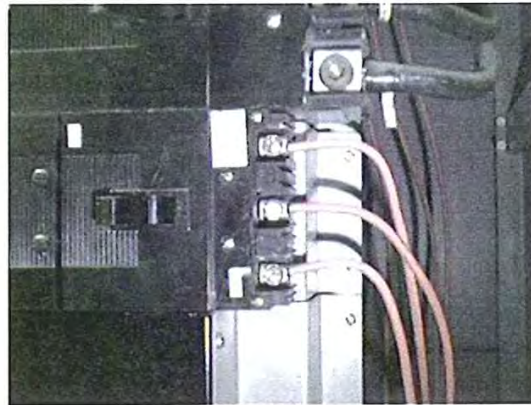
☒ Equipment Failure ☐ Fire Hazard ☐ Safety Hazard ☒ Power/Business Interruption

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



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62\DC_2925.jpg



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Infrared Inspection Report Sheet

Page 13A

Technician Clint Gottschalk	Location 5th. Floor Mech.
Tag ID 1471 Distribution Panel Single Front (>= 400 amp)	Equipment Type Distribution Panel Single Front (>= 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature 54.7C	Problem Temperature 74.3C	Difference Temperature 19.6C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 7	200	78	19	.021
Phase B	breaker 7	200	85	15	.066
Phase C	breaker 7	200	65	18	.031

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Circuit #_7_ has a temperature rise greater that 10 degrees C over the ambient air surrounding it under normal operating conditions.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Properly repair the breaker lug do to cross threading or check the lugs connection internally or replace the breaker with a new breaker.

☐ Problem Corrected

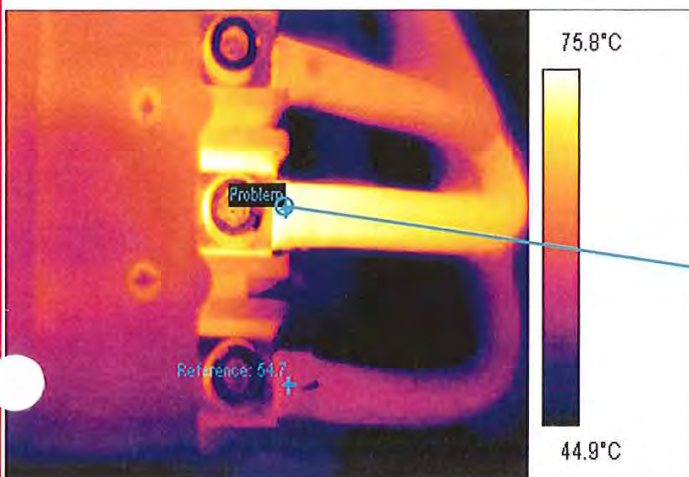
☒ Tightened/Torqued Connection

☐ Corroded/Discolored

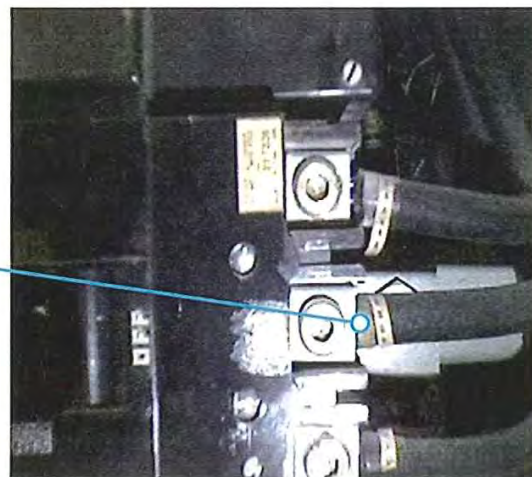
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☒ Stripped/Cross-threaded Hardware



62\IR_2937.jpg



62\DC_2938.jpg



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Infrared Inspection Report Sheet

Page 13B

Technician

Clint Gottschalk

Location

5th. Floor Mech.

Tag ID

1471 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Consequences if Not Corrected

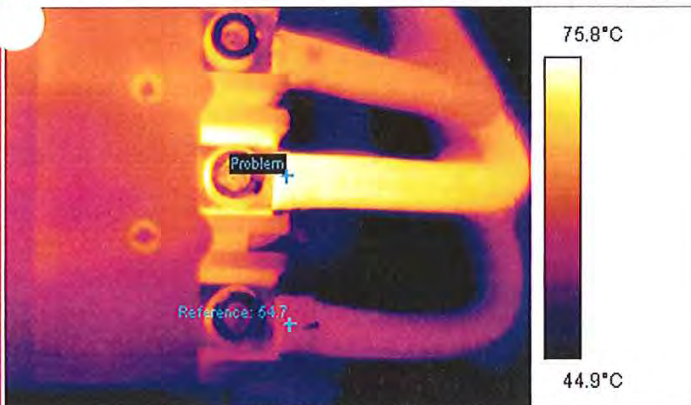
☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Unwanted bussiness loss and a fire hazard.

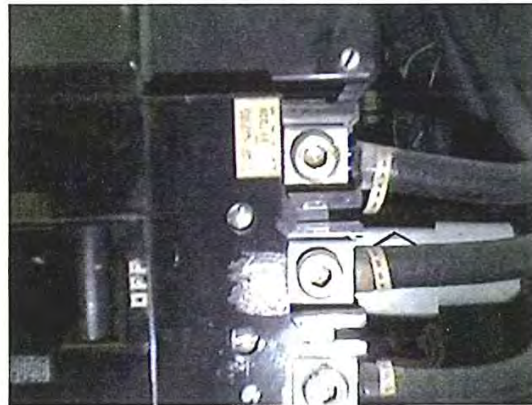
Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required

We did torque all the connection points of the breaker, we strongly believe that the B phase lug is cross threaded.



^[PROBLEM]^ - 62IIR_2937.jpg



62IDC_2938.jpg



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Infrared Inspection Report Sheet

Page 14A

Technician

Clint Gottschalk

Location

6th. Floor Mech.

Tag ID

1472 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
48.1C	54.6C	6.4C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 11	70	20	5	.003
Phase B	breaker 11	70	21	7	.039
Phase C	breaker 11	70	20	5	.004

Problem Description

☐ Immediate Hazard

☒ Customer Notified Immediately

Circuit #_11_B phase contact has a temperature rise greater than 10 degrees C over the ambient air surrounding it under normal operating conditions.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Exercise the breaker to prevent permanent pitting on the breakers contacts. Check the contacts internally for possible damage.

☐ Problem Corrected

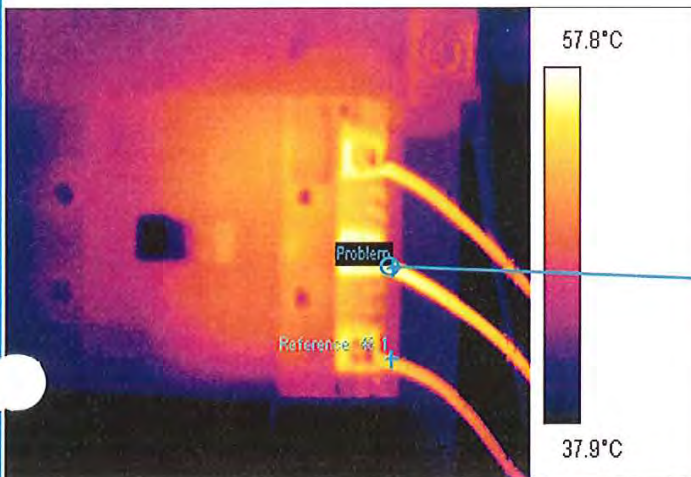
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

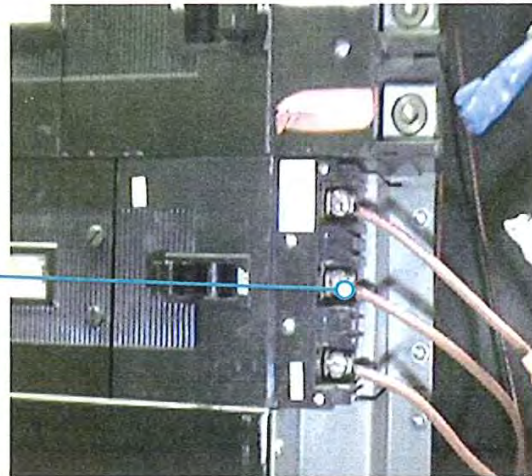
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62\IR_2943.jpg



62\DC_2944.jpg



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Page 14B

Technician

Clint Gottschalk

Location

6th. Floor Mech.

Tag ID

1472 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

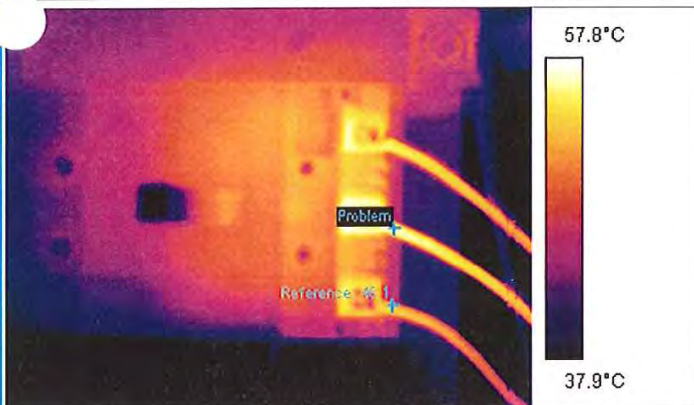
Distribution Panel Single Front (≥ 400 amp)

Consequences if Not Corrected

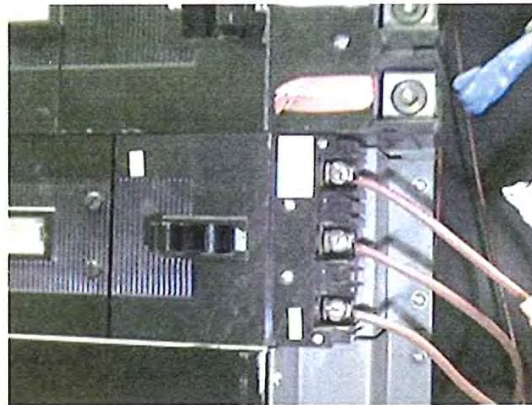
☒ Equipment Failure ☐ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^ [PROBLEM] ^ - 62\IR_2943.jpg



62\DC_2944.jpg



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Infrared Inspection Report Sheet

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10/13/2008

Technician

Clint Gottschalk

Location

1st Floor Air Handler Room

Tag ID

1458 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
77.8C	101.7C	24.0C

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	Breaker #8	70	18	5.1	.187
Phase B	Breaker #8	70	23	5	.035
Phase C	Breaker #8	70	21.5	4.1	.367

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_a_" and "_c_" Phase breaker contacts are displaying abnormal thermal patterns compared to the "_b_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

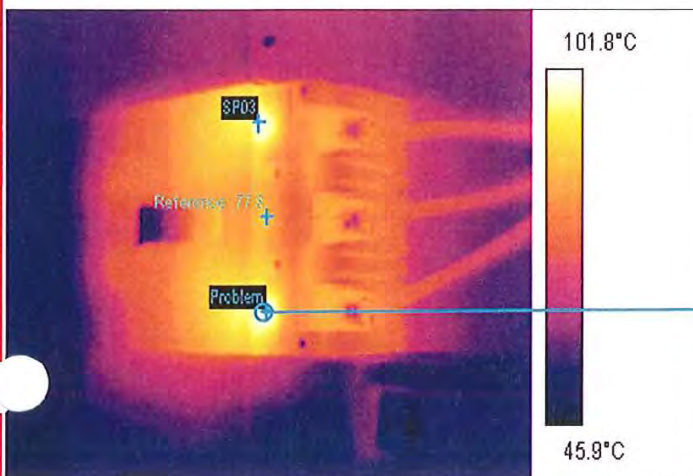
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



621VR_2892.jpg



621DC_2893.jpg



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Technician

Clint Gottschalk

Location

1st Floor Air Handler Room

Tag ID

1458 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

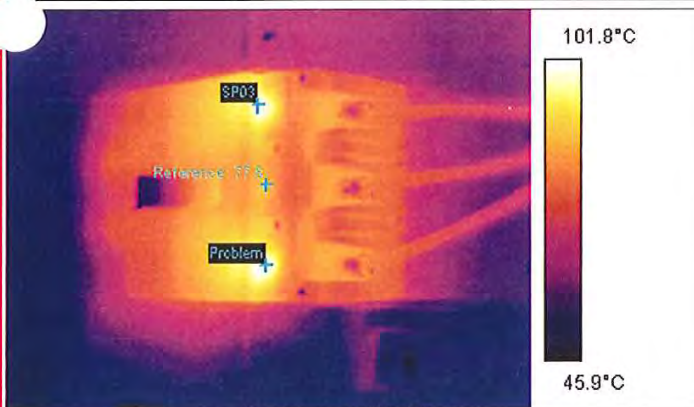
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

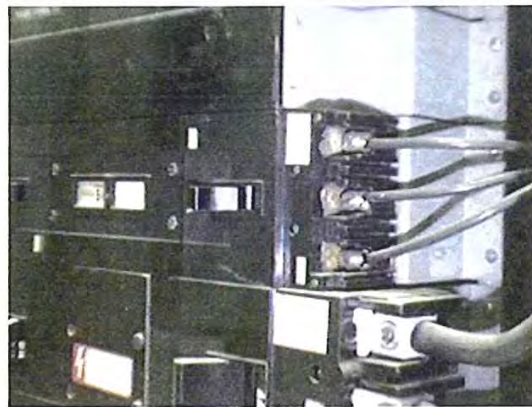
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^ (PROBLEM)^ - 62\IR_2892.jpg



62\DC_2893.jpg



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Infrared Inspection Report Sheet

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Technician Clint Gottschalk	Location Basement Air Handler Room
Tag ID 1445 Distribution Panel Single Front (≥ 400 amp)	Equipment Type Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature 42.0C	Problem Temperature 52.4C	Difference Temperature 10.4C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 10	100	14.2	24.7	.004
Phase B	breaker 10	100	11.1	42.5	.005
Phase C	breaker 10	100	45	20	.016

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_c_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_b_" Phase contacts.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.
Properly balance loading issues.

☐ Problem Corrected

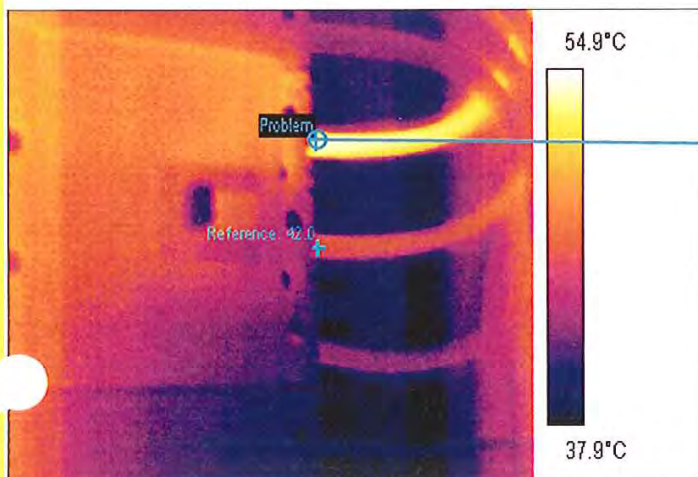
☒ Tightened/Torqued Connection

☐ Corroded/Discolored

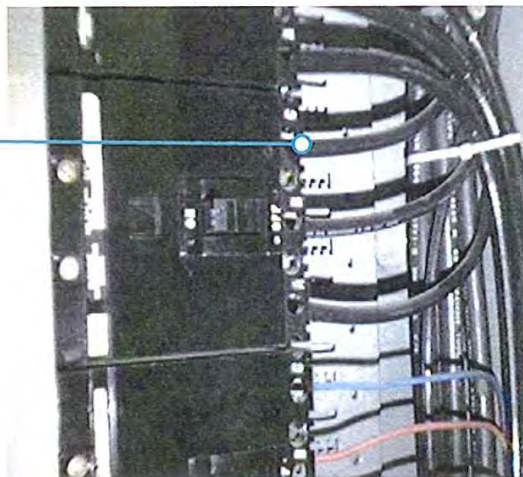
☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62WR_2868.jpg



62DC_2869.jpg



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Page 16B

Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1445 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

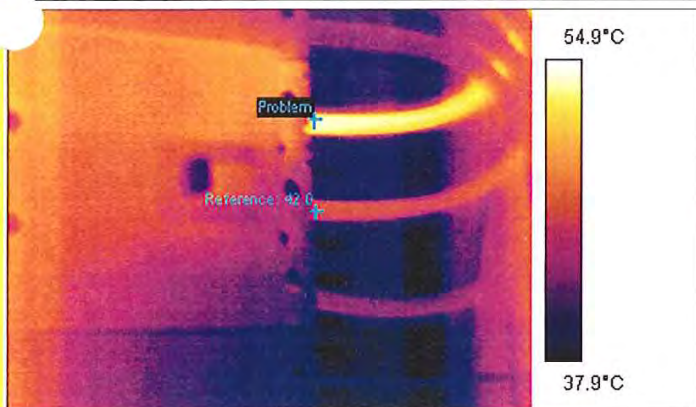
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^[PROBLEM]^ - 62\IR_2868.jpg



62\DC_2869.jpg



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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1447 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
41.2C	47.5C	6.4C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 17	100	0	0	Unable to Obtain
Phase B	breaker 10	100	4	65.5	Unable to Obtain
Phase C	breaker 10	100	27	14.6	Unable to Obtain

Problem Description

☐ Immediate Hazard

☒ Customer Notified Immediately

"_c_" Phase breaker contact is displaying abnormal thermal pattern compared to "_b_" and "_a_" Phase contact.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

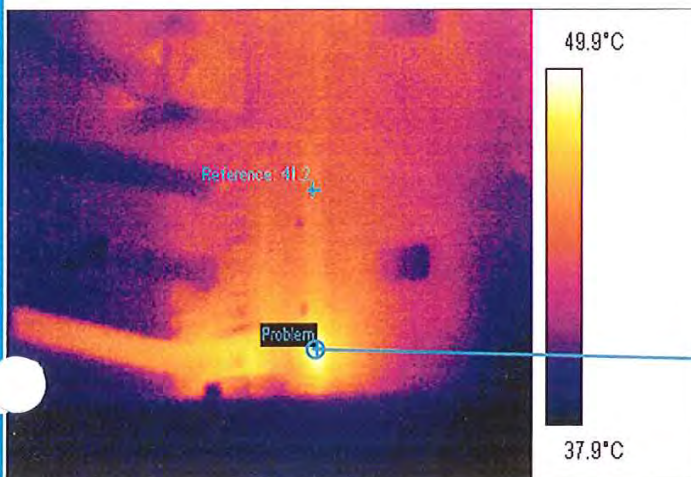
☒ Tightened/Torqued Connection

☐ Corroded/Discolored

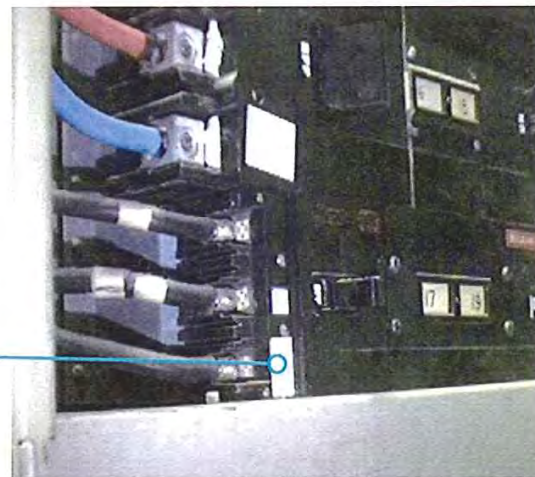
☐ Overloaded Circuit

☒ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62VR_2871.jpg



62DC_2872.jpg



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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1447 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

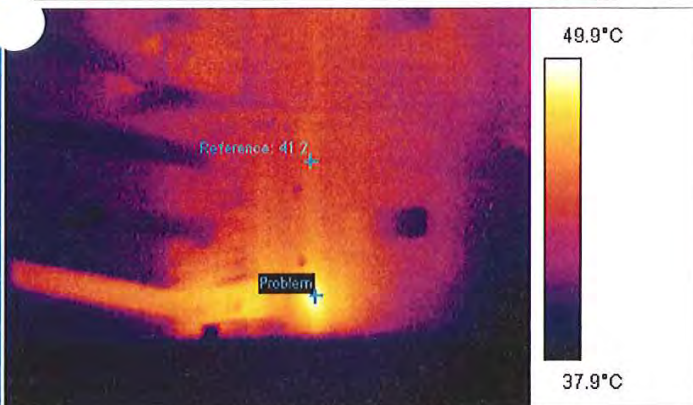
Consequences if Not Corrected

☒ Equipment Failure ☐ Fire Hazard ☐ Safety Hazard ☒ Power/Business Interruption

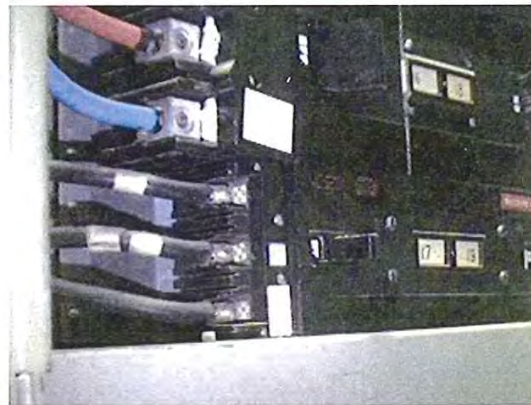
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^[PROBLEM]^ - 62\IR_2871.jpg



62\DC_2872.jpg



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Infrared Inspection Report Sheet

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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1447 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
49.1C	51.1C	2.0C	

Variables	Problem Pole	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	breaker 6	30	Not Applicable	Not Applicable	Not Applicable
Phase B	breaker 6	30	Not Applicable	Not Applicable	Not Applicable
Phase C	breaker 6	30	Not Applicable	Not Applicable	Not Applicable

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Tighten and Torque connection

☒ Problem Corrected

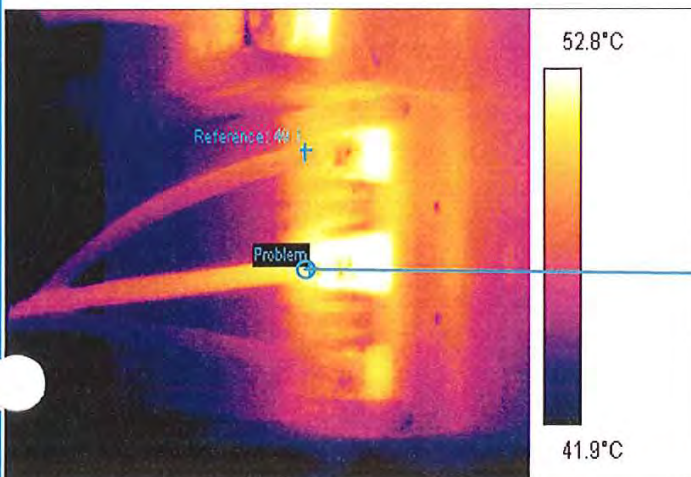
☒ Tightened/Torqued Connection

☐ Corroded/Discolored

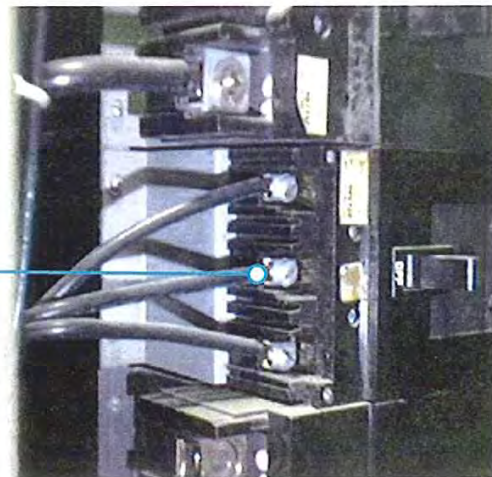
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62\IR_2875.jpg



62\DC_2876.jpg



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Infrared Inspection Report Sheet

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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1447 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

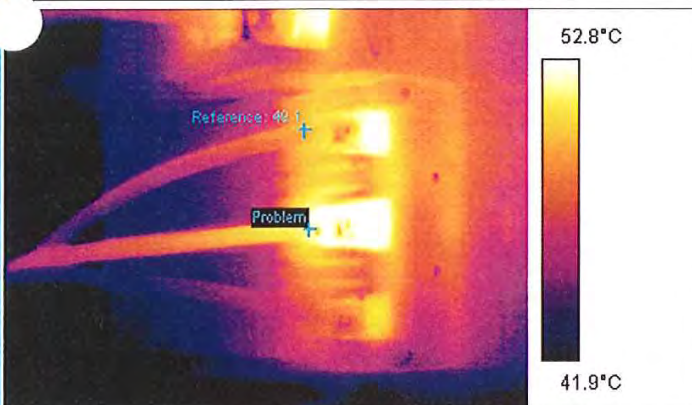
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

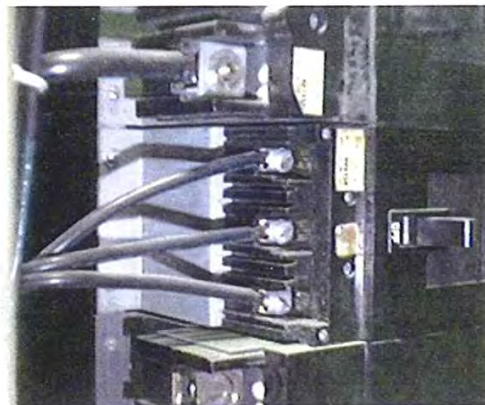
Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☐ Customer Will Correct ☐ Estimate Required

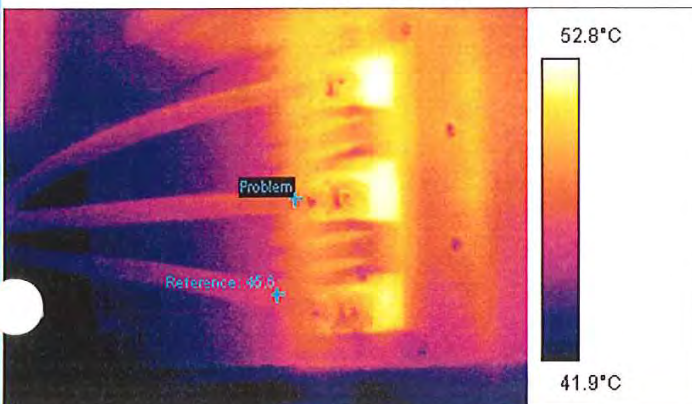
Properly torqued connections to the breaker.



^ (PROBLEM) ^ - 62\IR_2875.jpg



62\DC_2876.jpg



^ (CORRECTION) ^ - 62\IR_2877.jpg



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Infrared Inspection Report Sheet

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Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

1427 Motor Control Center (Per vertical section)

Equipment Type

Motor Control Center (Per vertical section)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
62.2C	83.4C	21.3C	

Variables	Problem Location	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	water pump #1	200	57	3.8	.004
Phase B	water pump #1	200	57	3.8	.003
Phase C	water pump #1	200	58	3.5	.108

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_C_" Phase breaker contact is displaying abnormal thermal patterns compared to "_B_" and "_A_" Phase contacts and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

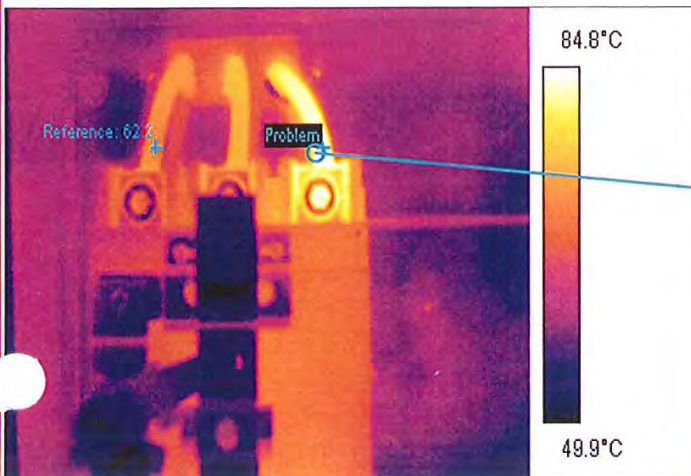
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

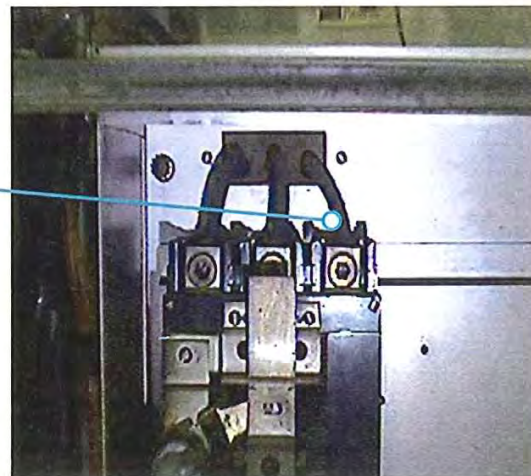
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62VR_2822.jpg



62DC_2823.jpg



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Infrared Inspection Report Sheet

Page 19B

Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

1427 Motor Control Center (Per vertical section)

Equipment Type

Motor Control Center (Per vertical section)

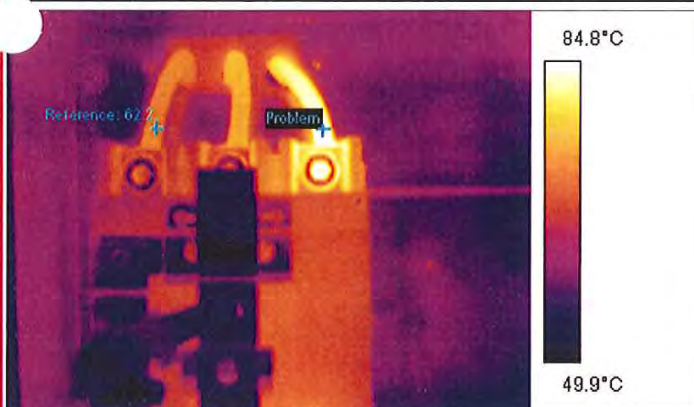
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

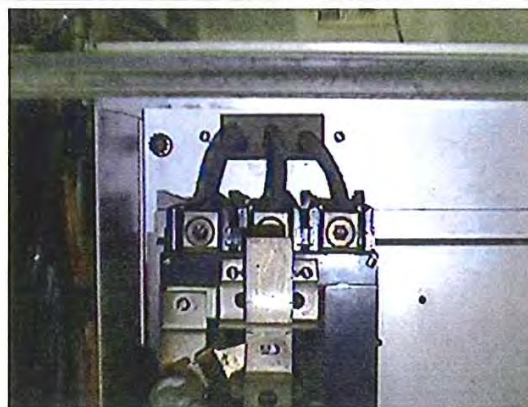
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^[PROBLEM]^ - 62\IR_2822.jpg



62\DC_2823.jpg



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Infrared Inspection Report Sheet

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Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

1432 Motor Control Center (Per vertical section)

Equipment Type

Motor Control Center (Per vertical section)

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature	Problem Temperature	Difference Temperature	
92.1C	116.0C	24.0C	

Variables	Problem Location	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	exhaust	Unable to Obtain	Unable to Obtain	Unable to Obtain	.09
Phase B	exhaust	Unable to Obtain	Unable to Obtain	Unable to Obtain	.09
Phase C	exhaust	Unable to Obtain	Unable to Obtain	Unable to Obtain	.08

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

Heat Related Problem, The contacts are getting bad.□□

Recommendations For Repair

☐ Repair Equipment

☒ Replace Equipment

Replace this contactor.

☐ Problem Corrected

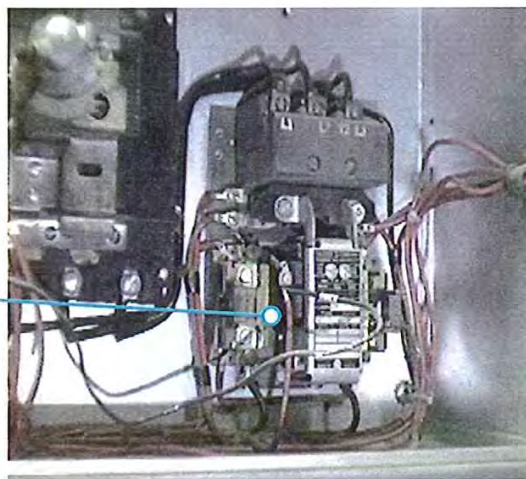
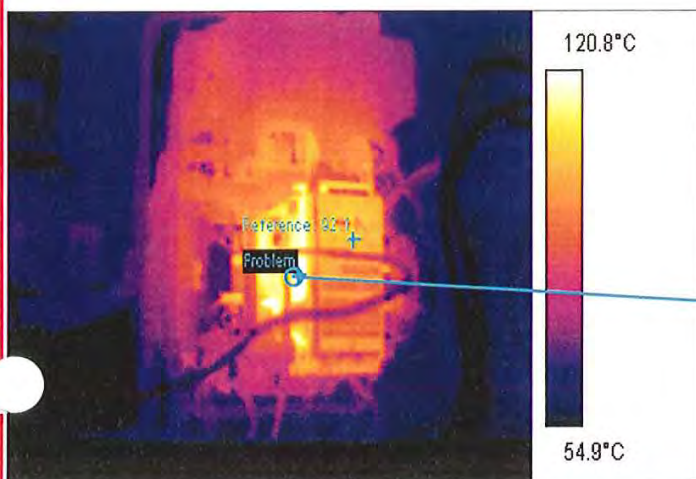
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



62WR_2840.jpg

62DC_2841.jpg



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Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

1432 Motor Control Center (Per vertical section)

Equipment Type

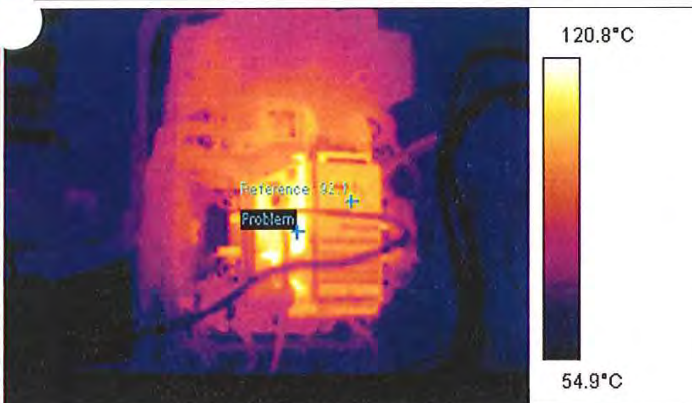
Motor Control Center (Per vertical section)

Consequences if Not Corrected

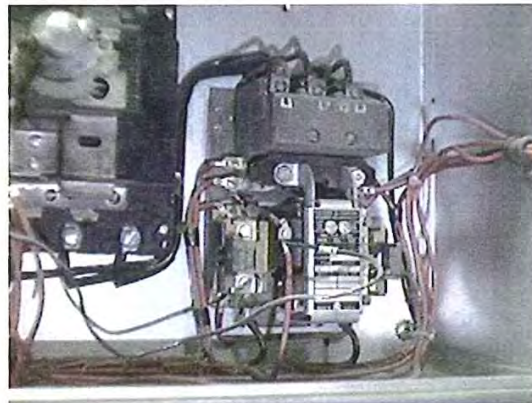
☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^ [PROBLEM] ^ - 62\IR_2840.jpg



62\DC_2841.jpg



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Technician Clint Gottschalk	Location Mezzanine
Tag ID 1432 Motor Control Center (Per vertical section)	Equipment Type Motor Control Center (Per vertical section)

Severity Criteria for Similar Comparisons

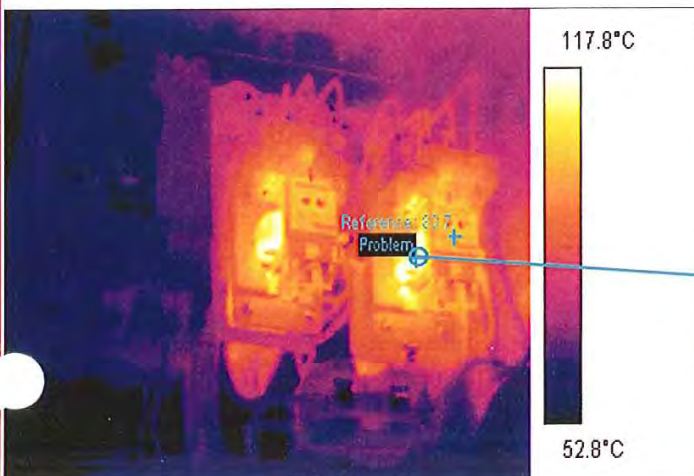
Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C
Reference Temperature 83.7C	Problem Temperature 112.1C	Difference Temperature 28.4C	

Variables	Problem Location	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	tunnel exhaust	Unable to Obtain	Unable to Obtain	Unable to Obtain	.09
Phase B	tunnel exhaust	Unable to Obtain	Unable to Obtain	Unable to Obtain	.08
Phase C	tunnel exhaust	Unable to Obtain	Unable to Obtain	Unable to Obtain	.08

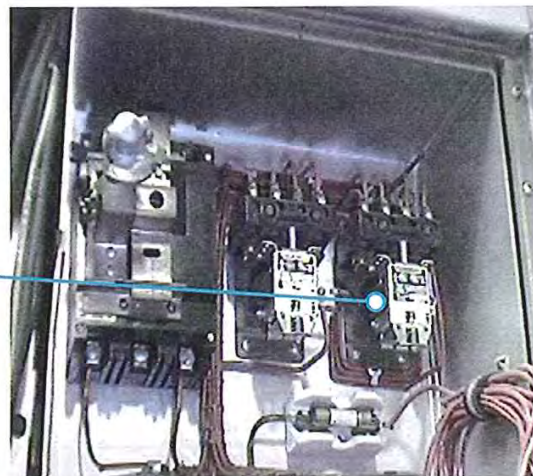
Problem Description	☒ Immediate Hazard	☒ Customer Notified Immediately
Heat Related Problem, The contacts are getting bad.		

Recommendations For Repair	☐ Repair Equipment	☒ Replace Equipment
Replace this contactor.		

- | | | |
|---|---|---|
| ☐ Problem Corrected | ☐ Tightened/Torqued Connection | ☐ Corroded/Discolored |
| ☐ Overloaded Circuit | ☐ Excessive Current Harmonics | ☐ Stripped/Cross-threaded Hardware |



62VR_2838.jpg



62DC_2839.jpg



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Infrared Inspection Report Sheet

Page 21B

Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

1432 Motor Control Center (Per vertical section)

Equipment Type

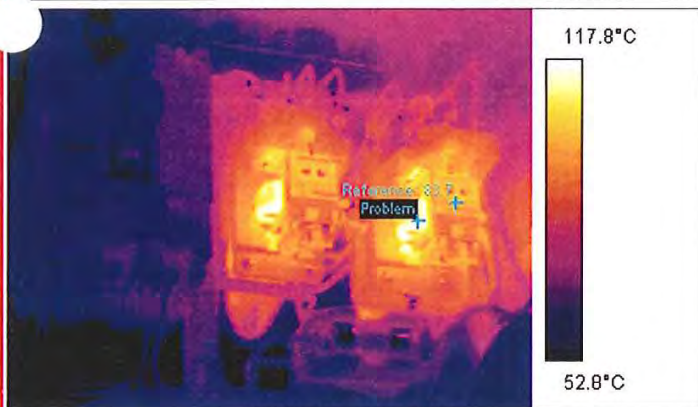
Motor Control Center (Per vertical section)

Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^ [PROBLEM]^ - 62\IR_2838.jpg



62\DC_2839.jpg



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Infrared Inspection Report Sheet

Page 22A

Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

chiller 1 MCC: Motor Starters

Equipment Type

MCC: Motor Starters

Severity Criteria for Similar Comparisons

Normal	Alert	Severe	Critical
Less Than 4.1C	4.1C to 8.0C	8.0C to 15.0C	Greater Than 15.0C

Reference Temperature	Problem Temperature	Difference Temperature
96.0C	112.2C	16.2C

Variables	Contactor Size	Current Rating (Amps)	Current Draw (Amps)	THDC (%THD-F)	Voltage Drop (Volts)
Phase A	Unable to Obtain	600	230	4.8	.83
Phase B	Unable to Obtain	600	218	4.7	1.17
Phase C	Unable to Obtain	600	228	4.3	.9

Problem Description

☒ Immediate Hazard

☒ Customer Notified Immediately

"_B_" Phase breaker contact is displaying abnormal thermal pattern compared to "_A_" and "_C_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, inspect and repair contacts as a matched set if applicable, or install properly rated replacement breaker.

☐ Problem Corrected

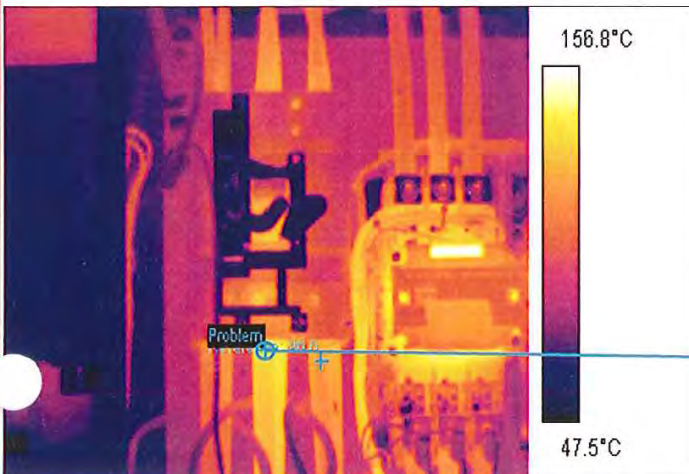
☐ Tightened/Torqued Connection

☐ Corroded/Discolored

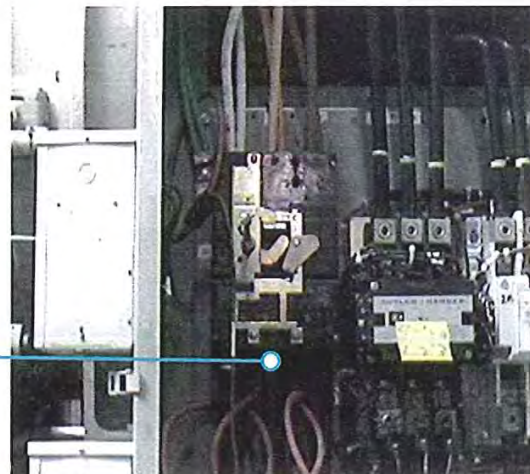
☐ Overloaded Circuit

☐ Excessive Current Harmonics

☐ Stripped/Cross-threaded Hardware



621R_3602.jpg



621DC_3603.jpg



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Infrared Inspection Report Sheet

Page 22B

Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

chiller 1 MCC: Motor Starters

Equipment Type

MCC: Motor Starters

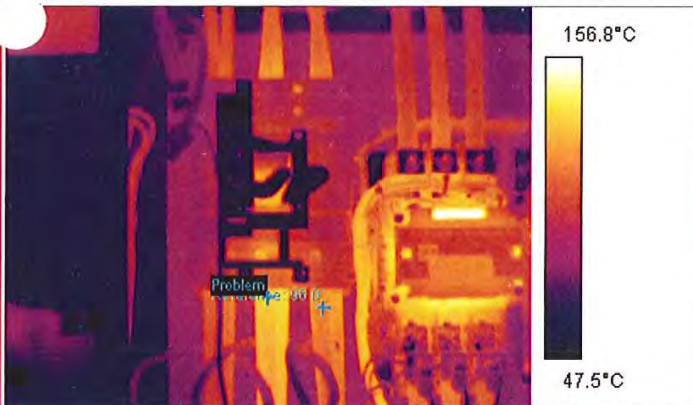
Consequences if Not Corrected

☒ Equipment Failure ☒ Fire Hazard ☒ Safety Hazard ☒ Power/Business Interruption

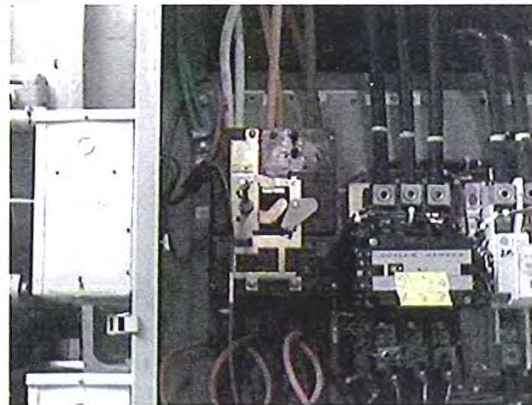
Additional loading and continued exposure to this condition will more than likely accelerate a failure of this device.

Corrective Actions

☐ Fixed During Visit ☐ Contractor Will Correct ☒ Customer Will Correct ☐ Estimate Required



^ [PROBLEM] ^ - 62\IR_3602.jpg



62\DC_3603.jpg



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SUMMARY PAGE

PAG	EQUIPMENT TYPE	LOCATION	PROB.	REF/AMB	DIFF.
2	Distribution Panel Single Front (>= 400 amp)	10th. Floor Mech.	86.8C	51.6C	35.2C
3	Distribution Panel Single Front (>= 400 amp)	11th. Floor Mech.	40.4C	33.9C	6.4C
4	Distribution Panel Single Front (>= 400 amp)	12th. Floor Mech.	44.0C	38.1C	5.9C
5	Distribution Panel Single Front (>= 400 amp)	2nd Floor Mech.	99.0C	82.1C	16.9C
6	Distribution Panel Single Front (>= 400 amp)	2nd Floor Mech.	95.0C	69.7C	25.3C
7	Distribution Panel Single Front (>= 400 amp)	2nd Floor Mech.	101.0C	66.2C	34.8C
8	Distribution Panel Single Front (>= 400 amp)	2nd Floor Mech.	78.1C	73.1C	5.0C
9	Distribution Panel Single Front (>= 400 amp)	2nd Floor Mech.	75.3C	66.1C	9.2C
10	Distribution Panel Single Front (>= 400 amp)	3rd. Floor Mech.	75.5C	55.0C	20.5C
11	Distribution Panel Single Front (>= 400 amp)	3rd. Floor Mech.	75.2C	65.2C	10.0C
12	Distribution Panel Single Front (>= 400 amp)	3rd. Floor Mech.	60.2C	53.1C	7.0C
13	Distribution Panel Single Front (>= 400 amp)	5th. Floor Mech.	74.3C	54.7C	19.6C
14	Distribution Panel Single Front (>= 400 amp)	6th. Floor Mech.	54.6C	48.1C	6.4C
15	Distribution Panel Single Front (>= 400 amp)	1st Floor Air Handler Room	101.7C	77.8C	24.0C
16	Distribution Panel Single Front (>= 400 amp)	Basement Air Handler Room	52.4C	42.0C	10.4C
17	Distribution Panel Single Front (>= 400 amp)	Basement Air Handler Room	47.5C	41.2C	6.4C
18	Distribution Panel Single Front (>= 400 amp)	Basement Air Handler Room	51.1C	49.1C	2.0C
19	Motor Control Center (Per vertical section)	Mezzanine	83.4C	62.2C	21.3C
20	Motor Control Center (Per vertical section)	Mezzanine	116.0C	92.1C	24.0C
21	Motor Control Center (Per vertical section)	Mezzanine	112.1C	83.7C	28.4C
22	MCC: Motor Starters	Mezzanine	112.2C	96.0C	16.2C



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Equipment Item Problems Report - Including All Images

Page 1

Technician

Clint Gottschalk

Location

11th. Floor Mech.

Tag ID

1482 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62\lr_2965.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

Page 2

Technician

Clint Gottschalk

Location

12th. Floor Mech.

Tag ID

1484 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62lir_2971.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

13th Floor Mech.

Tag ID

1486-A Phase 5-15kV Dry Transformers <= 500 kVA

Equipment Type

5-15kV Dry Transformers <= 500 kVA

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

There is possible resin residue beneath the phase coils.



62IDC_2984.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Further coil testing must be done. Megger testing would be able to determine the state that the coils are in. It must be addressed immediately before further deterioration occurs to this transformer.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Technician

Clint Gottschalk

Location

13th Floor Mech.

Tag ID

1486-A Phase 5-15kV Dry Transformers <= 500 kVA

Equipment Type

5-15kV Dry Transformers <= 500 kVA

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Ultrasonic Anomaly, There is a significant higher decibal level and a strong sound of unwanted internal arcing on the 3rd phase coil in comparison to the 1st and second phase coils.



62IDC_2985.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Proper megger testing on all phase coils.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

Page 5

Technician

Clint Gottschalk

Location

13th Floor Mech.

Tag ID

1486-B Phase 5-15kV Dry Transformers <= 500 kVA

Equipment Type

5-15kV Dry Transformers <= 500 kVA

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Ultrasonic Anomaly, There is a significant higher decibal level and a strong sound of unwanted internal arcing on the 3rd phase coil in comparison to the 1st and 2nd phase coils.



62IDC_2985.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Proper megger testing on all phase coils to determine deterioration.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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03, 2008		Equipment Item Problems Report - Including All Images		Page 6
Technician Clint Gottschalk		Location 13th Floor Mech.		
Tag ID 1486-B Phase 5-15kV Dry Transformers <= 500 kVA		Equipment Type 5-15kV Dry Transformers <= 500 kVA		

Problem Description - CRITICAL		☒ Immediate Hazard	☒ Customer Notified Immediately
There is possible resin residue from the phase coils indicating possible failure.			



62IDC_2984.jpg

Consequences if Not Corrected			
☒ Equipment Failure	☒ Fire Hazard	☒ Safety Hazard	☒ Power/Business Interruption

Recommendations For Repair		☒ Repair Equipment	☒ Replace Equipment
Further coil testing must be done. Megger testing would be able to determine the state that the coils are in. It must be addressed immediately before further deterioration occurs to this transformer.			

Corrective Actions			☐ Problem Corrected
☐ Fixed During Visit	☐ Contractor Will Correct	☒ Customer Will Correct	☐ Estimate Required



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Technician

Clint Gottschalk

Location

13th Floor Mech.

Tag ID

1486-C Phase 5-15kV Dry Transformers <= 500 kVA

Equipment Type

5-15kV Dry Transformers <= 500 kVA

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Ultrasonic Anomaly, There is a significant higher decibal level and a strong sound of unwanted internal arcing on the 3rd phase coil in comparison to the 1st and 2nd phase coils.



62DC_2985.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Proper megger testing on all phase coils to determine deterioration.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

13th Floor Mech.

Tag ID

1488 DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)

Equipment Type

DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Ultrasonic Anomaly, the contacts of breaker #11 are displaying very high decibal levels and need to be cleaned immediately.



62\DC_2990.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Inspect and clean the contacts of this breaker, If the breaker appears to be in bad condition internally, "replace immediately".

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Technician

Clint Gottschalk

Location

13th Floor Mech.

Tag ID

1486-C Phase 5-15kV Dry Transformers <= 500 kVA

Equipment Type

5-15kV Dry Transformers <= 500 kVA

Problem Description - **ALERT**

☒ Immediate Hazard

☒ Customer Notified Immediately

There is possible resin residue beneath the phase coils.



62IDC_2984.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Further coil testing must be done. Megger testing would be able to determine the state that the coils are in. It must be addressed immediately before further deterioration occurs to this transformer.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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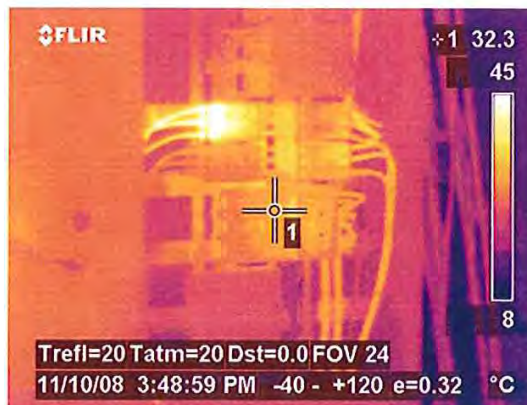
Technician Clint Gottschalk	Location 13th Floor Mech.
Tag ID 1488 DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	Equipment Type DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)

Problem Description - **ALERT**

☐ Immediate Hazard

☐ Customer Notified Immediately

Millivolt drop is greater than 50% deviation of the lowest measured value on adjacent poles (2001 NETA Maintenance Testing Specification) or 100 millivolts at full load, which is defined as 80% of a device rating.



62lir_2988.jpg

Consequences if Not Corrected

☒ Equipment Failure ☐ Fire Hazard ☐ Safety Hazard ☒ Power/Business Interruption

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize device, clean, repair, or replace defective items as necessary and torque connection to manufacturer specifications.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☐ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

Page 11

Technician

Clint Gottschalk

Location

14th Floor Mech.

Tag ID

1490 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

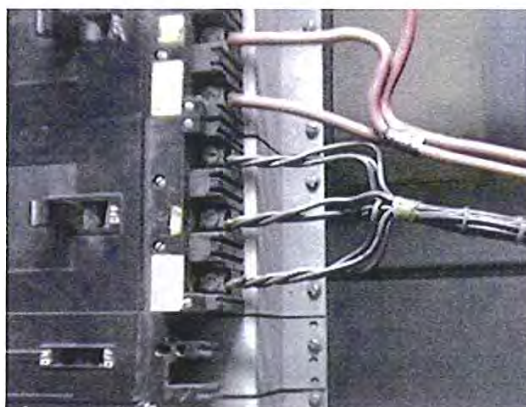
Distribution Panel Single Front (≥ 400 amp)

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Parallel conductors smaller than 1/0 are installed improperly. 2002 NEC 310.4



62ldc_2995.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☐ Safety Hazard

☐ Power/Business Interruption

A failure of one conductor may result in the overheating and failure of the other.

Recommendations For Repair

☐ Repair Equipment

☒ Replace Equipment

Remove and reinstall proper sized conductors for this application.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

14th Floor Mech.

Tag ID

1490 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

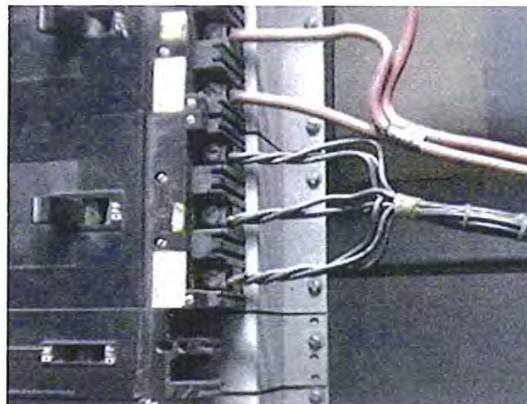
Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

Multiple conductors under one lug on a breaker or fused disconnect.



62IDC_2995.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

This may cause overloading of the protective device resulting in premature operation and unscheduled interruptions.

Recommendations For Repair

☒ Repair Equipment

☒ Replace Equipment

Deenergize circuit, remove additional conductor(s), and terminate on properly sized overcurrent device.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Current phase imbalance is greater than 20%.



62lir_2896.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

If there are non-linear devices on this system, the heating characteristics will be amplified due to 60 hZ return currents on the neutral conductor.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate load distribution and redistribute to allow for reduction of neutral return currents.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62lir_2896.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

2nd Floor Mech.

Tag ID

1460 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62\lr_2896.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

Page 16

Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1465 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **CRITICAL**

☐ Immediate Hazard

☒ Customer Notified Immediately

Current phase imbalance is greater than 20%.



62lir_2918.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

If there are non-linear devices on this system, the heating characteristics will be amplified due to 60 hZ return currents on the neutral conductor.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate load distribution and redistribute to allow for reduction of neutral return currents.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1465 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62lir_2918.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

Page 18

Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1469 Individual Disconnect Switch

Equipment Type

Individual Disconnect Switch

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

Missing insulated fittings/bushings (2002 NEC 300.4 (F)), raceways containing ungrounded conductors 4 AWG or larger entering a cabinet or box enclosure must have bushings installed.



62IDC_2928.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Chaffing of the conductors may cause an arc flash if the insulation were to degrade and allow the conductor material to contact conductive parts of the equipment.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Deenergize the circuit(s), remove conductor(s), install properly sized fittings/bushings, reinstall conductors and return to operation.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

3rd. Floor Mech.

Tag ID

1469 Individual Disconnect Switch

Equipment Type

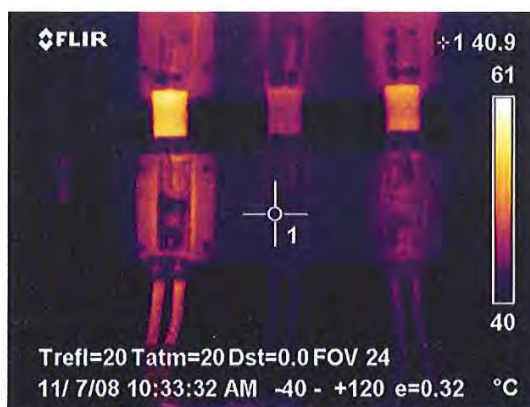
Individual Disconnect Switch

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

Current phase imbalance is greater than 20%.



62\lr_2926.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

If there are non-linear devices on this system, the heating characteristics will be amplified due to 60 hZ return currents on the neutral conductor.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate load distribution and redistribute to allow for reduction of neutral return currents.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1445 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

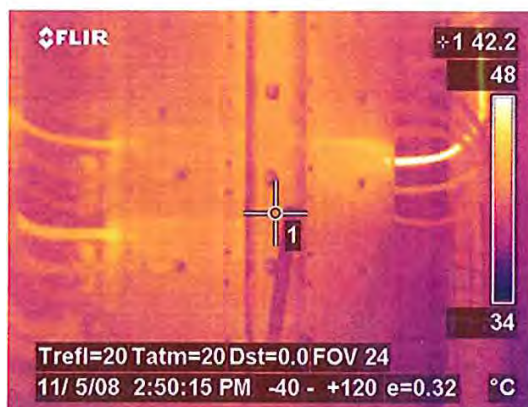
Distribution Panel Single Front (≥ 400 amp)

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62lir_2866.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1445 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☒ Immediate Hazard

☒ Customer Notified Immediately

Current phase imbalance is greater than 20%.



62lir_2866.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

If there are non-linear devices on this system, the heating characteristics will be amplified due to 60 hZ return currents on the neutral conductor.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate load distribution and redistribute to allow for reduction of neutral return currents.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1445 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

Missing insulated fittings/bushings (2002 NEC 300.4 (F)), raceways containing ungrounded conductors 4 AWG or larger entering a cabinet or box enclosure must have bushings installed.



62IDC_2870.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Chaffing of the conductors may cause an arc flash if the insulation were to degrade and allow the conductor material to contact conductive parts of the equipment.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Deenergize the circuit(s), remove conductor(s), install properly sized fittings/bushings, reinstall conductors and return to operation.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1447 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

Distribution Panel Single Front (≥ 400 amp)

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Current phase imbalance is greater than 20%.



62lir_2873.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

If there are non-linear devices on this system, the heating characteristics will be amplified due to 60 hZ return currents on the neutral conductor.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate load distribution and redistribute to allow for reduction of neutral return currents.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Technician

Clint Gottschalk

Location

Basement Air Handler Room

Tag ID

1447 Distribution Panel Single Front (≥ 400 amp)

Equipment Type

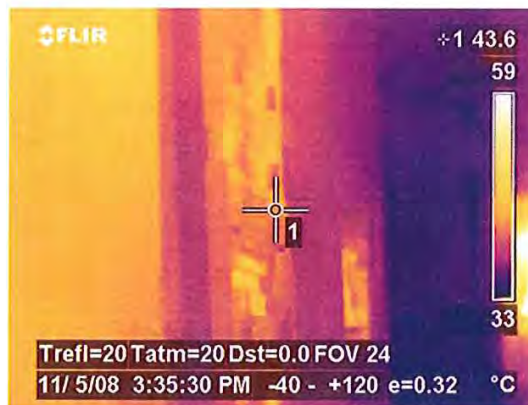
Distribution Panel Single Front (≥ 400 amp)

Problem Description - **ALERT**

☐ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62\lr_2873.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Problem Corrected

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

1432 Motor Control Center (Per vertical section)

Equipment Type

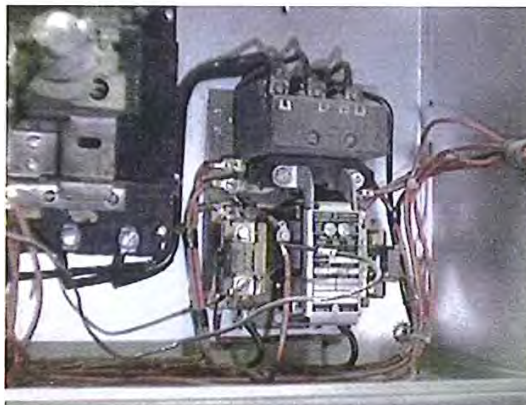
Motor Control Center (Per vertical section)

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Ultrasonic Anomaly, The decibals are at high levels on this contactor in comparison to the other contactors surrounding it. Wave file-007



62lde_2841.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☐ Repair Equipment

☒ Replace Equipment

Replace this contactor.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician Clint Gottschalk		Location Mezzanine
Tag ID 1432 Motor Control Center (Per vertical section)	Equipment Type Motor Control Center (Per vertical section)	

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

Ultrasonic Anomaly, The decibal level of this contactor is far greater than the contactors surrounding it.
Wave file-008



62ldc_2839.jpg

Consequences if Not Corrected

☒ Equipment Failure

☒ Fire Hazard

☒ Safety Hazard

☒ Power/Business Interruption

Recommendations For Repair

☐ Repair Equipment

☒ Replace Equipment

Replace this contactor.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Equipment Item Problems Report - Including All Images

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Technician

Clint Gottschalk

Location

Mezzanine

Tag ID

chiller 1 MCC: Motor Starters

Equipment Type

MCC: Motor Starters

Problem Description - **CRITICAL**

☒ Immediate Hazard

☒ Customer Notified Immediately

THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)



62\lr_3604.jpg

Consequences if Not Corrected

☒ Equipment Failure

☐ Fire Hazard

☐ Safety Hazard

☒ Power/Business Interruption

Not only will this cause increased heating at the main transformer, but it can cause excessive levels of voltage distortion that will escape the facility onto the utility distribution system and affect neighboring operations.

Recommendations For Repair

☒ Repair Equipment

☐ Replace Equipment

Investigate non-linear loads downstream in the facility to determine proper mitigation method(s) to employ that will allow a reduction of the THDC%F to manageable levels.

Corrective Actions

☐ Fixed During Visit

☐ Contractor Will Correct

☒ Customer Will Correct

☐ Problem Corrected

☐ Estimate Required



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Equipment Item Problem Count Summary

Agreement: BAS207472JW
Site Name: State of Kansas Docking Building
Site Visit Dates: 11/3/2008 - 11/4/2008
Site Visit Status: Completed

Location Within Facility

<u>Equip Tag ID</u>	<u>Equipment Item Description / Equipment Type</u>	<u>Problem Count</u>
<u>10th. Floor Mech.</u>		
1480	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	1 Problem Found None Corrected
1481	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>11th. Floor Mech.</u>		
1482	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	2 Problems Found 1 Corrected
1483	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>12th. Floor Mech.</u>		
1484	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	2 Problems Found None Corrected
1485	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>13th Floor Mech.</u>		
1486-A Phase	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	2 Problems Found None Corrected
1486-B Phase	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	2 Problems Found None Corrected
1486-C Phase	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	2 Problems Found None Corrected
1487	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	2 Problems Found None Corrected
1488	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
DP_401_NEW_1	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
SWB_MUL_NEW_1	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
<u>14th Floor Mech.</u>		
1489	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	2 Problems Found None Corrected
1490	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
1491	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
1492	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>2nd Floor Mech.</u>		
1459	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	6 Problems Found None Corrected
1460	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
1461	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
462	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	2 Problems Found None Corrected



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Equipment Item Problem Count Summary

Agreement: BAS207472JW
Site Name: State of Kansas Docking Building
Site Visit Dates: 11/3/2008 - 11/4/2008
Site Visit Status: Completed

<u>Location Within Facility</u>	<u>Equip Tag ID</u>	<u>Equipment Item Description / Equipment Type</u>	<u>Problem Count</u>
<u>2nd Floor Mech.</u>			
	DP_401_NEW_3	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	SWB_MUL_NEW_	DISTRIBUTION SWITCHBOARD Multi Cover (Per Section) / DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)	
	TRDI_5_NEW_3	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>3rd. Floor Mech.</u>			
	1463	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
	1464	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	1 Problem Found None Corrected
	1465	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	3 Problems Found None Corrected
	1466	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
	1467	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	1 Problem Found None Corrected
	1468	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
	1469	Individual Disconnect Switch / Individual Disconnect Switch	2 Problems Found None Corrected
<u>5th. Floor Mech.</u>			
	1470	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
	1471	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	1 Problem Found None Corrected
<u>6th. Floor Mech.</u>			
	1472	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	1 Problem Found None Corrected
	1473	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>7th. Floor Mech.</u>			
	1474	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
	1475	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
<u>8th. Floor Mech.</u>			



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Equipment Item Problem Count Summary

Agreement: BAS207472JW
Site Name: State of Kansas Docking Building
Site Visit Dates: 11/3/2008 - 11/4/2008
Site Visit Status: Completed

Location Within Facility

<u>Equip Tag ID</u>	<u>Equipment Item Description / Equipment Type</u>	<u>Problem Count</u>
<u>8th. Floor Mech.</u>		
1476	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
1477	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>9th. Floor Mech.</u>		
1478	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
1479	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
<u>1st Floor Air Handler Room</u>		
1457	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
1458	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	1 Problem Found None Corrected
DP_401_NEW_2	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	
<u>Pancreas Air Handler Room</u>		
145	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	4 Problems Found None Corrected
1446	5-15kV Dry Transformers ≤ 500 kVA / 5-15kV Dry Transformers ≤ 500 kVA	
1447	Distribution Panel Single Front (≥ 400 amp) / Distribution Panel Single Front (≥ 400 amp)	4 Problems Found 1 Corrected
<u>Main Switch Gear</u>		
1448	5-15kV Switchgear / 5-15kV Switchgear	
1449	5-15kV Switchgear / 5-15kV Switchgear	
1450	5-15kV Switchgear / 5-15kV Switchgear	
1451	5-15kV Switchgear / 5-15kV Switchgear	
1452	5-15kV Switchgear / 5-15kV Switchgear	
1453	5-15kV Switchgear / 5-15kV Switchgear	
1454	5-15kV Switchgear / 5-15kV Switchgear	
1455	5-15kV Switchgear / 5-15kV Switchgear	
1456	5-15kV Switchgear / 5-15kV Switchgear	
DSSO_5_NEW_1	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_2	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_3	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	



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Equipment Item Problem Count Summary

Agreement: BAS207472JW
Site Name: State of Kansas Docking Building
Site Visit Dates: 11/3/2008 - 11/4/2008
Site Visit Status: Completed

Location Within Facility

<u>Equip Tag ID</u>	<u>Equipment Item Description / Equipment Type</u>	<u>Problem Count</u>
<u>Main Switch Gear</u>		
DSSO_5_NEW_4	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_5	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_6	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_7	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_8	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
DSSO_5_NEW_9	5-15kV Disconnects (Open) / 5-15kV Disconnects (Open)	
TRD1_5_NEW_1	5-15kV Dry Transformers <= 500 kVA / 5-15kV Dry Transformers <= 500 kVA	
<u>Mezzanine</u>		
1427	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	1 Problem Found None Corrected
1428	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1429	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1430	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1431	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1432	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	4 Problems Found None Corrected
1433	5-15kV Dry Transformers <= 500 kVA / 5-15kV Dry Transformers <= 500 kVA	
1434	Distribution Panel Single Front (>= 400 amp) / Distribution Panel Single Front (>= 400 amp)	
1435	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1436	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1437	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1438	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1439	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1440	Motor Control Center (Per vertical section) / Motor Control Center (Per vertical section)	
1441	Switchgear - Incoming Main Service (Per Section) / Switchgear - Incoming Main Service (Per Section)	
1442	Switchgear - Incoming Main Service (Per Section) / Switchgear - Incoming Main Service (Per Section)	
1443	Switchgear - Incoming Main Service (Per Section) / Switchgear - Incoming Main Service (Per Section)	



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Equipment Item Problem Count Summary

Agreement: BAS207472JW
Site Name: State of Kansas Docking Building
Site Visit Dates: 11/3/2008 - 11/4/2008
Site Visit Status: Completed

Location Within Facility

<u>Equip Tag ID</u>	<u>Equipment Item Description / Equipment Type</u>	<u>Problem Count</u>
Mezzanine		
1444	5-15kV Dry Transformers <= 500 kVA / 5-15kV Dry Transformers <= 500 kVA	
SWG_MAIN_NEW	Switchgear - Incoming Main Service (Per Section) / Switchgear - Incoming Main Service (Per Section)	
TRD2_5_NEW_1	5-15kV Dry Transformers 501-5000 kVA / 5-15kV Dry Transformers 501-5000 kVA	
TRD2_5_NEW_2	5-15kV Dry Transformers 501-5000 kVA / 5-15kV Dry Transformers 501-5000 kVA	
chiller 1	MCC: Motor Starters / MCC: Motor Starters	2 Problems Found None Corrected
chiller 2	MCC: Motor Starters / MCC: Motor Starters	
chiller 3	MCC: Motor Starters / MCC: Motor Starters	



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EDS Component Problem Summary

State of Kansas Docking Building

BAS207472JW

Tag ID	Date	Category	Customer Identification	Problem Description	Repaired
Location: 10th. Floor Mech.					
1480			Distribution Panel Single Front (>= 400 amp)		Repaired
11/03/08	HEAT		"_a_" Phase breaker contact is displaying abnormal thermal pattern compared to "_b_" and "_c_" Phase contacts and elevated contact resistance is confirmed by millivolt measurements.		☐
Location: 11th. Floor Mech.					
1482			Distribution Panel Single Front (>= 400 amp)		Repaired
11/03/08	BENCHMARK VAL		THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)		☐
11/03/08	HEAT		"_b_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_c_" Phase contacts.		☒
Location: 12th. Floor Mech.					
1484			Distribution Panel Single Front (>= 400 amp)		Repaired
11/03/08	BENCHMARK VAL		THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)		☐
11/03/08	HEAT		"_b_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_c_" Phase contacts.		☐
Location: 13th Floor Mech.					
1486-A Phase			5-15kV Dry Transformers <= 500 kVA		Repaired
11/03/08	Transformer		There is possible resin residue beneath the phase coils.		☐
11/03/08	ULTRASONIC		Ultrasonic Anomaly, There is a significant higher decibal level and a strong sound of unwanted internal arcing on the 3rd phase coil in comparison to the 1st and second phase coils.		☐
1486-B Phase			5-15kV Dry Transformers <= 500 kVA		Repaired
11/03/08	Transformer		There is possible resin residue from the phase coils indicating possible failure.		☐
11/03/08	ULTRASONIC		Ultrasonic Anomaly, There is a significant higher decibal level and a strong sound of unwanted internal arcing on the 3rd phase coil in comparison to the 1st and 2nd phase coils.		☐
1486-C Phase			5-15kV Dry Transformers <= 500 kVA		Repaired
11/03/08	ULTRASONIC		Ultrasonic Anomaly, There is a significant higher decibal level and a strong sound of unwanted internal arcing on the 3rd phase coil in comparison to the 1st and 2nd phase coils.		☐
11/03/08	Transformer		There is possible resin residue beneath the phase coils.		☐
1488			DISTRIBUTION SWITCHBOARD Multi Cover (Per Section)		Repaired
11/03/08	ULTRASONIC		Ultrasonic Anomaly, the contacts of breaker #11 are displaying very high decibal levels and need to be cleaned immediately.		☐
11/03/08	BENCHMARK VAL		Millivolt drop is greater than 50% deviation of the lowest measured value on adjacent poles (2001 NETA Maintenance Testing Specification) or 100 millivolts at full load, which is defined as 80% of a device rating.		☐
Priority Code:	Critical - Immediate attention required!		Severe - Attention required within the next 30-90 days!		Alert - Needs attention as time permits!

TGO-119 (1/1/05)

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EDS Component Problem Summary

State of Kansas Docking Building

BAS207472JW

Tag ID	Date	Category	Customer Identification	Problem Description	Repaired				
Location: 14th Floor Mech.									
1490			Distribution Panel Single Front (>= 400 amp)		Repaired				
11/03/08	CONDUCTOR SIZE	Parallel conductors smaller than 1/0 are installed improperly. 2002 NEC 310.4		☐					
11/03/08	CONNECTIONS	Multiple conductors under one lug on a breaker or fused disconnect.		☐					
Location: 2nd Floor Mech.									
1460			Distribution Panel Single Front (>= 400 amp)		Repaired				
11/03/08	HEAT	"_c_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_b_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.		☐					
11/03/08	HEAT	"_a_" and "_c_" Phase breaker contacts are displaying abnormal thermal patterns compared to "_b_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.		☐					
11/03/08	HEAT	Heat Related Problem. Total Current Harmonic Distortion levels are at a high percent on each phase.		☐					
11/03/08	BENCHMARK VAL	Current phase imbalance is greater than 20%.		☐					
11/03/08	BENCHMARK VAL	THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)		☐					
11/03/08	BENCHMARK VAL	THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)		☐					
1462			Distribution Panel Single Front (>= 400 amp)		Repaired				
11/03/08	HEAT	Heat Related Problem, The total harmonic current distortion is at a high percentage.		☐					
11/03/08	HEAT	Heat Related Problem. High total current harmonic distortion percentage.		☐					
Location: 3rd. Floor Mech.									
1464			Distribution Panel Single Front (>= 400 amp)		Repaired				
11/03/08	HEAT	"_a_" Phase breaker contact is displaying abnormal thermal pattern compared to "_b_" and "_c_" Phase contacts and elevated contact resistance is confirmed by millivolt measurements.		☐					
1465			Distribution Panel Single Front (>= 400 amp)		Repaired				
11/03/08	BENCHMARK VAL	Current phase imbalance is greater than 20%.		☐					
11/03/08	HEAT	Heat Related Problem, Unbalanced loads are occurring. Harmonics are also at near to high percentage levels		☐					
11/03/08	BENCHMARK VAL	THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)		☐					
1467			Distribution Panel Single Front (>= 400 amp)		Repaired				
11/03/08	HEAT	Heat Related Problem. Pitting inside the breaker is forming do to the age and constant load on this breaker.		☐					
1469			Individual Disconnect Switch		Repaired				
<table border="1"> <tr> <td>Priority Code:</td> <td>Critical - Immediate attention required!</td> <td>Severe - Attention required within the next 30-90 days!</td> <td>Alert - Needs attention as time permits!</td> </tr> </table>						Priority Code:	Critical - Immediate attention required!	Severe - Attention required within the next 30-90 days!	Alert - Needs attention as time permits!
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EDS Component Problem Summary

State of Kansas Docking Building

BAS207472JW

Tag ID	Date	Category	Customer Identification	Problem Description
Location: 3rd. Floor Mech.				
1469			Individual Disconnect Switch	Repaired
11/03/08	CONNECTIONS		Missing insulated fittings/bushings (2002 NEC 300.4 (F)), raceways containing ungrounded conductors 4 AWG or larger entering a cabinet or box enclosure must have bushings installed.	☐
11/03/08	BENCHMARK VAL		Current phase imbalance is greater than 20%.	☐
Location: 5th. Floor Mech.				
1471			Distribution Panel Single Front (>= 400 amp)	Repaired
11/03/08	HEAT		Circuit #_7_ has a temperature rise greater that 10 degrees C over the ambient air surrounding it under normal operating conditions.	☐
Location: 6th. Floor Mech.				
1472			Distribution Panel Single Front (>= 400 amp)	Repaired
11/03/08	HEAT		Circuit #_11_B phase contact has a temperature rise greater than 10 degrees C over the ambient air surrounding it under normal operating conditions.	☐
Location: 1st Floor Air Handler Room				
8			Distribution Panel Single Front (>= 400 amp)	Repaired
11/03/08	HEAT		"_a_" and "_c_" Phase breaker contacts are displaying abnormal thermal patterns compared to the "_b_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.	☐
Location: Basement Air Handler Room				
1445			Distribution Panel Single Front (>= 400 amp)	Repaired
11/03/08	BENCHMARK VAL		THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)	☐
11/03/08	HEAT		"_c_" Phase breaker contact is displaying abnormal thermal pattern compared to "_a_" and "_b_" Phase contacts.	☐
11/03/08	CONNECTIONS		Missing insulated fittings/bushings (2002 NEC 300.4 (F)), raceways containing ungrounded conductors 4 AWG or larger entering a cabinet or box enclosure must have bushings installed.	☐
11/03/08	BENCHMARK VAL		Current phase imbalance is greater than 20%.	☐
1447			Distribution Panel Single Front (>= 400 amp)	Repaired
11/03/08	BENCHMARK VAL		Current phase imbalance is greater than 20%.	☐
11/03/08	BENCHMARK VAL		THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)	☐
11/03/08	HEAT		"_c_" Phase breaker contact is displaying abnormal thermal pattern compared to "_b_" and "_a_" Phase contact.	☐
11/03/08	HEAT		Heat Related Problem	☒
Location: Mezzanine				
Priority Code:	Critical - Immediate attention required!	Severe - Attention required within the next 30-90 days!	Alert - Needs attention as time permits!	

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EDS Component Problem Summary

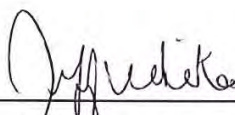
State of Kansas Docking Building

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Tag ID	Date	Category	Customer Identification	Problem Description	Repaired
Location: Mezzanine					
1427			Motor Control Center (Per vertical section)		Repaired
11/03/08	HEAT		"_C_" Phase breaker contact is displaying abnormal thermal patterns compared to "_B_" and "_A_" Phase contacts and elevated contact resistance is confirmed by millivolt measurements.		☐
1432			Motor Control Center (Per vertical section)		Repaired
11/03/08	HEAT		Heat Related Problem, The contacts are getting bad.		☐
11/03/08	HEAT		Heat Related Problem, The contacts are getting bad.		☐
11/03/08	ULTRASONIC		Ultrasonic Anomaly, The decibal level of this contactor is far greater than the contactors surrounding it. Wave file-008		☐
11/03/08	ULTRASONIC		Ultrasonic Anomaly, The decibals are at high levels on this contactor in comparison to the other contactors surrounding it. Wave file-007		☐
chiller 1			MCC: Motor Starters		Repaired
11/03/08	BENCHMARK VAL		THDC%F (At the point of common coupling) is greater than 5% in an industrial building or greater than 20% in a commercial building. (IEEE 519-1992)		☐
11/03/08	HEAT		"_B_" Phase breaker contact is displaying abnormal thermal pattern compared to "_A_" and "_C_" Phase contact and elevated contact resistance is confirmed by millivolt measurements.		☐

Review Date: _____

Customer Representative
Dale Bowman
Building Superintendent
BAS207472JW


TEGG Service Representative

Priority Code:	Critical - Immediate attention required!	Severe - Attention required within the next 30-90 days!	Alert - Needs attention as time permits!
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