LKPB ENGINEERS, INC.

State of Minnesota
Department of Administration
Plant Management Division and
Real Estate and Construction Services

Schematic Design Report
Centennial Office Building
Electrical Distribution Upgrades

State Project #: 02CO0018

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March 13, 2015

LKPB ENGINEERS, INC.
MECHANICAL • ELECTRICAL

March 13, 2015

Mr. Harvey Jaeger
Department of Administration
Real Estate and Construction Services
50 Sherburne Avenue
St. Paul, MN 55110

Re: Electrical Distribution System Upgrades at the Centennial Office Building
Final Schematic Design Report
RECS Project No.: 02CO0018
LKPB Project No.: 2014.079.00

Dear Mr. Jaeger:

LKPB Engineers greatly appreciates the opportunity to work with the State of Minnesota on this project. The Centennial Office Building is a long standing monument on the Capitol Complex and we enjoyed digging into the building's inner electrical system.

This Schematic Design report and the accompanying drawing set represent a useful design direction. While the project is indefinitely on hold, the information inside represents months of discussions and decisions, arriving at a feasible design for implementation. Please review the documents. If there are any questions or comments on any topic in the report, please contact me.

Sincerely,

LKPB Engineers, Inc.

Allen V. Theisen

Allen V. Theisen, P. E.
Vice President

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Attached
Schematic Design Report

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INTRODUCTION

This electrical system upgrade is an exciting project for Plant Management. It essentially replaces the building's power distribution system with whole new equipment, eliminating a number of maintenance and troublesome issues. This report introduces the project in the paragraphs below by describing the Project Basis, the Scope of Services, and introducing the Team.

Project Basis

The State of Minnesota constructed the Centennial Office Building (COB) in 1958 to meet the growing need for state services. Its electrical systems construction mimicked the modern construction methods for large buildings. Many of these methods are still used today because of their robust nature. Unfortunately, the equipment installed at the building's birth remains in the building and urgently needs updating.

Aged equipment is the first item driving the project basis. Plant Management stated that nearly all of the original equipment still in service and other equipment installed over 30 years has become a maintenance problem. They find it hard to obtain parts for old equipment and increasingly find equipment wear.

Electrical code violations occur periodically throughout the building. Some occur due to changing codes where updated safety considerations changed a legal installation to an installation that no longer complies. Other situations were a result of careless installation and missed red tag on inspection. The upgrade will eliminate electrical code issues.

The tenants noted an annoying 60 cycle hum as insulation began breaking down in riser closet transformers. This noise distracted tenants located near electrical closets and affected productivity. The noise seems to occur across the facility. Mitigating the problem is also part of the project basis.

From the first years this electrical system was in service, the state has modified the system to meet changing needs. The electrical system now consists of an overly complex arrangement where electrical feeders, branch circuits, and equipment support the building in a spaghetti like mess. This project is to mitigate everything it can.

The building's emergency egress lighting system is another project driver. The system lights far more than just the path of egress. Reducing the emergency lighting to more accurately represent a path of egress lighting system is part of the state's overall plan to reduce energy consumption.

These items, along with a few small ancillary items, create the basis for the electrical upgrade. In short, the aging electrical system needs an upgrade to address failing equipment, code issues, and an overly complex distribution system.

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Scope of Services

The design team was selected to provide full engineering consulting services. The process began with an extended schematic design where an extensive site survey was conducted, owner programming performed, and this report assembled. At the end of Schematic Design, the state will set the project budget based on the design team's recommendations and determine direction for completing the remainder of design and construction services.

As the project proceeds through Design Development and Construction Documents phases, a construction cost estimate will be prepared at the end of each design phase to reaffirm the project budget. Also during these two phases, the design team will develop a Basis for Design. This document will define criteria from which the commissioning agent will perform their services. An important part of any system installation is its final installation performance. The design team and commissioning agent interaction will assure that the new electrical system will perform as intended and meet the owner's needs.

At the completion of Construction Documents, the design team will turn over the construction documents and the State will post them for bid. During the bid period, the design team will facilitate a pre-bid meeting and facility tour. The team will also field contractor questions and issue addendum prior to the bid date.

After receiving the bid packages, the design team will assist the State with contractor evaluations. There may be references to check, follow up to conduct, and recommendations to make. The goal is to hire the most qualified contractor for the project.

Construction administration services consist of the typical support as defined under the State's basic services agreement. These services include but are not limited to:

- Act as the State's representative for construction and manage all communications with the contractor.
- Perform construction observations to ensure construction document conformance.
- Review applications for payment to ensure equitable payment for completed work.
- Review equipment submittals
- Manage and process any construction changes
- Perform a system 10 month review prior to warranty end and facilitate resolving any warranty issues.

The Design Team shall have an Electrical Engineer as Team Lead, skilled in project management. This skillset will translate into a successfully completed electrical system upgrade for this building.

Third is an introduction to the team. The published RFP defined a selection process where the most qualified team is chosen through the State Designer Selection Board. LKPB Engineers assembled the highly qualified team shown below and embarked on the project's complex design.

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Project Team

Department of Administration 309 Administration Building 50 Sherburne Ave St. Paul, MN 55155 Real Estate and Construction Services	Jim Aleckson Gene Peterman Howard Hiipakka Chad Olson Bruce Dzieweczynski Harvey Jaeger
Plant Management Division MnIT Services	Mike Tuuri

Design Team

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EXECUTIVE SUMMARY

The Centennial Office Building electrical system upgrade is a project that Plant Management has deemed necessary for over a decade. The existing electrical system consists of wide mixture of original building equipment to new backup power systems. The modifications over the years created a mass of electrical tendrils that crisscross throughout the building. The upgrade is an effort to bring order to the electrical system and address other concerns that accompany an aged over modified system.

This Schematic Design Report goes into detail describing the need to address four primary electrical system items. It also expands on these items and describes a number of attached smaller issues. For the purposes of summarizing the scope involved, the following is a list of the primary system items Plant Management wants addressed. We leave the smaller issues for the in-depth, full report reader.

Primary Electrical System Issues

- **Replace All Electrical Service Equipment –** The electrical service equipment is aged and parts are becoming hard to find. This affects the ability to modify and maintain the equipment.
- **Replace the Bus Duct Riser System –** The bus ducts are original to the building and are hard to access in certain areas. Lack of access plays into the ability to maintain the equipment. Couple this with the difficulty finding parts this issue necessitates equipment replacement.
- **Transformer Replacements –** Existing transformers located in electrical closets have increasingly become noisy. Removing these transformers and reconfiguring the branch distribution system to decrease the noise is a tenant priority.
- **Reconfiguring the Backup Power System –** The backup power system is oversized for the building and improperly supports the building life safety systems. This report makes recommendation to address the oversize and presents a plan to remedy the life safety system support.

This report describes the Centennial Office Building's existing electrical system and diagrammatically reflects the description in an accompanying set of plans. It presents a plan for upgrading this system with new equipment to address the primary electrical system items and accompanying smaller issues. The report appendices contain more detailed information about existing equipment, new design direction, equipment selections, and recommended processes.

The report's electrical design direction is a result of three months of intensive site survey, multiple planning meetings, and extensive industry research. The building's electrical systems are complex and serve a diverse set of office building constituents and equipment. Meeting the needs meant that the design team needed to understand not only what the electrical system serves, but also how the building is used. Schematic design was extended to 30 % of the design phase to gain an understanding of the building, its use, and Plant Management's desires. This report reflects this effort.

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This project requires a few design approaches that use unique equipment and services. These approaches will be apparent when reading about grounding and addressing transformer noise.

A unique approach will also appear where the design team recommended an electrical service switchover. Plant Management clearly defined that this project must minimize down time for the building. This included restricting power outages to times outside regular business hours. These requirements lead to developing a planned service migration that would require only one or two building outages.

Estimated Project Budget

The design team's estimated project budget consists of a joint effort by engineers, an electrical contractor, architect, cost estimator, and factory representatives. The team performed equipment take-offs and labor estimates to summarize actual installations. Some square foot estimating was included to account for loosely defined project scope, but these estimates represent a small minority.

A more detailed spreadsheet of the schematic budget can be found later in the report, but the following is a summary of the budget.

Electrical Systems	$7,461,000.00
Mechanical Systems	$114,860.00
Architectural Systems	$481,500.00
General Conditions	$805,736.00
Subtotal	**$8,863,096.00**
10% Design Contingency	$886,309.60
Total Budget Estimate	**$9,749,405.60**

This Schematic Design report was written as a standalone electrical upgrade. Near the end of the schematic phase, the design team found that the project cost would be well in excess of the planned budget. Plant Management weighed the options for proceeding with the project verses waiting with the upgrade until a total building renovation occurred. The final decision was driven by the cost of performing the upgrade while the building is occupied and the building wide tenant impact. The design team found that the project labor cost was at least two thirds higher than that of a vacant building renovation. Combine this with the tenant impacts, it seemed impractical to move ahead with the project.

The result of the Schematic design findings placed the electrical upgrade on hold. The following report presents the criteria for which a stand along electrical project, but many aspects can integrate into a full building renovation.

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EXISTING SYSTEM DESCRIPTION

The Electrical Service Equipment

The original Centennial Office Building began with a simpler electrical system than it has today. Over the years the tenant needs demanded more robust electrical support and so began the changes and upgrades to a mix of electrical equipment spanning 60 years.

A few aspects of the 1958 original building electrical system remain today. Most of these original components are replacement targets for this project. Of these components, the RE&I medium voltage switches are at the top of the list.

The RE&I switches were the first point of utility connection back in 1958. Power entered the building from Northern States Power, terminated on the four switches, then distributed to the downstream equipment. Today, the electrical system uses only two of the four switches in a 13.8 kV switching scheme downstream from a pair of motorized, 13.8 kV G&W switches.

In 1995, Plant Management Division began upgrading the campus electrical distribution system and to service all buildings with two 13.8 kV loops. The COB receives electrical power from campus loops S1 and S2 in 1998. The upgrade brought increased reliability across campus. In order for the individual buildings to take advantage of this reliability, a new 13.8 kV switching scheme was needed at the service entry point. Thus the installation of the G&W switches (shown at the right). These switches allow the campus electricians to seamlessly switch between the two campus loops affecting minimal building downtime.

The 1958 plans indicate that the RE&I equipment connected two unit substations. Today there are four. Two receive power from the RE&I switches and two receive power directly from the G&W switches. To see the existing interconnections between the campus loops, the 13.8 kV switches, and the unit substations, please refer to Sheet ED1.1.0 – Existing Partial One-line in the plan set.

Four main switchboards supply power to the entire building. Switchboards #1 and #2 consist of two of the above mentioned unit substations, configured as a main-tie-main, double ended substation. Switchboards #3 and #4 stand alone, supporting their respective areas of the building. Appendix A contains a listing of the existing switchboards with the equipment they serve. Refer to Appendix A for more information about these switchboards.

One main electrical room houses the above mentioned equipment. At the close of this project, the electrical room will no longer contain electrical service equipment. PMD may choose to repurpose the space for storage, maintenance staff muster space or other such useful purposes.

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The Backup Power System

A portion of this building is supported by a two megawatt (2 MW) engine generator. This generator is located inside the building adjacent to the loading dock on the south end of the facility. This Tier 2 rated system has a 10,000 gallon diesel tank that could fuel the generator for approximately 70 hours running at full load.

The generator currently supports about 40% of the main service connections. While it has the capacity to back up the entire building, it currently supports the building lighting, a major IT tenant, and life safety loads such as the fire pump and elevators.

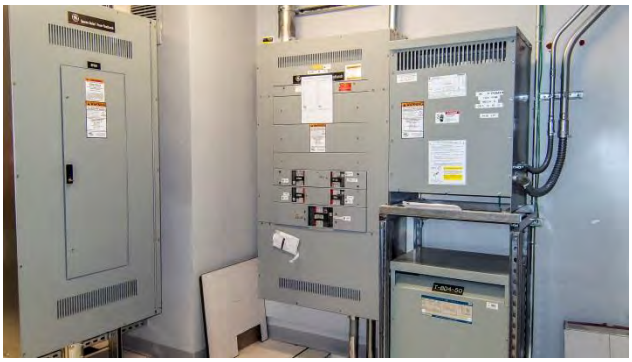
Throughout the schematic design, the group pursued several courses of action to create a backup power system that is appropriately sized for this building and its program. One scheme removed the 2 MW system and replaced it with two 750 kW generators. This scheme provided ample power to support life safety loads, optional standby loads, and a redundant backup power system for MnIT. Early on, it was determined that this scheme would adversely affect the project budget and was abandon.

A second scheme brought to the building an existing 350 kW generator from the State's 321 Grove Street facility. In this scheme, the 2 MW system would be dedicated to the MnIT group and the 350 kW system would support building life safety and select optional standby loads. The design team determined that the entire 350 kW capacity is needed to support egress lighting, the starting and running of an elevator, the starting and running of the fire pump, and the starting and running of stair pressurization fans. Plant Management wanted to use spare capacity to support general building, non-essential loads. Since the generator capacity was spoken for by the life safety loads, this approach was abandoned.

The goal of relocating the 350 kW generator was to separate COB backup power from MnIT backup power. It made no sense to relocate the generator if it supported only life safety for COB and offered no opportunity to create optional standby support. Since the budget would not support purchasing a new larger generator to create separation, a third scheme developed.

The third scheme will leave the 2 MW generator in place and separate COB loads from MnIT loads within the building. PMD and the design team are currently searching for ways to use the 2 MW generator more effectively.

The Distribution System



The building's internal electrical distribution system breaks down into several separate arteries. Each has its distinct purpose serving equipment, areas, or tenants within the building. Below is a general list of the major distribution arteries in the building. For a detailed description of the distribution system and the areas served by them, see the existing system's electrical riser diagram on sheet ED1.1.1-Riser diagram demolition attached.

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Distribution Artery	Area Served
Four bus ducts – A, B, C, D	These bus ducts rise from the ground floor through the 5th floor supplying power primarily to the equipment directly supporting the building users.
ATS #1	Supplies both optional standby and life safety loads. 80% - 90% of the building lighting receives power from this switch via a system of panels labeled EGH. The building elevators also reside on this transfer switch, fed by a dedicated feeder.
ATS #2	The building Fire Pump
MnIT (ATS #3, ATS #4, ATS #5, ATS #6, ATS #7, ATS #9, ATS #11)	This group's equipment primarily resides on the south half of 5th floor. The equipment is supplied power through a redundant system of transfer switches and UPS power systems
ATS #8	This serves the parking ramp lighting
Mechanical system loads	MCC-1, MCC-2a, ramp exhaust, mechanical systems control power.
Miscellaneous loads	These loads are a small part of what is not included above. These include general electrical power to the ramp.

Note: There is no ATS #10. This transfer switch was removed from the engine generator room leaving its enclosure as a cabling section for other equipment in the room.

The Life Safety Systems

The required life safety systems for COB consist of egress lighting, a fire pump, fire alarm system, an elevator, and stair pressurization fans. All except the stair pressurization fans receive power off from the backup power system. While the generator supports most of the required systems, the distribution system serving them does not appropriately separate life safety from other building loads.

The National Electrical Code requires an electrically separate distribution system for loads that support a building's life safety systems. This requirement ensures a measure of protection for life safety systems if there is a failure (e.g. short circuit or breakdown) in the system that supplies normal or optional standby power to a building. The COB life safety systems reside on the same distribution power system as other loads. This project will create a life safety distribution system and separate loads such as IT, from life safety loads.

The building lighting system is 80% to 90% generator supported. During this project, a lighting separation will be created that lights only the path of egress with emergency lighting. The normal power system or the optional standby system will power the remaining lighting.

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Separating the egress lighting resolves two issues PMD struggled with over the years. First, it creates the required separation of life safety systems from other building systems to meet code requirements. Second, it opens up the opportunity to implement energy saving control options on the general lighting system.

While the systems are integrated, extinguishing general office lighting means extinguishing egress lighting. Implementing code compliant egress lighting control means extensively controlling general office lighting as well. This leaves the option of leaving too many lights on or controlling more egress lighting than necessary. The first wastes energy and the second does not meet the building program needs.

Communications Cabling

This building contains a great deal of communications cabling. Since communications systems have changed more than any other building systems over the last 60 years, any infrastructure preparation installed to accommodate cabling is severely outdated. As a result, communications cable pathways installed over the past 20+ years used the most logical and available route. Most of the floor to floor routes exist in the electrical riser closets.

Removing communications cables from electrical rooms is one of the PMD goals for this project. Demolishing some of the cables will be easy. An example is old telephone system cabling. Most of the building converted to IP telephone systems within the last five years, eliminating the need for the supporting cable system.

A share of the cables will need relocation. Recently, the state completed a major fiber optic backbone cabling project within COB. These cables rise through the C & B electrical closets.

The design team was tasked to assess the extent of the communications cable system in the closets. From this, the team will develop a scope and budget to achieve the cable removal goal. This task is currently underway and will add to this report in addenda.

Existing HVAC Systems

As part of the recent MNIT HUB project, there were six (6) Liebert MCM-160 units installed that provided 304 MBH capacity to the building. Per conversations with the client, this provides adequate capability to provide electrical and communications closet cooling for this project given that the closets need less than 10% of this total capacity. This is the dry-cooler portion of the system that will operate 24 hours, seven days a week to maintain temperature in the space. Within existing spaces B2, B4 and B6, the existing mechanical systems will remain in place, if ceilings are to change, these need to be temporarily supported during construction and then rehung. Within space B87B, the existing mechanical systems will remain in place. If ceilings are to change these need to be temporarily supported during construction and then rehung. Within existing spaces G26, G53, 226, 270, 418 and 484, the existing mechanical systems will remain in place. If ceilings are to change these need to be temporarily supported during construction and then rehung.

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Existing Fire Sprinkler System

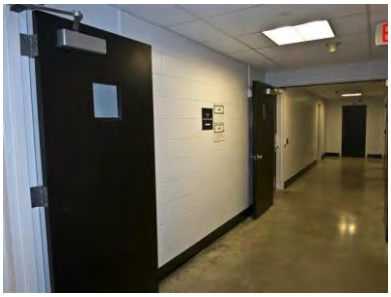
The building contains an existing wet-pipe fire sprinkler system with supplemental fire pump currently provides coverage of the spaces affected per this scope. The systems requiring modification during construction will be designed to provide a level of fire protection consistent with the fire hazard in accordance with the requirements of local codes, NFPA and the local fire authority.

Existing Architectural Systems – Demolition and Area Preparation

The existing architectural demolition will follow the construction path defined by the electrical system installation. As with the electrical system, work will begin in the new electrical room.

Demolition in the new space will begin prior to issuing construction documents. The team believes it is important to survey and understand what is above the existing ceiling spaces (see adjacent photo). The State has agreed to contract an early demolition package to remove the ceilings where the new electrical services will reside. This will provide the opportunity to define what equipment is installed and resolve any code or construction issues.

Three primary architectural construction items require demolition. The first occurs in the same space where the early demolition package took place. The new electrical room will take over three large rooms and a number of small rooms on the west side of the building. Walls need to come down and doors removed in order to create the space. See detail 4 on sheet ED0.00 for the scope of demolition of rooms B2, B4, and B6.



The second demolition area deals with the basement level corridor and ceilings in rooms west of the corridor. The contractors will move equipment and materials in and out of the building using the lower level corridor. The design team is recommending that the doors, door frames, and ceilings be removed. This will allow the maximum space for continuous access to work spaces. Additionally, the acoustical ceilings in the basement rooms along the west end of the building must temporarily come out. This allows access to the building structure for mounting feeder conduits, cable tray, and other new equipment.

The last demolition areas occur on the upper floors. Each floor requires an expansion of electrical closets. Most expansions occur at the north – A closet, where additional space is claimed and a new opening cut into the existing electrical closet. These expansions and the new openings are best represented on the plan sheets E1.1.0 through E1.6.0.

Other miscellaneous demolition will be necessary to complete this project. Further project definition is needed to refine where these areas will occur.

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NEW SYSTEM RECOMMENDATIONS

Introduction

Updating the COB electrical system is more complicated than just replacing all of the electrical equipment. Some of the existing equipment is less than two years old. Some equipment is original to the building. The design team waded through existing construction documents and surveyed the facility to determine what is usable and what must be replaced.

The system update must also reconcile existing equipment and systems with code changes that occurred over the course of time. Good examples of this include changes in electrical room exiting requirements, and life safety system updates. Reconciling these two items and addressing other facility issues are written below.

As the design team proceeded through Schematic Design, it was clear there were certain themes PMD wanted to carry through the project. These topics were mentioned often in the biweekly design meetings and garnered attention. The team noted them and integrated them into the design. The list is as follows:

One opportunity to build this right – Both PMD and the design team agree that it is vitally important to design a robust system that is flexible enough to support building modifications over the coming years. These criteria stretch from the equipment specified, the installation criteria, to the overall design. To achieve the goal, the design team and the owner have met at lease every other week to review progress and to refine design direction. During these meetings, the design team carefully noted specific equipment requirements and manufacturer prerequisites the owner desired. The team has also documented specific installation criteria asked for by PMD.

Reaching these goals also meant honing the design parameters to align with the project budget. As with most large projects, issues even remotely related to the project scope are tossed into the mix. The schematic design process is expected to determine what is really important to attain the goals and what is fluff. In the end, this process will provide the robust flexible system needed to productively use COB for years to come.

Designing a system for the Tenants – One of the reasons this project came into being was because the electrical system did not meet or interfered with tenant needs. A tenant interference example is the noise created by transformer hum. Every electrical closet contains at least one transformer. In a share of cases the transformers are lightly loaded and hum continuously. Because there is little noise isolation between the electrical closet and the tenant spaces, this constant 60 hertz hum becomes monotonously intrusive for people sitting in close proximity. The design team was tasked to resolve this issue.

Another example includes the needs of the COB's largest client; MnIT. This tenant group requires an elaborate backup power system to keep their equipment operational. The existing electrical system meets their needs, but has quirks that compromise the power quality during backup system servicing. The design team was asked to address these quirks and resolve them.

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The entire construction process will occur while the building is occupied. This means that the contractor must build the new electrical system before the existing system is removed from service. As a result the electrical system renewal process will affect the tenants. The design team's task is to develop a plan that will minimize the tenant impact while allowing construction to proceed. See the Appendix E: *Remodeled Electrical System Switchover – Existing to New* for proposed approaches to minimize the impact.

Separating MnIT from COB – Because MnIT is a large tenant and because their IT equipment will continue to require special electrical system support, this project will separate the IT systems support from the general COB tenant space support.

Energy conservation – Decreasing energy use is state mandated for every project with a budget over $100,000. While this project's equipment modifications do not significantly change energy consumption there are two aspects of energy reduction focus.

The existing electrical system uses transformers consisting primarily of the standard efficiency type. Along with this, larger lightly loaded transformers are less efficient than a more heavily loaded smaller transformer. This project will specify the highest efficiency transformers available and then "right size" the transformers to effectively load the transformers for improved efficiency.

The second energy reduction effort addresses building lighting use. The building lighting is 80% to 90% supported by the backup power system. The lighting is also connected in such a way that these very same lights act as the egress lighting system. Egress lighting is typically left on 24/7. When it is controlled, it is left on for longer periods of time than general area lighting. Overall, this arrangement leaves more lighting on for an extended period of time than is necessary. This project will reduce the amount of egress lighting to a level closer to the required amount, reducing the lighting energy consumption in the building through reduced use.

Design Approach

Accompanying this written report is a schematic design set of plans. The plans convey design intent complimentary to this written document. Occasionally this report directly refers to the plan set. This report and the plan set are meant to convey the Schematic Design as a complete package.

The Building's Main Electrical Services

The capitol complex receives power from Xcel Energy via three of the utility's area substations. Four campus loops connect to these substations. Two of them (Loops S1 & S2) serve COB.

The building's new main electrical services will consist of four power sources. Each contains a medium voltage switch and a unit substation transformer attached to a main circuit breaker. The design configures these power sources in pairs. One pair is dedicated to the MnIT equipment while the other pair supports the remainder of the building.

The team designed the electrical services in redundant pairs such that any one of two services can receive maintenance while the second service supports its portion of the building fully. Please see plan sheet E3.0.0 accompanying this report for the services' schematic one-line and Appendix A for equipment cut sheets.

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The four services consist of the following equipment.

Equipment Designation	Equipment Description	Equipment Rating	Notes
Service Tap S1	13.8 kV bus bar and taps		S1 campus loop connection
Service Tap S2	13.8 kV bus bar and taps		S2 campus loop connection
COB SW-1	13.8 kV switch with over current protective relay		Tie switch connection to COB SW-2
COB SW-2	13.8 kV switch with over current protective relay		Tie switch connection to COB SW-1
COB SW-3	13.8 kV switch with over current protective relay		Tie switch connection to COB SW-4
COB SW-4	13.8 kV switch with over current protective relay		Tie switch connection to COB SW-3
COB T1	13.8 kV to 480/277 volt unit substation transformer	2000 kVa	Cast coil transformer
COB T2	13.8 kV to 480/277 volt unit substation transformer	2000 kVa	Cast coil transformer
COB T3	13.8 kV to 480/277 volt unit substation transformer	750 kVa	Cast coil transformer Service dedicated to MnIT
COB T4	13.8 kV to 480/277 volt unit substation transformer	750 kVa	Cast coil transformer Service dedicated to MnIT
MCB-1	Draw out electronic circuit breaker	2500 Amperes	GFCI and phase differential detection
MCB-2	Draw out electronic circuit breaker	2500 Amperes	GFCI and phase differential detection
MCB-3	Draw out electronic circuit breaker	1000 Amperes	GFCI and phase differential detection Service dedicated to MnIT
MCB-4	Draw out electronic circuit breaker	1000 Amperes	GFCI and phase differential detection Service dedicated to MnIT
TCB-1/2	Draw out electronic circuit breaker	2500 Amperes	Electronic interlock with MCB-1 & MCB-2
TCB-3/4	Draw out electronic circuit breaker	1000 Amperes	Electronic interlock with MCB-3 & MCB-4 Service dedicated to MnIT

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The system obtains power from load break style cable connections in a manhole east of the building. Loop S1 and S2 each contain one spare connection. The design intent uses these to connections to provide power to the new electrical system. The contractor will connect to each loop at the beginning of the renovation with a new pair of 13.8 kV service lines, leaving the existing system active until the end of the project.

There are two empty conduits between the manhole and a cable pull box located just inside the building's east basement wall. The contractor will pull new cables into the building using these conduits and terminate them on a set of fixed termination buses in the main electrical room. This arrangement allows the 13.8 kV service feeders to supply power to all four substations without extensively modify the loop connections in the manhole. Additionally, this cabling scheme builds in system flexibility and robustness. The arrangement allows for easy maintenance on downstream equipment and room for additional connections.

PMD standardized the 13.8 kV switching and over current protection systems for buildings on the campus. Any new projects or upgrades receive G&W's SF_6 series switches. The standard asks the design team to specify the switches with motorized operators for automatic transfer. This allows staff to remotely switch between campus loops S1 & S2 and enables the switches to automatically switch between loops when there is a power failure. See plan sheet E3.0.0 for the medium voltage oneline diagram and switch configuration.

The standard also asks that the team specify the switches with gas pressure gauge and fill valve and ground lugs. Voltage and current sensing are options that will accompany the automatic transfer option.

Electrical Distribution Switchgear

This equipment starts the distribution pathways to the entire building and is considered the beginning of the building's main electrical arteries. Refer to plan sheets E1.0.1 and E1.0.2 for the equipment locations. Refer to the building riser diagram sheets E3.0.0 – E3.0.6 for their interconnection within the system.

There are three pieces of main building switchgear. The first is a lineup labeled COB-1 and COB-2. This lineup serves most of COB, including the general mechanical systems, the two bus duct risers, and the ramp.

The second is a lineup labeled COB-3 and COB-4. This lineup is dedicated to serving the tenant MnIT. This includes their two UPS systems and their two mechanical cooling system risers.

The third lineup is labeled *Backup Riser System*. This lineup serves the building's backup power system. Included in this system are the life safety riser and the two optional standby risers.

Each of these three lineups contain draw out style circuit breakers that protect their respective downstream equipment. PMD specifically requested that the design team specify switch gear for the main service equipment to assist them with building maintenance. While either switch gear or switch boards will electrically protect the equipment, switch gear will allow maintenance staff to draw out the over current protective device, disconnecting it from the power source, before working on it. This feature is not available in switch boards. Staff must de-energize the entire board if they wish to work on a specific piece of equipment.

See plan sheet E3.0.1 for the lineup configurations.

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Backup Power Systems

The backup power system goals may be one of the more difficult aspects of the project. PMD is searching for a more effective way to use the 2.0 MW system because its capacity well exceeds the COB electrical load connected to the system.

The design team is also challenged with separating life safety electrical loads from optional standby loads. The available space to install equipment to address this challenge is slim. Adding to this, the equipment used for generator maintenance and testing is inconvenient to use and is outside code compliance.

Since the building will remain occupied for the duration of the project and the backup power system is required to support the system, the design team approached the system upgrade in the same manner as the normal power system upgrade. The design specifies the installation of the new backup power system infrastructure before the existing system is deconstructed.

There are three components supported by the backup power system. The life safety system is the first and the only system that legally requires backup power in the building. The second is the complex optional standby system for MnIT. The third is the optional standby system for the rest of the building.

Life Safety System – The life safety code requires that several systems in this building remain operational when there is a power outage. These systems must have power to help occupants safely exit the building in the event of an emergency. The systems must also assist emergency personnel in their actions within the building. This building's systems include:

COB Life Safety Systems

1. Egress Lighting – This lighting is used to illuminate the path of egress that guides occupants out of the building.
2. Fire Pump – This pump boosts the water pressure in the fire sprinkler system. When a sprinkler head activates, the pump starts and boosts the system pressure throughout the building. The generator must support both the starting and the running of the fire pump.
3. Stair Pressurization Fans – High rise buildings such as this must have systems that keep smoke out of the stair towers. These towers are the main path of egress if there is a fire and pressurizing them pushes smoke out when doors open during the exiting process.
4. Elevator(s) – This building must have at least one elevator operating during a power outage. Elevators, just like fire pumps, require more current to start than when they are running. Because of this fact, the generator size is adjusted upward to support the additional demand.
5. Fire Alarm System – All aspects of this detection and notification system receive support from the life safety branch of the system. Because of this building's size, the fire alarm system consists of multiple main components spread throughout the building. These main components are powered locally rather than from the main fire alarm panel. This translates to a need for life safety power across the facility.

The design team plans to locate this new life safety switchgear in Room B24E located in the southwest corner of the lower level.

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MnIT Optional Standby System – The complicated backup system dedicated to MnIT maintains power to the state's telecommunications hub. Their 5th floor data center has redundant uninterruptable power, redundant backup power distribution, and redundant cooling systems. The building generator supports all of these loads.

These redundant systems are design to avoid situations where equipment breakdown causes a power outage or cooling shortage in the data center. The systems also allow maintenance while the data center remains fully operational. The design team will leave much of this existing optional standby electrical system intact, but will reconfigure both the main and backup power sources so that the distribution system serves MnIT separately from the rest of the COB distribution system. This entails specifying separate distribution components from the backup power source. See the *Optional Standby and UPS Riser* diagram on sheet E3.0.4 for component definition.

The backup power switchgear for MnIT feeds transfer switches that support UPS-A, UPS-B, Mech-A, Mech-B and the other dedicated MnIT distribution equipment. The design team plans to locate this dedicated switchgear in Room B20.

COB Optional Standby System – The COB optional standby system is designed with flexibility in mind, but purposefully limits the amount of power available on the system. PMD and the design team deeply discussed the building program needs with respect to backup power. It was made clear to the design team that it is not the state's intent to have a fully functional building during a power outage. In general, outages occur during significant events (e.g. severe weather, utility equipment overload during peak demand, etc). When these events occur, there is reduced staff working in the building and those who are working may have concerns outside the workplace. The building should close if an extended outage occurs.

This said, there are exceptions to the rule where certain building functions must continue to function. To support these exceptions, the new system design will include a small piece of switchgear that supports an optional standby riser on each end of the building. See sheet E3.0.4 for the *Optional Standby and UPS Riser* System for the system configuration. The planned location for this equipment is not determined at this time.

<u>Electrical Riser System</u>

Five new electrical riser systems will supply power to the building. Three of the four systems originate at the switchgear noted above. The fourth originates at the UPS distribution boards located in the 5th Floor D-Riser Closet. The five system descriptions are as follows:

> **Normal Riser System –** Through most of the Schematic Design phase, two major riser concepts dominated design discussion. One concept involves a 480/277 volt bus duct system with four 225 kVa transformers feeding 208/120 volt distribution boards. The other involves a 208/120 volt bus duct system with larger transformers located in the basement.
>
> There are pro's and con's to both approaches. If the design specifies the 208 volt bus duct, the owner's request to eliminate transformer noise on the upper floors easily becomes a reality. All 120/208 volt electrical loads are served directly from the bus duct and the closet transformers are no longer necessary.
>
> The con's to the 208 volt bus duct include the need to also specify a new lighting system riser and an overall higher materials and installation cost. There is also a reduced reliability factor for the design. The transformer supporting the bus duct sets up a single point of equipment failure at each riser.

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The con's in the 480 volt bus duct design revolve primarily around the need to place transformers on the upper floors leaving the possibility of noise infiltrating the tenant spaces. When the comparison analysis was complete, the 480 volt bus duct pro's outweighed the cons. The design did not need a lighting riser, the design was more robust, and the system cost less. The result, it was integrated into the final schematic design.

The chosen concept consists of two 800 ampere, 480/277 volt bus ducts. One rises through the building in expanded electrical closets on the north side of the building. This riser is designated Riser-A. The second rises through the building in the existing south side electrical closets. This riser is designated Riser-D.

The concept also includes 225 kVa transformers that tap off from the bus ducts on floors Ground, 2nd, and 4th and feed 208/120 volt distribution boards. These, in turn, will support the existing panelboards that serve tenants. Refer to the plan sheets E3.0.2 and E3.0.3 for the schematic system risers.

Life Safety Riser System – This riser system also consists of two sets of conduits and panels. One 100 ampere feeder rises through the building in the north side A-Electrical closets. The second in the south side D-Electrical closets.

The life safety risers do not support a great deal of building load. They support only the egress lighting and the occasional 120 volt life safety system (e.g. fire alarm power supplies). To support these small loads, one 480/277 volt and one 208/120 volt panel are placed on floors one and four for each riser. Refer to plan sheet E3.0.5 for the Emergency System riser configuration.

MnIT Optional Standby System – For all practical purposes, this optional standby system is the existing equipment and feeders that currently serve MnIT. The few exceptions include relocation or replacement of select automatic transfer switches. The *Existing Systems Description* earlier in this report and the Appendix A equipment spreadsheet lists these transfer switches. The existing system riser diagram and the Demolition plan sheets show their locations. The new optional standby riser diagram on plan sheet E3.0.4 mimics the MnIT riser system shown on the existing plans.

The existing system description indicates that seven transfer switches support MnIT. Three of these switches, ATS-5, ATS-9, and ATS-11 reside in the existing electrical room B87B. These three switches will either be relocated or be replaced by new switches. As mentioned earlier in this report, the design will remove as much existing electrical equipment from the existing electrical room as possible and every effort will be made to meet this goal.

COB Optional Standby System – The design creates two 200 ampere optional standby risers in the building. One 200 ampere feeder rises through the building in the north side A-Electrical closets. The second in the south side D-Electrical closets. One 480/277 volt and one 208/120 volt panel are placed on 1st and 4th floors for each riser. Refer to plan sheet E3.0.4 for the optional standby System configuration.

UPS Riser System – Schematic design discussions covered a number of topics. During the October 2nd, 2014 meeting, there was a request to provide UPS power for the IP phone systems and some of the IT closet loads in the building. This raised the question about the extent and type of power needed in the closets.

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The extent of and type of power needed was communicated at the October 23rd meeting. With input given by MnIT, the design team would work up a scheme that supports dual power supply equipment.

Almost all of the equipment is small and rack mount 120 volt loads, with a share containing dual power supplies. Discussions ensued about whether to provide dual UPS risers to support two power supplies. MnIT staff considered one UPS source as a reasonable level of backup power. The primary source for dual power supply equipment could originate from the building's normal power system.

From this, the design team created a scheme where a 208/120 volt UPS riser will follow the same scheme as the emergency and optional standby system riser schemes. A 100 ampere, 3-phase riser will reside in the north A-closets and the south D-closets. Once again, panels will reside on 1st and 4th floors. See the plan sheet E3.0.4 for the UPS riser system configuration.

Constructing the new riser system to create an electrical infrastructure to keep the building operation challenged PMD and the design team to minimize the tenant impact. The new risers could not physically co-exist with the existing risers because of space limitations in existing closets. Conversely, acquiring additional closet spaces is logistically difficult.

The new riser system will require space on each floor to house the new bus ducts, new transformers, and new distribution panels. This translates to floor space acquisition negotiations with multiple tenants. To minimize the acquisition impact, area in and around the north A-closet and south D-closet were selected for use.

As the design team laid out equipment, they found that very little additional real estate was needed outside the larger D-closets. Only Ground floor would require closet expansion. The north A-closets are a different story.

The existing A-closets are not as large as their south riser counterparts. In addition, existing equipment typically occupies every inch of wall space. The solution proposes that this project creates closet expansions directly north of the existing A-closets, expanding space capacity approximately than 70 square feet. Refer to the floor plan sheets E1.1.0 – E1.1.6 for the proposed closet expansions.

When these closet expansions occur, the project will also implement further noise mitigation factors to greatly reduce (if not eliminate) transformer noise. These factors include:

- Removing all existing transformers in the upper floor closets and refeeding panels from a new riser system.
- Acoustically treat the electrical closets with full height walls, acoustic wall insulation panels, and wall seals.
- Provide new transformers rated with sound levels -8 dB below industry standards.
- Implement transformer mounting criteria that isolates equipment and mitigates their humming sound.

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New HVAC Systems

Main Electrical Room B4: Provide two (2) Liebert MMD96F evaporator units will handle the cooling for the Main Electrical Room B4 that will house a total of 2750 kVA in operation at any one time. Each unit will provide eight (8) tons of mechanical cooling. These units will be fully redundant so that during maintenance or other periods of downtime, this space remains at or below the required set-point. Remote condensing units are the existing Liebert units as mentioned above, and refrigerant piping installed between these units to comply with the manufacturer's recommendations.

Remote Electrical closets (that require cooling): Provide six (6) Liebert MMD18F evaporator units that will handle the cooling for the Ground Floor (Room G26 and G53), Second Floor (Room 226 and 270) and Fourth Floor (Room 418 and 484) electrical closets that will each house a 225 kVA transformer. Each unit will provide 1.5 tons of mechanical cooling. Remote condensing units are the existing Liebert units as mentioned above, and refrigerant piping installed between these units to comply with the manufacturer's recommendations.

Sensors

All spaces will have temperature sensors for each Split System Cooling unit.

New Fire Sprinkler Systems

The new fire protection system will essentially modify sprinkler head branches and head locations. As ceilings are taken out of existing spaces and spaces modified, the branch piping will be reconfigured to appropriately cover the remodeled spaces.

Fire protection piping will be light wall steel piping with threaded or mechanical grooved-end fittings and will be extended above grade within ceiling and wall cavities to fire sprinklers located throughout the building. Exposed piping will be Schedule 40 black steel piping.

Fire sprinklers will be conventional wet or dry types consistent with fire protection required and with the architectural design. Sprinklers in areas with ceilings will be concealed type with white flat ceiling plate. Exposed areas will have upright heads.

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BID AND CONSTRUCTION PROCESS

Bid and Construction Process

Bid Phase

Plant Management discussed creating a bid package that will award the electrical system upgrade to the most qualified contractor. While project cost is a key consideration in selecting a contractor because the renovation cost must meet the budget, there are several other factors that play into successfully completing the project.

Discussions during schematic design meetings set forth the importance of:

- A contractor with capitol complex campus experience.
- A project manager with good organizational and good communications skills.
- An electrical contractor with a history working in buildings with large, complex electrical systems.
- An electrical contractor with 13.8 kV electrical system experience.

Plant Management also expressed criteria important for their constituents. They asked that these criteria also factor into the contractor selection.

- The 5th floor data center must remain operational during the project.
- A quiet work atmosphere is important for staff. No disruptive work is allowed on occupied floors during normal business hours.
- The building will remain occupied the duration of the project. It is expected that electrical power will be available during work hours. Note that there are building areas where work hours fall outside the 8 to 4 workday. This necessitates close coordination when scheduling outages.
- Project progress and planned work areas must be coordinated through proper channels.

The design team will integrate the above criteria into the bid documents. Some of the criteria will require that contractors submit an experience resume. Other criteria will require the bidding contractors to submit an action plan. Each of these components, with the bid number, will determine the most qualified contractor.

The design team will continue working with Plant Management to refine the criteria during design development. Integrating the criteria into the specification front end will need careful coordination with RECS and the state's contracts group. When contractors submit their project bids, they must clearly understand that the lowest price may or may not receive the award.

Construction Phase

Early Demolition Package – The construction phase will begin with an early bid package to remove the ceilings in the new electrical room. The timing for the demolition will occur during the construction document phase, at the request of the design team. Both the design team and the owner agreed that it is vitally important to understand what is concealed above the ceilings to avoid change orders during the construction phase. It is very likely that the contractor awarded the ceiling demolition will not bid on the complete electrical upgrade package.

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Construction Upgrade Package – The construction phase upgrading the electrical system will be a well-coordinated effort between the contractor, the design team, and the owner. Each of these three players has a key role in creating a smooth transition from the old electrical system to the new. This phase is where the most qualified contractor's skills come into play. The contractor's ability to quickly understand the project, plan the construction, and communicate with the team will greatly enhance the project outcome.

The owner has indicated that they need to stay well informed regarding construction progress, planned outages, and areas of work. Knowing this, the design team recommended incorporating these desires into the construction documents as a framework under which the contractor must work. Doing so will communicate that the contractor must keep the facility operational and stay within the confines defined by the owner.

The contract documents will require the contractor to develop a work plan using the specified framework as a guide. The framework will ask for:

1. A schedule defining affected work areas, planned outages, equipment deliveries, and other critical work items.
2. A review of the recommended electrical system replacement sequence, updated with perspectives gained after acquiring an understanding of the building.
3. A matrix defining the communications paths for certain aspects of the project. Contracts generally mandate that communications travel through the design team. Because the electrical power loss has a direct impact on the building users, certain circumstances may dictate an alternate communications path directly with the owner.
4. A process for communicating a two week look ahead.
5. A reaction plan if an unplanned outage occurs.
6. A framework for biweekly meetings that visually updates where work is occurring, what critical path items are starting/underway/ending.
7. Providing information to the owner that allows them to give their users a measured level of information about construction progress.

From this, the contractor will create and submit their work plan for an interactive review and comment.

The construction process is expected to take a year. Shortly after contracts are signed, the shop drawing process begins. This is the point where the commissioning agent becomes integrally involved with the project. After the engineer checks the equipment submittals, the commissioning agent will cross check them against the basis of design and the specifications. This quality control step will ensure that the design intent is met with the equipment ordered.

Weekly meetings will begin as the contractor familiarizes themselves with the building. Prior to and following each of the meetings, the design team will walk the site with the contractor and owner's representative. This level of interaction between the team members will maintain the consistency needed to communicate issues, expectations, and resolutions.

From this point, the project construction is a methodical step-by-step process upgrading the electrical system. The continued construction process will receive weekly over site by the design team and intermittent interface with the commissioning agent as new systems come on line.

As the project construction comes to a close, the final system adjustments begin. These adjustments rely on existing building conditions and require live onsite measurements. The electrical contractor will take these measurements and give them to the design team. The

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design team will incorporate them into the electrical system fault current and coordination studies to produce device settings and arc fault potential information.

The arc fault potential information provides the electrical contractor their final piece of information needed to complete arc fault potential hazard labeling. In coordination with the commissioning agent, these labels are created and adhered to the building's electrical equipment.

The device settings produced from the coordination study provide the electrical contractor with circuit breaker and relay setting information. The final system adjustments on medium voltage switches, switchgear, and switchboards ensure that over current and short circuit devices trip in appropriate order. These settings are the final items required to complete the system installation.

10 Month Warranty – State contracts require that a 10 month warranty walk through occur. This process provides the owner the opportunity to verify new equipment performance prior to the end of the one year warranty period. This walkthrough will be attended by the design team, the prime contractor, and the owner. Any adjustments or equipment issues will be noted and addressed prior to the close of the year.

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Electrical Systems Budget Estimate			
Equipement Description	**Estimated Budget**		**Notes**
Medium Voltage Equipment	$1,524,000		Includes G&W switches, unit substations, MCB's and 13.8 kV demo (switches and cables)
Demolition & Removal	$770,000		Removes existing equipment and feeders entirely
Switchgear & Switchboards	$375,000		
Riser Bus Duct, Panels, Transformers	$450,000		Reflects Scheme #1
Distribution Feeders			Includes pipe & wire. Does not include 13.8 kV feeders
Normal System	$2,650,000		
Backup System	$1,250,000		
Backup System Modifications & Upgrades	$250,000		Includes $$ for the existing States Electric gear and a new distribution switchboard that feeds elevators, fans, fire pump, lighting riser, optional standby system.
Life Safety Lighting Systems Upgrads	$100,000		Consists of primarily recircuiting - Mostly labor and
Stair Pressurization Fans	$12,000		Reconnecting fans, new branch ciruit feeds.
Life Safety - Fire Pump & Elevators	$60,000		Reconnecting equipment, new branch ciruit feeds.
Cable Tray	$20,000		24" cable tray running the length of the building
Subtotal	**$7,461,000**		Numbers include 20% markup, $5000 for permit, 1.5X for shift work and some 2X for weekend labor
Mechanical Systems Budget Estimate			
Equipement Description	**Estimated Budget**		**Notes**
Fire Protection	$22,110.00		$3 PSF for remodel areas
HVAC/Cooling Equipment	$73,600.00		6 units at $5600, 2 units at $20,000
Miscellaneous items	$19,150.00		
Subtotaal	**$114,860.00**		
Architectural Systems Budget Estimate			
Equipement Description	**Estimated Budget**		**Notes**
Basement Level Construction	$212,500.00		
Ground through 5th Floor Construction	$269,000.00		
Subtotal	**$481,500.00**		
Project Construction Subtotal	**$8,057,360.00**		
10% General Conditions	$805,736.00		General contractor management, markup, permits, etc.
Project Construction Cost	**$8,863,096.00**		
10% Design Contingency	$886,309.60		Contingency held for scope changes and unforseen building conditions
Total Project Budget	**$9,749,405.60**		

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PROJECT SCHEDULE

This schedule was developed near the end of Schematic Design as a template for review by the PMD. It is included here to provide a framework for what the design team considered a reasonable starting point for the defining the project's life. Refinements will take place as the project progresses

The design phases take into account a review process by PMD and allow for some unforeseen roadblocks. Knowing that schematic design accounted for 30% of the design, a shortened design development phase is planned. Construction documents phase will button up the details needed to issue a bid package.

Depending on the exact posting date, contractors will receive three to four weeks to assemble a project bid number. After the bids are received, the contractor will receive a notice to proceed and sign contracts. The period between bid and construction start is known as Contract Negotiations. The duration typically takes less than three weeks for a project this size. Note that the schedule allows for allows for this process to occur.

The design team believes that this project will extend through the better part of a year. A large share of the work will occur off hours and critical electrical system switch overs will occur on weekends or holidays. The time of day in which work occurs has an effect on project duration because of an inherent lag in communication lines between contractor working off hours, the design team responding most hours, and the owner working primarily during the day. Additionally, extensive planning is needed for major power outages and only select days are possible outage candidates.

The following is the proposed project schedule.

Project Schedule	
Schematic Design Complete	January 22, 2015
Design Development Complete	March 12, 2015
Construction Documents Complete	May 22, 2015
Bidding Complete	June 18, 2015
Begin Construction	July 13, 2015
Complete Construction	July 2016
Warranty Walkthrough	May 2017

The following page contains a graphical representation of the schedule.

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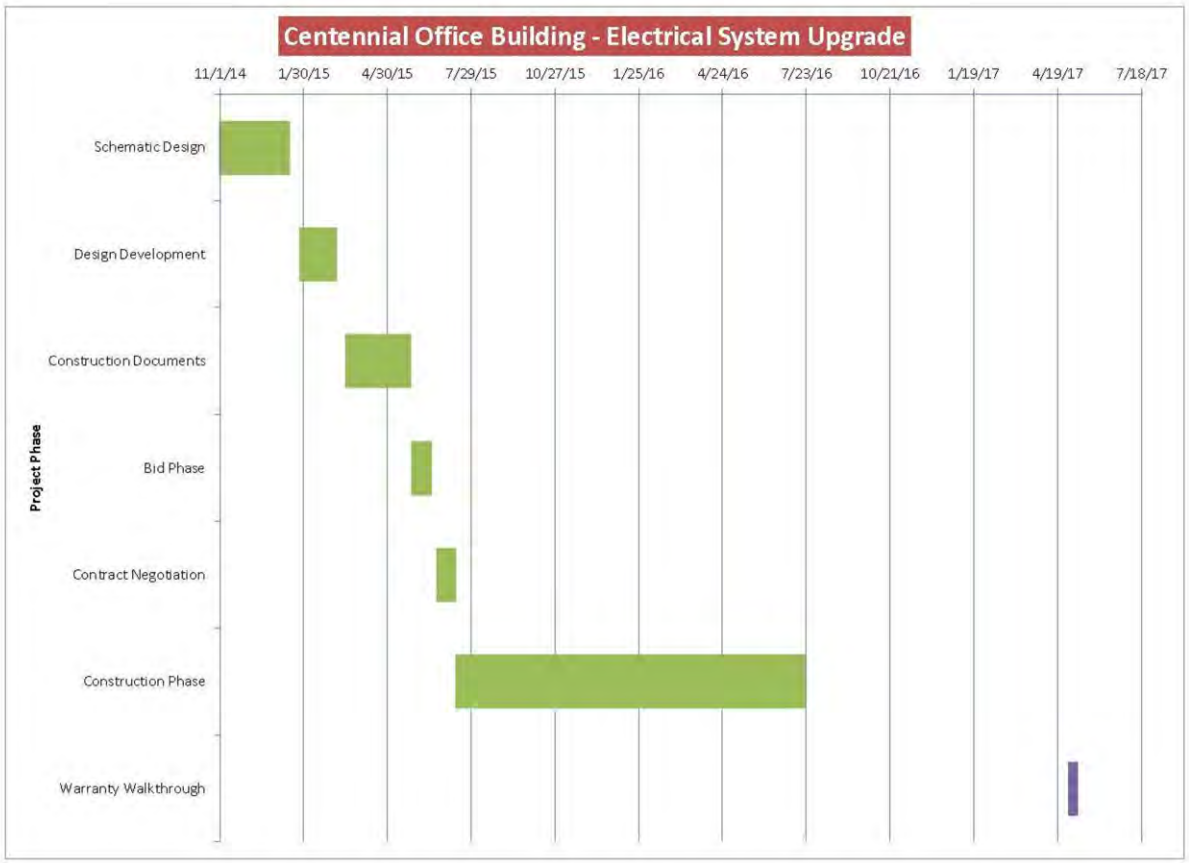
Centennial Office Building - Electrical System Upgrade
11/1/14
1/30/15
4/30/15
7/29/15
10/27/15
1/25/16
4/24/16
7/23/16
10/21/16
1/19/17
4/19/17
7/18/17
Project Phase
Schematic Design
Design Development
Construction Documents
Bid Phase
Contract Negotiation
Construction Phase
Warranty Walkthrough

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CONCLUSION

This concludes the Schematic Design presentation. The bulk of the efforts involved with Schematic Design included existing system discovery, system programming, and early project engineering. The additional efforts put forth to accurately estimate the project represent the design team's ability to pull together the necessary pieces and assign value on a complex project.

Moving forward with the concepts defined in this report requires further understanding of the existing building. It also requires the necessary steps into engineering details not yet addressed in this project. Adding these details to the design during Design Development and Construction Document phases will solidify the design and gain a complete bid package.

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APPENDICIES

Appendix A – Spreadsheet of Major Equipment – Replace/Reuse

Appendix B – Riser Diagrams – 11/ 17 foldouts

Appendix C – Equipment Cut Sheets

Appendix D – Basis of Design Specific Lists

Appendix E – Recommended Electrical System Switchover – Existing to New

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Appendix A – Spreadsheet of Major Equipment – Replace/Reuse

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Basement Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
EGL-BN-1	Panelboard			B3		
EGH-BN-1	Panelboard			B3		
B4A	Panelboard			B4		
B4B	Panelboard			B4		
LP-004-3	Panelboard			B6		
EGHL-BD2-SB	Panelboard	277/480V	400A MLO	B6	X	GE A Series AEF3364MTX
LP-004-BL	Panelboard			B6		
EGL-BN-2	Panelboard			B3A		
EGL-B2-SB	Panelboard			B3		
EGL-B1	Panelboard			B87B		
EGH-21	Panelboard			B87B		
EGHD-SB3 Fused	DB?	277/480V	400A MLO	B87B		GE Spectra Series Switchboard
EGHL-BD3-SB				B19A		
Ramp XFMR	XFMR			B87B		
SP				B19	X	
3-B1				B19		
T-002	XFMR			B19	X	
Sprint/Nextel	Panelboard			B17		
CEL-F5-B1	Panelboard			B16		
EGHT-BD4-SB	Panelboard			B30		
LP-006	Panelboard			B30	X	
CEH-F5-DP1	Panelboard	277/480V	400A MCB	B20	X	GE Spectra Series - 300A Spare
CEH-F5-DP2	Panelboard	277/480V	225A MLO	B20	X	GE A Series AEF9422MT - 27 spaces
TX-F5-T1	XFMR		30 KVA	B20	X	
T-EGL-B34-1	XFMR			B27		
EGL-B34-1				B27		
T001	XFMR		37.5 KVA	Elect. Room B3		
ATS-1	Transfer Switch	480V				
ATS-2	Transfer Switch	480V		Engine Gen. Room B27		
ATS-3	Transfer Switch	480V				
ATS-4	Transfer Switch	480V	600A OCP			
ATS-5	Transfer Switch	480V		B87B		
ATS-6	Transfer Switch	480V				
ATS-7	Transfer Switch	480V	400A OCP	MNIT Rm. B20		
ATS-8	Transfer Switch	480V		B87B		
ATS-9	Transfer Switch	480V		B87B		
ATS-11	Transfer Switch	480V		B87B		
Em. Standby	Switchboard	277/480V		Engine Gen. Rm. B27		
DPA		480V, 3P, 3W	600A MCB	MNIT Rm. B20	X	Kirk Key Interlock with DPB GE Spectra Series
UPSA				MNIT Rm. B20		
DPB	Dist. Panelboard	480V	600A MCB	MNIT Rm. B20	X	Kirk Key Interlock with DPA GE Spectra Series
UPSB				MNIT Rm. B20		
LPB	Load Center	120/208V 1 PH	600A MCB	MNIT Rm. B20	X	GE Power Max Load Center Inline Main - 10 spaces
LPA	Load Center	120/208V 1 PH	600A MCB	MNIT Rm. B20	X	GE Power Max Load Center Inline Main - 10 spaces

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Ground Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
LP-BD1-B0	Panelboard	120/208V	MCB	North Elec - G27	X	GE - Reasonably good shape, full
LP-BD1-B1	Panelboard	120/208V	225A MCB	North Elec - G27	X	GE AQF3422 MTX - Reasonably good shape, full
EGL-GA-1	Panelboard	120/208V	100A MCB	North Elec - G27		24 ckt. GE load ctr. Feed T-A1-1 with inline main 15 spaces, duct smokes
LP02	Panelboard	120/240 1PH		North Elec - G27	X	Old Trumble Elec - needs upgrade
T-2	Transformer		112.5 KVA	North Elec - G27	X	
Bus A				North Elec - G27		
EGHL-BD1-B0	Panelboard	277/480V	100A MLO	G55		Old 12 ckt.
LP-BD2-B0	Panelboard	120/208V	225A MLO	Middle North Elec - G10	X	GE A series AQF3422MTX, Reasonably good shape, full
LP-BD2-B1	Panelboard	120/208V	225A MCB	Middle North Elec - G10	X	GE A series Reasonably good shape, full
LP03 Pullbox???	Panelboard			Middle North Elec - G10		
EGHL-BD2-B0	Panelboard	277/480V	100A MLO	Open Area G17 outside G10	X	Old GE NHB panel Feed EGHL-BD2-SB - relocate and replace
T3	Transformer		75 KVA	Middle North Elec - G10	X	
Bus B				Middle North Elec - G10		
LP-BD3-B1	Panelboard	120/208V	400A MCB	Middle South Elec G20	X	GE A series - Reasonably good shape, full
LP-BD3-B1	Panelboard	120/208V	400A MLO	Middle South Elec G20	X	GE A series -AQF3424MBX Reasonably good shape, full
Bus C???						
LP-BD4-B1 Right	Panelboard	120/208V	400A MCB	South Elec - G53	X	GE A Series AF76SN Reasonably good shape 30/3 spare 2 spaces
LP-BD4-B1 Left	Panelboard	120/208V	400A MLO	South Elec - G53	X	GE A Series AQF3424 MBX Reasonably good shape 2 spare 2 spaces
EGHL-BD4-B0	Panelboard	277/480V	400A MLO	South Elec - G53		GE A Series AF64SN Feed EGHB-SB-2, (B2) RE B87B Reasonably good shape, jockey pump
T-1	Transformer		150 KVA	South Elec - G53	X	
Bus D				South Elec - G53		
2nd Bus Tap	Bus Tap					
MCC-2-A	Motor Control Center	277/480V	225A Rated 200A OCP @ US 003	Mechanical - G84		Eation/Cutler Hammer
HL-BD4-B1	Panelboard	120/208V Verify on photos	400 MLO	South Elec - G53	x	GE A Series, AQF3424MBX Reasonably good shape, 3 spares
MCC-2-B	Motor Control Center	277/480V	225A Rated 150A OCP @ US 002			

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First Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
LP-BD1-10	Panelboard	120/208V	225A MLO	North Elec - 107		GE A Series AF49SN Reasonably good shape 7 spares
LP-BD1-11	Panelboard	120/208V	225A MLO	North Elec - 107		GE A Series AF49SN Reasonably good shape 9 spares
LP-BD1-12	Panelboard	120/208V	225A MCB	North Elec - 107		GE A Series AF55SN Reasonably good shape 14 spares 1 space
EGH-1A-1	Panelboard	277/480V	225A MLO	North Elec - 107		GE Load Center, Feed tap box BN-1 BKR #1 Rm B87B GENHB 42 ckt, 6 poles used - recheck with photos
EGHL-BD1-10	Panelboard	277/480V	100A MLO	Open area 111 outside 107		Feed EGHL-BD1-11, old GE panel, Remove/relocate/replace
EGHL-BD1-11	Panelboard	277/480V	400A	North Elec - 107		GE A Series AF 64 SN, Feeds all old riser A panels, 400 A Feed
T-1A-1	Transformer			North Elec - 107		Feed EGH-1A-1, 2, 4, 6
T-7	Transformer		75 KVA	North Elec - 107		
EGL-1A-1	Load Center	120/208V	100A MCB	North Elec - 107		100A inline CB, Feed T-1A-1
Bus A				North Elec - 107		
EGL-1A-1 Sub Panel	Load Center	120/208V 1 Ph	60 MLO	IT Closet 122		8 ckt GE Load Center, 3 spaces
LP-BD2-10	Panelboard	120/208V	225A MLO	Middle North Elec - 123		GE A Series, AQF3422STX, Reasonably good shape, 14 spares
LP-BD2-11	Panelboard	120/208V	225A MLO	Middle North Elec - 123		GE A Series, AQF3422STX, Reasonably good shape, full
LP-BD2-12	Panelboard	120/208V	225A MCB	Middle North Elec - 123		GE A Series AQF3422ABX, Reasonably good shape, full
EGHL-BD2-10	Panelboard	277/480V	100A MLO	Open Area 111 outside 123		Feed EGHL-BD2-SB, old GE panel, Relocate and replace
T6	Transformer		75 KVA	Middle North Elec - 123		
Bus B				Middle North Elec - 123		
LP-BD3-10	Panelboard	120/208V	225A MCB	Middle South Elec 150		GE A Series AQF3422ABX, Reasonably good shape, full
LP-BD3-11	Panelboard	120/208V	225A MLO	Middle South Elec 150		GE A Series AQF3422STX, Reasonably good shape, full
LP-BD3-12	Panelboard	120/208V	225A MLO	Middle South Elec 150		GE A Series AQF3422STX, Reasonably good shape, full
EGHL-BD3-10	Panelboard	277/480V	100A MLO	Rm 161 outside Elec 150		Feed EGHL-BD3-SB, Old GE panel, Relocate and replace
T5	Transformer		75 KVA	Middle South Elec 150		
Bus C				Middle South Elec 150		
LP-BD4-10	Panelboard	120/208V	MCB	South Elec - 176		GE A Series, Reasonably good shape, 2 spares
LP-BD4-11	Panelboard	120/208V	225A MLO	South Elec - 176		GE A Series AQF3422ABX, Reasonably good shape, full
EGHL-BD4-10	Panelboard	277/480V	225A MLO	South Elec - 176		GE A Series AQF3422STX, 30 spares, 50/3 spares, 100A Feed, Feeds a XFMR somewhere
T-4	Transformer		45 KVA	South Elec - 176		
Bus D				South Elec - 176		
LP-BD4-11-1	Panelboard	120/208V	225A MLO	167B		GE A Series AQUB182RCX, 80A Feeder from EGL-44-1, Reasonably good shape
T4A	Transformer		30 KVA	South Elec - 176		
EGL-4A-1	Panelboard	120/208V	100A MCB			Recheck location with photos

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Second Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
LP-BD1-20	Panelboard	120/208V	225A MLO	North Elec - 226 (205)		GE A Series, Reasonably good shape, 12 spares
LP-BD1-21	Panelboard	120/208V	225A MLO	North Elec - 226 (205)		GE A Series, Reasonably good shape, 9 spares
LP-BD1-22	Panelboard	120/208V	225A MCB	North Elec - 226 (205)		GE A Series, AXT1B4, Reasonably good shape, 6 spares
EGL-2-1	Panelboard	120/208V	100A MCB	North Elec - 226 (205)		GE Load Center, Feed T-1A-1, In Line Main
T-11	Transformer		75 KVA	North Elec - 226 (205)		
EGHL-BD1-20	Panelboard	277/480V	100A MLO	Corr - 225 outside 226		Feed EGHL-BD1-11, Old GE panel, Replace/relocate
Bus A				North Elec - 226		
LP-BD2-20	Panelboard	120/208V	225A MLO	Middle North Elec - 214		GE Series, Reasonably good shape, 9 spares
LP-BD2-21	Panelboard	120/208V	225A MLO	Middle North Elec - 214		GE Series, Reasonably good shape, 8 spares
LP-BD2-22	Panelboard	120/208V	xxx MCB	Middle North Elec - 214		GE A Series, AQF3422ABX, Reasonably good shap, 2 spares
EGHL-BD2-20	Panelboard	277/480V	100A MLO	Corr. - 200B outside 214		Feed EGHL-BD2-SB, Old GE panel, Replace/relocate
T10	Transformer		45 KVA	Middle North Elec - 214		XFMR downsized from oneline
Bus B				Middle North Elec - 214		
LP-BD2-23	UPS Panel	120/208V	100A MCB4 Pole	Rm 229		GE A Series AQF3361ABX, Reasonably good shape, 30 spares
LP-BD3-20	Panelboard	120/208V	225A MLO	Middle South Elec 236		GE A Series AF49SN, Reasonably good shape, 2 spaces
LP-BD3-21	Panelboard	120/208V	225A MLO	Middle South Elec 236		GE A Series AF49SN, Reasonably good shape, 2 spaces
LP-BD3-22	Panelboard	120/208V	100A MCB 225 Rated	Middle South Elec 236		GE A Series AF55SN, Reasonably good shape, full, Down sized recently?
EGHL-BD3-20	Panelboard	277/480V	100A MLO	Rm 200D outside Elec 236		Feed EGHL-BD3-SB, Old GE panel, Replace/relocate
T9	Transformer		30 KVA	Middle South Elec 236		XFMR appears brand new - one line reads 75KVA
Bus C				Middle South Elec 236		
2nd Bus Tap	Not labeled					
LP-BD4-20	Panelboard	120/208V	225 MCB	South Elec - 270		GE A Series, Reasonably good shape, full, freight Elev Ltg
LP-BD4-21	Panelboard	120/208V	225A MLO	South Elec - 270		GE A Series, AQF3422MTX,Reasonably good shape, full
EGHL-BD4-20	Panelboard	277/480V	100A MLO	Corr. - 200D outside 270		Feed EGHL-BD3-G0, Old GE panel, Replace/relocate
T-8	Transformer		45 KVA	South Elec - 270		
Bus D				South Elec - 270		
2nd Bus Tap	Not labeled					
LP-212R	PNL	120/208V	xxx MCB	Room 229		GE A Series, Reasonably good shape, lots of space
LP-212 L	PNL	120/208V	225 MLO	Room 229		GE A Series, Reasonably good shape, lots of space
Comp Room Transformer	Transformer		75 KVA	Room 229		
UPS	UPS	120/208V	10 KW/42A	Room 229		Excide mo#18/15, 120/208V input, 120/208V output

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Third Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
LP-BD1-30	Panelboard	120/208V	225A rated 150A MCB	North Elec - 312	X	GE A Series AQF 3422 ABX Reasonably good shape, 2 spares
LP-BD1-31	Panelboard	120/208V	225A MLO	North Elec - 312	X	GE A Series AQF 3422 MBX Reasonably good shape, 7 spares
LP-BD1-3	Panelboard	120/208V	225A MLO	North Elec - 312	X	GE A Series AQF 3422 MBX Reasonably good shape, 12 spares
EGL-3A-1	Load Center	120/208V	100A MCB	North Elec - 312		Feed T-4A-1, Inline Main, 21 spaces
T-BD1-30	Transformer		45 KVA	North Elec - 312		
EGHL-BD1-30	Panelboard	277/480V	100A MLO	Corr - outside 312		Feed EGHL-BD1-11 Old GE Panel Replace/Relocate, 12 spares
Bus A				North Elec - 312		
2nd Bus Tap	Bus Tap					feeds unknown equ.
LP-BD2-30	Panelboard	120/208V	225A rated 150A MCB	Middle North Elec - 321	X	GE A Series AQF 3422 ABX Reasonably good shape, full
LP-BD2-31	Panelboard	120/208V	225A MLO	Middle North Elec - 321	X	GE A Series AQF 3422 MBX Reasonably good shape, 11 spares
LP-BD2-32	Panelboard	120/208V	225A MLO	Middle North Elec - 321	X	GE A Series AQF 3422 MBX Reasonably good shape, 2 spares
EGHL-BD2-30	Panelboard	277/480V	100A MLO	Corr. - 328 outside 321		Feed EGHL-BD2-SB Old GE Panel Replace/Relocate 13 spares
T-BD2-30	Transformer		45 KVA	Middle North Elec - 321		
Bus B				Middle North Elec - 321		
LP-BD3-30	Panelboard	120/208V	225A rated 225A MCB	Middle South Elec 336		GE A Series Reasonably good shape, 2 spares, full - verify MCB site
LP-BD3-31	Panelboard	120/208V	225A MLO	Middle South Elec 336	X	GE A Series AQF 3422 MBX Reasonably good shape, 11 spares
LP-BD3-32	Panelboard	120/208V	225A MLO	Middle South Elec 336	X	GE A Series AQF 3422 MBX Reasonably good shape,2 spares
EGHL-BD3-30	Panelboard	277/480V	100A MLO	Rm 335 outside Elec 336		Feed EGHL-BD3-SB Old GE Panel Replace/relocate
T-BD3-30	Transformer		45 KVA	Middle South Elec 336	X	
HP-BD3-30	Panelboard	277/480V	225A MLO	Middle South Elec 336	X	(2) 3 pole spares, (1) 2 pole spare, 28 spaces
Bus C				Middle South Elec 336		
LP-PU-30	Panelboard	120/208V	225A rated ____ MCB			GE A Series AQF 3422 ABX Reasonably good shape, 10 spares
LP-BD4-30	Panelboard	120/208V	225A rated 150A MCB	South Elec - 336	X	GE A Series AQF 3422 ABX Reasonably good shape, 4 spares
LP-BD4-31	Panelboard	120/208V	225A rated 150A MCB	South Elec - 336	X	GE A Series AQF 3422 ABX Reasonably good shape, 9 spares
EGHL-BD4-30	Panelboard	120/208V	100A MLO	Corr. - 200D outside 270		Feed EGHL-BD3-G0 Old GE Panel - replace/relocate 14 spares
T-BD4-30	Transformer		45 KVA	South Elec - 270	X	
Bus D				South Elec - 270		

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Fourth Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
LP-BD1-40	Panelboard	120/208V	MCB ____	North Elec - 418		GE A Series
LP-BD1-41	Panelboard	120/208V	225A MLO	North Elec - 418	X	GE A Series AQF3422STX Reasonably Good Shape, 10 spaces
LP-BD1-42	Panelboard	120/208V	225A MLO	North Elec - 418	X	GE A Series AQF3422STX Reasonably Good Shape, 22 spaces
EGH-4A-1	Panelboard	277/480V	225A MLO	North Elec - 418		Feed Tapbox BN-1 - 22 spaces
T-15	Transformer		45 KVA	North Elec - 418		
T-4A-1	Transformer		30 KVA	North Elec - 418	X	Feed EGH-4A-1, Feeds EGL-3A-1, EGL-4A-1, EGL-5A-1 pad mount
EGHL-BD1-40	Panelboard	277/480V	100A MLO	Corr - 430 outside 418	X	Feed EGHL-BD1-11 Old GE Panel - Replace/Relocate
Bus A				North Elec - 418		
EGL-4A-1	Load Center	120/208V	100A MCB	North Elec - 418	X	Inline Main - 10 spaces
T-4A-3	Transformer		30 KVA	North Elec - 418	X	Suspended
LP-B01-43	Panelboard	120/208V	100 MCB		X	GE A Series-II AQU3302RCX New 10 spaces
LP-BD2-40	Panelboard	120/208V	225A MLO	Middle North Elec - 444	X	GE A Series AQF3422STX Reasonably Good Shape
LP-BD2-41	Panelboard	120/208V	225A MLO	Middle North Elec - 444	X	GE A Series AQF3422STX Reasonably Good Shape
LP-BD2-42	Panelboard	120/208V	MCB ____	Middle North Elec - 444		GE A Series AQF3422ATX Reasonably Good Shape
EGHL-BD2-40	Panelboard	277/480V	100A MLO	Corr. - 434 outside 444	X	Feed EGHL-BD2-SB Old GE Panel - Replace/Remove
T-14	Transformer		45 KVA	Middle North Elec - 444		
Bus B				Middle North Elec - 444		
LP-BD3-40	Panelboard	120/208V	225A MLO	Middle South Elec 465	X	GE A Series AQF3422STX Reasonably Good Shape, one spare
LP-BD3-41	Panelboard	120/208V	225A MLO	Middle South Elec 465	X	GE A Series AQF3422STX Reasonably Good Shape, one spare
LP-BD3-42	Panelboard	120/208V	MCB ____	Middle South Elec 465		GE A Series Reasonably Good Shape, 2 spare
EGHL-BD3-40	Panelboard			Corr. outside Elec 465		Feed EGHL-BD3-SB
T-13	Transformer		45 KVA	Middle South Elec 465	X	
Bus C				Middle South Elec 465		
LP-BD4-40	Panelboard	120/208V		South Elec - 484		
LP-BD4-41	Panelboard	120/208V	225A MLO	South Elec - 484		
EGHL-BD4-40	Panelboard	277/480V	100A MLO	Corr. - outside 484	X	Feed EGHL-BD3-SB Old GE Panel - Replace/Relocate
T-12	Transformer		45 KVA	South Elec - 484		
Bus D				South Elec - 484		
2nd Bus Tap	Bus Tap			South Elec - 484		Feed unknown load

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Fifth Floor Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
A5LA	Panelboard	120/208V	225A rated 150A MCB	North Elec - 516	X	New Panelboard Square D NQ0B New
A5LB	Panelboard	120/208V	225A MLO	North Elec - 516	X	New Panelboard Square D NQ0B New
EGH-5A-1	Load Center	120/208V	100A MLO	North Elec - 516	X	Feed Tapbox BN-1 Inline Main
T-19	Transformer		45 KVA	North Elec - 516	X	Square D
EGHL-BD1-50	Panelboard			Corr - 520 outside 516	X	Feed EGHL-BD1-11
Bus A				North Elec - 516	X	
5B-LA	Panelboard	120/208V	225A rated 150A MCB	Middle North Elec - 510	X	Square D NQ0B New
5B-LB	Panelboard	120/208V	225A MLO	Middle North Elec - 510	X	Square D NQ0B New
T-17	Transformer		45 KVA	Middle North Elec - 510	X	
EGHL-BD2-40	Panelboard			Corr. - 434 outside - 510		Feed EGHL-BD2-SB
T-18	Transformer		15 KVA	Middle North Elec - 510	X	Jefferson Electric Feed - CEH-F6 - DP2, 40A CB on Secondary
2nd Bus Plug	Bus Plug			Middle North Elec - 510		
Bus B				Middle North Elec - 510		
CEL-F6-B2		120/208V		Room 508		
5C-LA	Panelboard	120/208V	225A rated 150A MCB	Middle South Elec 550		Square D NQ0B New - 4 spaces
5C-LB	Panelboard	120/208V	225A MLO	Middle South Elec 550		Square D NQ0B New (Need to know - double lugs?) 17 spaces, 6 spare
LP-308	Panelboard	120/208V 1 Ph.	?	Middle South Elec 550	X	Old Trimble Electric Panel - Replace - 28 crt, full
EGHL-BD3-50	Panelboard			Corr. outside Elec 550		Feed EGHL-BD3-SB
T-16	Transformer		45 KVA	Middle South Elec 550	X	Square D
2nd Bus Plug	Bus Plug			Middle South Elec 550		No label - feeds?
3rd Bus Plug	Bus Plug			Middle South Elec 550		Feeds nothing
Bus C				Middle South Elec 550		
LP-BD4-50	Panelboard	120/208V	225A MLO	South Elec - 546		
LP-BD4-51	Panelboard	120/208V	225A rated 150A MCB	South Elec - 546		
EGHL-BD4-50	Panelboard			Corr. - outside 546		Feed EGHL-BD3-SB
T-BD4-50	Transformer		45 KVA	South Elec - 546		
Bus D				South Elec - 546		
Mech A	Panelboard	480V, 3W	800A MCB	South Elec - 546		100% Rated GE Spectra Series
Mech B	Panelboard	480V, 3W	800A MCB	South Elec - 546		GE Spectra Series
Mech C	Panelboard	480V, 3W	600A MCB	South Elec - 546		GE Spectra Series
DP A5	Panelboard	480V, 3W	800A MCB	South Elec - 546		GE
DP B5	Panelboard	480V, 3W	600A MCB	South Elec - 546		GE Spectra Series
Hub LP1	Transformer		30 KVA	South Elec - 546		
Hub LP1	Panelboard	120/208V	100A MCB	South Elec - 546		
2nd Bus Plug	Bus Plug			South Elec - 546		No Label - Feeds?
3rd Bus Plug	Bus Plug			South Elec - 546		Feeds HP-BD4-SPDP-1 in Elev. Penthouse

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Penthouse Electrical Connections

Equ. Name	Equ. Type	Voltage	Rating	Location	Site Verified	Notes
HP-BD4-SPDP-1	Panelboard	277/480V	600A	Elev. Penthouse		Cutler Hammer MP40 Average Shape (8) 3-pole CB's full
CEH-F6-DPO	Panelboard	277/480V	600A MLO	Center Penthouse	X	New Siemens S4E60LX600DTS
F2/F6 Interconnect	Switchgear	277/480V		Center Penthouse		States Electric Custom made, New - Feeds Mech A & F6
F1/F3 Interconnect	Switchgear	277/480V		Center Penthouse		States Electric Custom made, New - Feeds Mech C & F3
CEH-F3-DP0	Panelboard	277/480V	600A MCB	Center Penthouse	X	GE Type CCB Style 2 - Reasonably Good Shape - 2 spares
CEH-F3-DP1	Panelboard	277/480V	400A MLO	Center Penthouse	X	Square D I Line 3256-4 - Average Shape - 2 spares
CEH-F6-DP2	Panelboard	277/480V	225A MLO	Center Penthouse	X	GE A Series AEQ3422MB - Average Shape, 150A Feed - 6 spaces
CEH-F6-DP3	Panelboard	277/480V	400A MLO			

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Appendix B – Riser Diagrams – 11/ 17 foldouts

(These sheets are duplicated in the larger plan set.)

1. 13.8KV Distribution One-Line
2. Normal Riser System Switchgear New
3. Normal Riser System A & B New
4. Normal Riser System C & D New
5. Optional Standby and UPS System
6. Emergency System – Riser
7. Emergency Generator System – One Line Diagram

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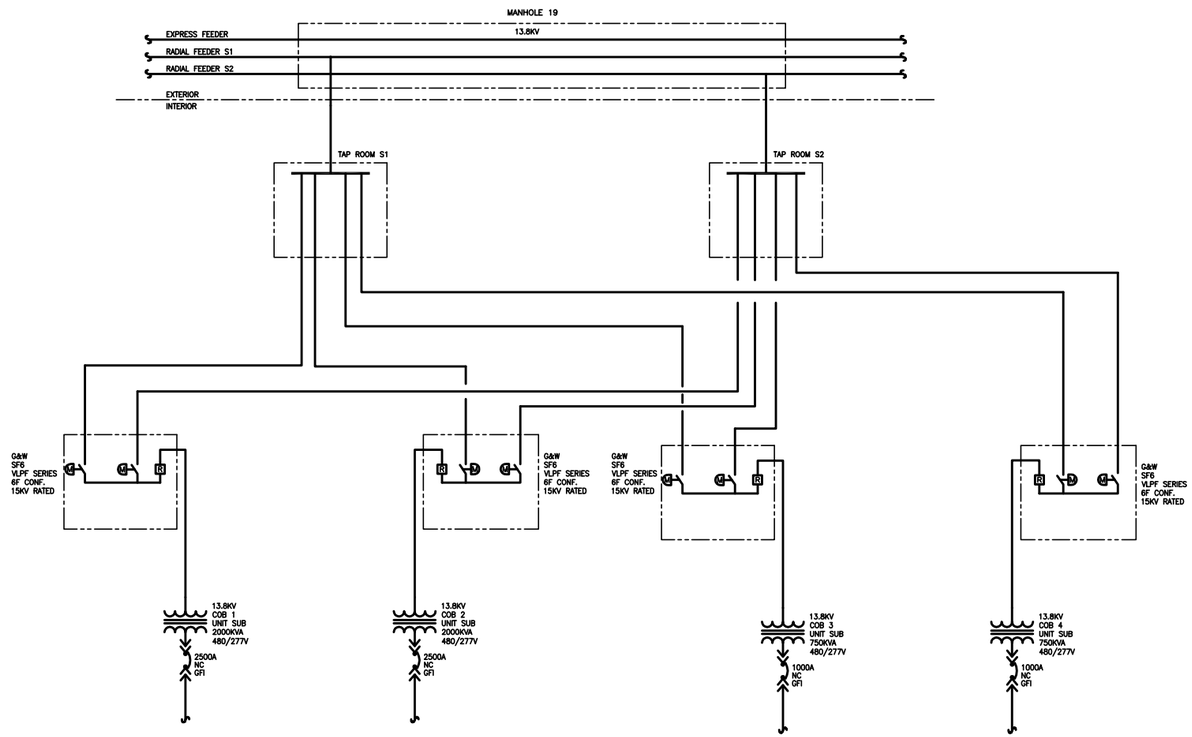

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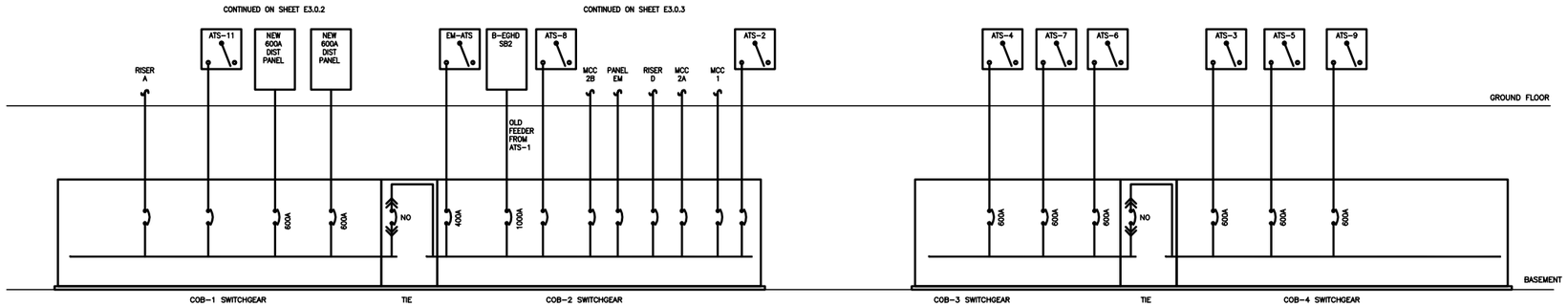
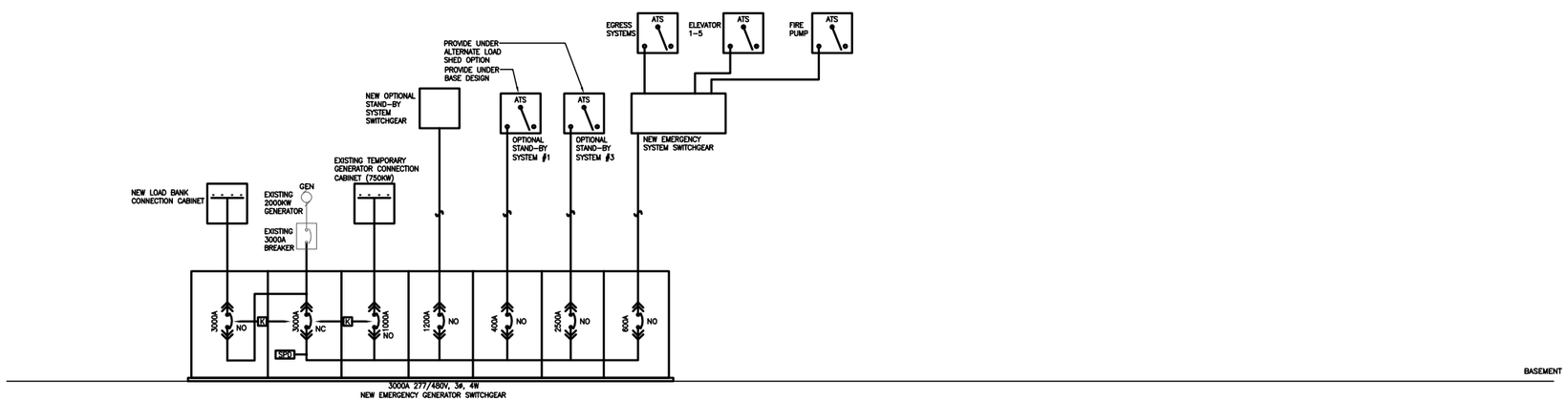


1 ONE-LINE DIAGRAM - COB - NORMAL RISER SYSTEM SWITCHGEAR NEW



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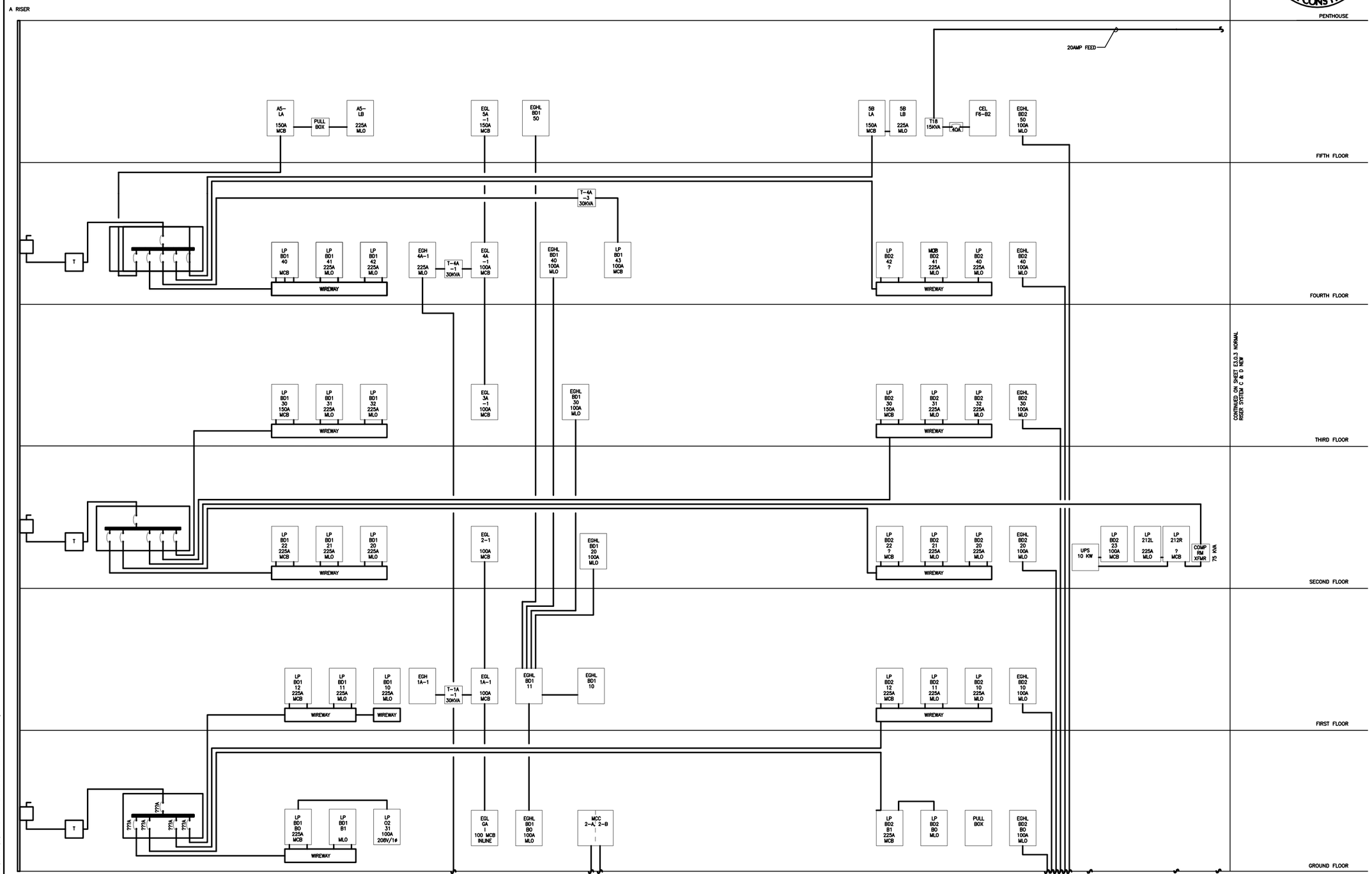

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1 ONE-LINE DIAGRAM - NORMAL RISER SYSTEM C & D NEW

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ST. PAUL, MINNESOTA

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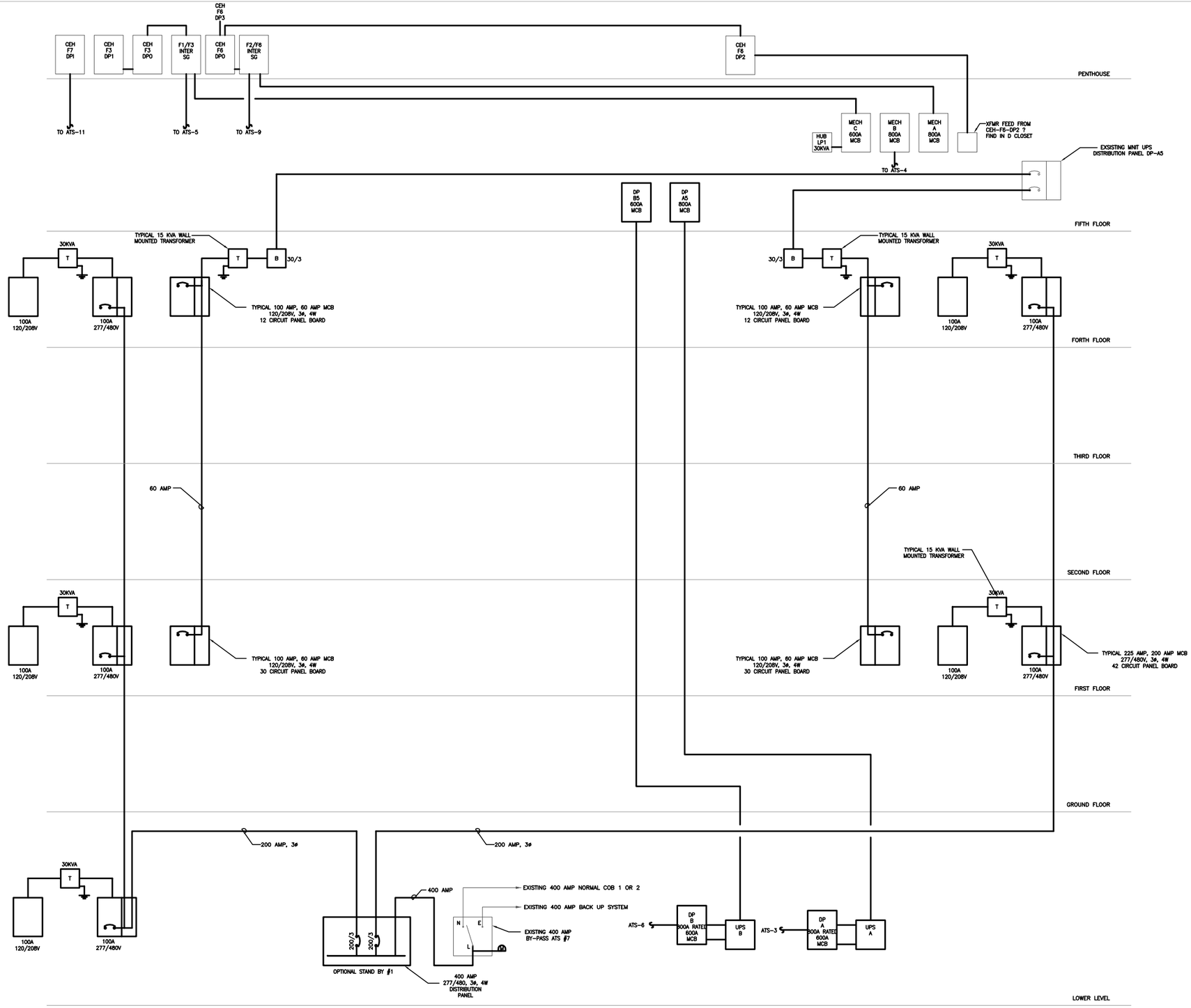

1 ONE-LINE DIAGRAM - COB - OPTIONAL STANDBY AND UPS SYSTEMS

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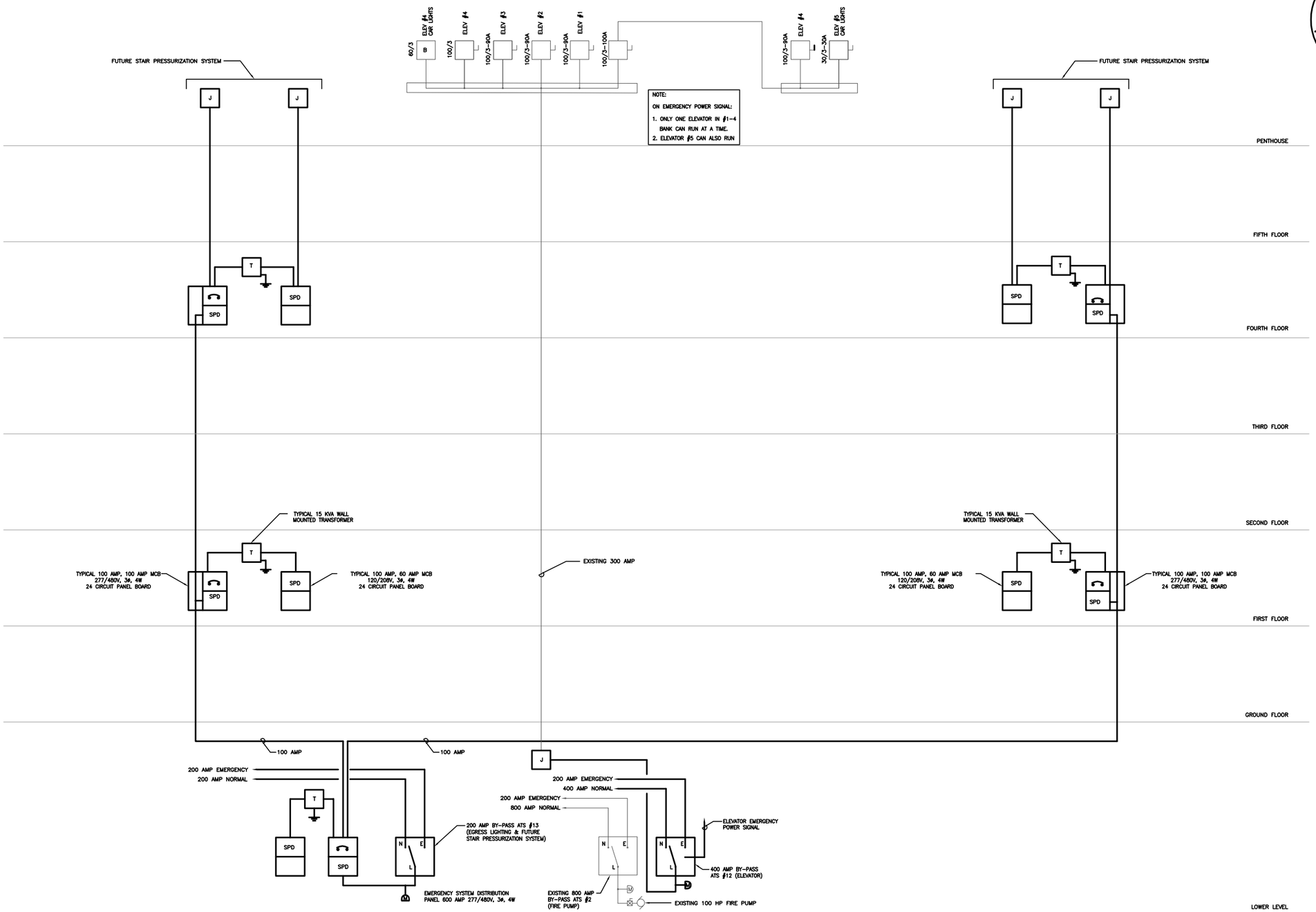

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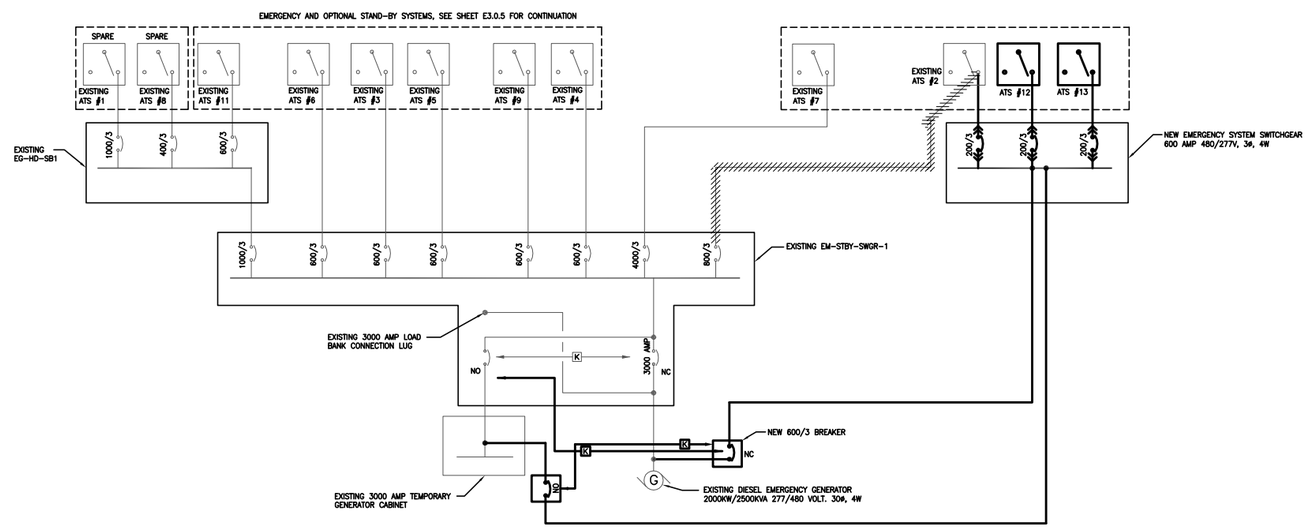

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Appendix C – Equipment Cut Sheets

8. G&W Medium Voltage SF_6 Switch
9. Square D Medium Voltage Cast Transformers
10. 480 Volt Unit Substations 1 and 2
11. 480 Volt Unit Substations 3 and 4
12. ASCO 7000 Bypass Isolation ATS
13. 15 kV Multi-Conductor Cable for Cable Tray Installation
14. 15 kV Single Cable for Conduit Installation
15. Dead Break Junctions
16. 200 Ampere Dead Break Connectors

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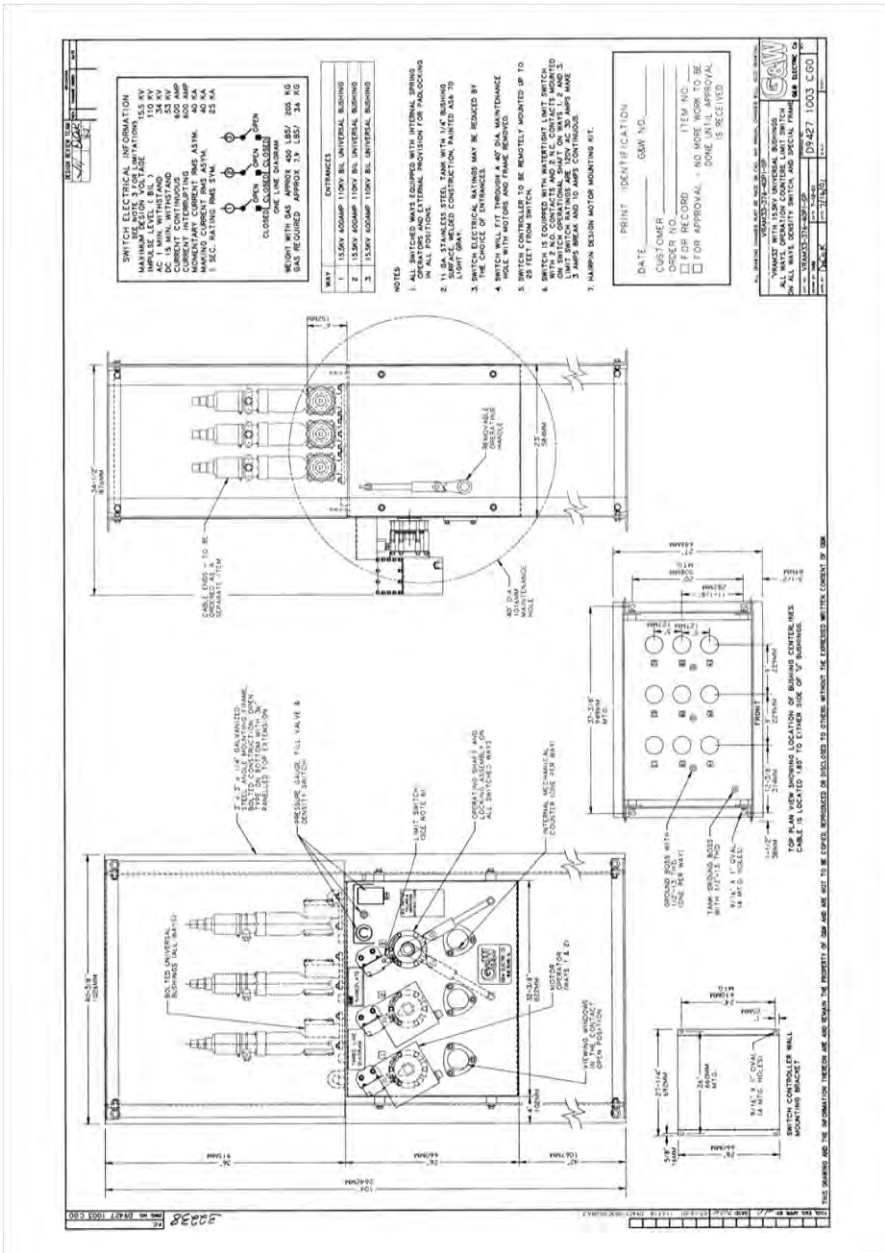
G&W Medium Voltage SF_6 Switch



7310DB0501R08/10
08/2010
Nashville, TN USA

Data Bulletin

Replaces 7310DB0501R04/10 04/2010

Power-Cast II™ Cast Transformers

225–15,000 kVA, 2.5–46 kV Primary Voltage, 120 V–15 kV Secondary Voltage Class 7310

Retain for future use.

Introduction

Power-Cast II™ cast-epoxy, unit substation-type transformers are particularly suited for applications requiring a dry-type transformer with superior performance characteristics. These transformers provide the rugged durability needed for harsh environments where chemical fumes, dust, or vibration may be present. The coils are cast in epoxy in a mold, using a computer-controlled mixing and casting process that ensures the absence of voids. The epoxy used in the casting process is mineral-filled epoxy that is Underwriters Laboratories (UL) approved. The mineral filling has been proven to enhance pure epoxy to increase its thermal conductivity, mechanical strength, arc resistance, and adhesion to the conductor, and change its coefficient of thermal expansion to be closer to that of the conductor material. The windings are also fiberglass reinforced to provide additional mechanical strength. Each winding is partial-discharged tested using induced voltage to ensure that it is void-free. The core is manufactured from high permeability, cold-rolled, grain-oriented, silicon steel laminations using a step-lap mitered core construction to ensure optimum performance and minimal sound levels. Magnetic flux densities are kept well below the saturation point.

Environmental Information

- Intended for harsh environments where long-term dependability is a must
- No special waste disposal considerations
- Excellent replacement for PCB-filled transformers

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SQUARE D by Schneider Electric

Ratings

- 225–15,000 kVA (fan cooling allows higher kVA ratings)
- Primary voltage: 2.5–46 kV
- Primary BIL: Up to 250 kV
- Secondary voltage: 120 V–15 kV
- Secondary BIL: Up to 95 kV
- Temperature rise: 80 °C (standard); 80/115 °C (optional)

Certifications

- ISO 9001 registered
- Optional UL and CSA certification
- DOE 2010 Energy Efficient (225–2500 kVA)

Special Design Options

- Seismic qualifications
- Special sound requirements
- Special altitude requirements
- Retrofit designs
- Higher efficiency requirements
- Special ambient conditions

Applicable Standards

- IEEE C57.12.01™—Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings
- ANSI C57.12.50—Requirements for Ventilated Dry-Type Distribution Transformers, 1–500 kVA Single-Phase and 15–500 kVA Three-Phase, with High Voltage 601–34,500 Volts, Low Voltage 120–600 Volts
- ANSI C57.12.51—Requirements for Ventilated Dry-Type Power Transformers, 501 kVA and larger Three-Phase, with High Voltage 601–34,500 Volts, Low Voltage 208Y/120–4,160 Volts
- ANSI C57.12.55—Conformance Standard for Transformers—Dry-Type Transformers Used in Unit Installations, Including Unit Substations
- IEEE C57.12.59™—Guide for Dry-Type Transformer Through-Fault Current Duration
- IEEE C57.12.70™—Terminal Markings and Connections for Distribution and Power Transformers
- IEEE C57.12.80™—Standard Terminology for Power and Distribution Transformers
- IEEE C57.12.91™—Test Code for Dry-Type Distribution and Power Transformers
- IEEE C57.96™—Guide for Loading Dry-Type Distribution and Power Transformers
- IEEE C57.124-1991™—Recommended Practice for the Detection of Partial Discharges and the Measurement of Apparent Charge in Dry-Type Transformers

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Specifications

A. The transformer(s) shall be the substation type with side-wall mounted primary and secondary terminations.

B. Transformer(s) shall be of solid-cast, dry-type construction, mounted in a suitable, ventilated [indoor] [outdoor] enclosure.

C. The average temperature rise of the transformer windings shall not exceed [80] [80/115] °C when the transformer is operated at full nameplate AA and FA rating. The transformer(s) shall be capable of carrying 100% of nameplate kVA rating in a 40 °C maximum, 30 °C average ambient as defined by IEEE C57.12.01™.

D. Terminations shall be side-wall mounted for: [close-coupling to high and low voltage switchgear sections] [close-coupling to high voltage switchgear on the primary side and terminating in an air-filled terminal chamber for cable connections to the low voltage side] [close-coupling to low voltage switchgear on the secondary side and termination in an air-filled terminal compartment on the primary side for cable entrance] [terminations within air-filled terminal chambers on both high voltage and low voltage side for cable entrance and exit].

E. Primary and secondary locations shall be as follows: [primary: ANSI Segment 2, *i.e.*, to observer's left when facing the transformer front; secondary: ANSI Segment 4, *i.e.*, to observer's right when facing the transformer front] [primary: ANSI Segment 4, *i.e.*, to observer's right when facing the transformer front; secondary: ANSI Segment 2, *i.e.*, to observer's left when facing the transformer front].

F. The transformer(s) shall be rated [_____kVA AA] [_____/_____kVA AA/FFA] [_____/ _____kVA AA/FA]. Primary voltage _____volts delta. Secondary voltage _____volts [wye] [delta], [3-wire] [4-wire], 60 Hz with two 2½% full-capacity above normal and two 2½% full-capacity below normal primary taps. Impedance shall be [_____%] [manufacturer's standard impedance], ±7½%. Sound level shall not exceed [the maximum specified by NEMA TR-1,1980 for the applicable kVA size of dry-type transformer] [_____dB].

G. Forced air cooling shall increase the allowable full-load kVA by [33⅓] [50] %.

NOTE: 50% increase is not available for transformers rated 750 kVA and below, or above 5000 kVA while also maintaining an 80 °C rise.

H. Both high and low voltage windings shall be of [copper] [aluminum] conductors. High and low voltage windings shall each be separately cast as one rigid tubular coil, and arranged coaxially. Each cast coil shall use a mineral-filled epoxy reinforced with fiberglass mat, and cast to provide complete, void-free resin impregnation throughout the entire insulation system. The coil supports shall maintain constant pressure during thermal expansion and contraction of the coils. There shall be no rigid mechanical connection between high and low voltage coils.

I. The windings must not absorb moisture and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100% humidity at temperatures from -30 °C to + 40 °C and shall be capable of immediately being switched on after such storage without predrying.

J. The impulse rating of the high voltage windings must be at least equal to the basic impulse level specified by IEEE C57.12.00™ for liquid-filled distribution transformers of the same voltage class, without the use of supplemental surge arresters.

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K. The impulse rating of the low voltage winding must be at least [30 kV for low voltage windings rated 1.2 kV and below] [45 kV for low voltage windings rated 2.5 kV and below] [60 kV for low voltage windings rated 5 kV and below].

L. The transformer core shall be constructed of high grade, grain-oriented, silicone steel laminations, with high magnetic permeability. Magnetic flux density is to be kept well below the saturation point. The core shall be cruciform in shape, with mitered joints to keep core losses, excitation current, and noise level at a minimum. The outside surfaces of the core shall be protected against corrosion by painting with a suitable coating after assembly. Core dipping is not acceptable.

M. The enclosure(s) shall be constructed of heavy-gauge sheet steel. All ventilating openings shall be in accordance with NEMA and NEC® standards for ventilated enclosures. The cabinet shall have a minimum of four [hinged doors] [removable panels; removable panels shall have handles].

N. The base(s) shall be constructed to permit rolling or skidding in any direction, and shall be equipped with jacking pads designed to be flush with the transformer enclosure.

O. Fan cooling equipment shall include multiphase electronic temperature monitor controlled automatically by sensors placed in the low voltage air ducts. The temperature monitor must contain yellow and red indicating lights. The yellow and red lamps signal that fan and alarm contacts have been activated. A 0–1 milliampere output is required for remote indication. Alarm contacts shall be provided for fans, alarm, and trip function. An audible alarm must sound when the highest phase temperature exceeds a preset point. The fans must be able to operate in either manual or automatic mode. A fan exerciser circuit must operate the cooling fans for approximately one minute every six days. [Minimum 12 fans shall be provided] [Minimum six "squirrel cage" centrifugal blowers shall be required] and shall be controlled automatically by sensors placed in the low voltage air ducts. Forced air cooling system shall include: fans, control wiring, controller with test switch, current limiting fuses in the power supply to the controller, indication lights, alarm silencing relay, and necessary push buttons to properly control the system.

P. Provision for future forced air cooling equipment shall include mounting provision for fans, bussing sized to the fan-cooled rating, and provisions for mounting the fan control system.

Q. Low voltage bus shall be silver flash-plated [aluminum] [copper] throughout.

R. The transformer shall comply with all applicable portions of NEMA TR-1 and IEEE C57.12.01™.

S. Testing shall be conducted in accordance with IEEE C57.12.91™ and shall include, at a minimum, the following tests:

1. Ratio
2. Polarity
3. Phase rotation
4. No-load loss
5. Excitation current
6. Impedance voltage
7. Load loss
8. Applied potential
9. Induced potential

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10. The transformer windings must be free of partial discharge up to at least 1.2 times the rated line-to-ground voltage. All coils shall be subjected to a partial discharge test to verify its partial discharge.
11. Quality control impulse
12. Temperature (typical data from previous unit is acceptable)
13. Sound (typical data from previous unit is acceptable)

Technical Data

Table 1: Standard Transformer Ratings, Primary Voltage Class 2.3–46 kV, 80 °C Rise, 30 °C Ambient

kVA Self-Cooled	kVA Fan-Cooled	Secondary Voltage		
		208Y/120 V 240 V Delta	480Y/277 V 480 V Delta	4160Y/2400 V 4160 V Delta 2400 V Delta
225		X	X	
300	400	X	X	
500	667	X	X	X
750	1000	X	X	X
1000	1500	X	X	X
1500	2250	X	X	X
2000	3000		X	X
2500	3750		X	X
3750	5625			X
5000	7500			X
7500	9375			X
10000	13333			X

The above combinations are based on standard designs. Other than standard designs may place further restrictions on the availability of voltage and kVA combinations. Consult the factory for final determination.

Table 2: Altitude Derating Factor[1]

Altitude (FT)	kVA Correction		BIL Correction
	VPI (AA)	Forced Air (FA)	
3300	1.00	1.00	1.00
4000	0.994	0.989	0.98
5000	0.985	0.974	0.95
6000	0.975	0.959	0.92
7000	0.966	0.944	0.89
8000	0.957	0.929	0.86
9000	0.948	0.914	0.83
10,000	0.939	0.898	0.80
11,000	0.930	0.883	0.77
12,000	0.921	0.868	0.75
13,000	0.912	0.853	0.72
14000	0.903	0.838	0.70
15,000	0.894	0.823	0.67

[1] 3.28 feet = 1 meter

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Table 3: Audible Sound Levels

Self-Cooled		Forced Air-Cooled	
Equivalent Two-Winding kVA	Class AA Rating	Equivalent Two-Winding kVA	Class FA/AFA Rating
0–9	40	0–1167	67
10–50	45	1168–1667	68
51–150	50	1668–2000	69
151–300	55	2001–3333	71
301–500	60	3334–5000	73
501–700	62	5001–6667	74
701–1000	64	6668–8333	75
1001–1500	65	8334–10000	78
1501–2000	66	10001–13333	82
2001–3000	68		
3001–4000	70		
4001–5000	71		
5001–6000	72		
6001–7500	75		
7501–10000	79		
10001–15000	82		

Table 4: System Voltages and Transformer BIL Ratings

Nominal System Voltage (kV)	Standard and Optional Transformer BIL Ratings									
	10	30	45	60	75	95	110	125	150	200
1.2		S	1							
2.5			S	1						
5.0				S	1					
8.7					S	1				
15.0						S	1			
25.0								S	1	
34.5								2	1	S

S = Standard value.

1 = Optional higher levels where exposure to overvoltage occurs and improved protective margins are required.

2 = Lower levels where protective characteristics of applied surge arresters have been evaluated and found to provide appropriate surge protection.

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Table 5: Performance Data

Typical Performance Data					Regulation			
kVA	%IZ	%IR	%IX	X/R Ratio	1.0 PF	0.9 PF	0.8 PF	0.7 PF
225	5.75	1.20	5.62	4.69	1.36	3.63	4.41	4.90
300	5.75	1.30	5.60	4.32	1.45	3.71	4.47	4.95
500	5.75	0.82	5.69	6.92	0.98	3.33	4.15	4.70
750	5.75	0.59	5.72	9.68	0.75	3.14	3.99	4.56
1000	5.75	0.76	5.70	7.53	0.92	3.28	4.11	4.66
1500	5.75	0.72	5.70	7.92	0.88	3.25	4.08	4.64
2000	5.75	0.70	5.71	8.12	0.87	3.24	4.07	4.63
2500	5.75	0.61	5.72	9.45	0.77	3.16	4.00	4.57
3000	5.75	0.57	5.72	10.03	0.73	3.12	3.98	4.55
3750	5.75	0.56	5.72	10.21	0.72	3.12	3.97	4.54
5000	5.50	0.52	5.48	10.53	0.68	3.09	3.94	4.52
7500	5.50	0.40	5.49	13.71	0.56	2.98	3.86	4.45
10000	5.50	0.36	5.49	15.25	0.52	2.95	3.83	4.42

Table 6: Typical Performance Data: High Voltage—15 kV Class; Low Voltage—600 V Class

kVA	No Load Losses (Watts)	Full Load Losses [1] (Watts)	Total Losses (Watts)	Efficiency [1]						
				150%	133%	112%	100%	75%	50%[1]	25%
225	1000	2700	3700	—	98.11	98.29	98.38	98.53	98.58	97.96
300	1100	3880	4990	—	98.04	98.25	98.36	98.56	98.68	98.24
500	2000	4110	6110	—	98.63	98.74	98.79	98.86	98.83	98.23
750	2700	4430	7130	—	98.95	99.03	99.06	99.09	98.95	98.44
1000	3100	7570	10670	98.68	98.78	98.89	98.94	99.03	99.04	98.59
1500	4100	10810	14910	98.75	98.85	98.96	99.02	99.10	99.13	98.74
2000	5000	14050	19050	98.79	98.89	99.00	99.06	99.15	99.18	98.84
2500	6200	15130	21330	98.94	99.02	99.11	99.15	99.22	99.23	98.87
3000	9000	17000	26000	98.98	99.03	99.06	99.14	99.18	99.12	98.68
3750	10000	21000	31000	98.99	99.06	99.09	99.18	99.23	99.19	98.81
5000	13000	26000	39000	—	99.12	99.17	99.23	99.27	99.23	98.84
7500	16500	30000	46500	—	99.31	99.33	99.38	99.41	99.36	99.03
10000	21000	36000	57000	—	99.37	99.39	99.43	99.45	99.40	99.08

[1] Full load losses and efficiencies are at a reference temperature of 100 °C in accordance with IEEE Standard C57.12.91. The efficiencies of transformers with a 225–2,500 kVA rating at 50% load are at a reference temperature of 75 °C in accordance with DOE Test Procedure 10 CFR, Part 431, Subpart K, Appendix A.

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Table 7: Standard % Impedance

HV BIL	Low Voltage Rating		
	208Y/120 V, 240 V	480Y/277 V, 480 V	2400–4800 V
45–150 kV	6.5%	5.75%	5.5%
200–250 kV	7.5%	6.75%	6.5%

Table 8: Standard Enclosure Design Dimension and Weights [1]

kVA	Dimensions (inches)			Weight (lbs)
	Height	Width	Depth	
225	94.0	84.0	54.0	6400
300	94.0	84.0	54.0	6800
500	94.0	84.0	54.0	8000
750	94.0	84.0	54.0	10600
1000	94.0	90.0	54.0	12000
1500	94.0	102.0	54.0	15000
2000	100.0	108.0	54.0	17000
2500	100.0	108.0	54.0	19200
3000	112.0	120.0	66.0	23500
3750	112.0	120.0	66.0	27000
5000	124.0	132.0	78.0	35000
7500	124.0	154.0	78.0	50000
10000	136.0	154.0	78.0	60000

[1] Values listed are typical and should not be used for construction purposes.

Loading

Power-Cast II transformers are designed to operate at rated load with rated voltage and frequency applied in "usual service" conditions. It is possible to carry overloads without loss of life expectancy. The following table shows the permissible overloads that may be carried without loss of transformer life expectancy only if occurring once in any 24-hour period given a 80 °C rise transformer in a 30 °C ambient.

ANSI/IEEE Loading Guide

Daily loads above rating to give normal life expectancy. Following and followed by a constant load of:

Peak Load Time In Hours	Times Rated kVA		
	90%	70%	50%
0.5	1.47	1.59	1.65
1	1.30	1.36	1.39
2	1.20	1.23	1.25
4	1.13	1.15	1.16
8	1.07	1.09	1.09

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Heat Contribution

Heat contribution is the heat a transformer may contribute to its environment. This may represent additional air conditioning burden in summer months, or may be used in calculating heating requirements during winter months. This heat is the result of transformer losses and is a function, in part, of loading. The following table demonstrates the effect of loading on heat contribution.

Table 9: Typical Heat Contribution: High Voltage—15 kV Class; Low Voltage—480Y/277 V [1]

kVA	% Load	BTU/Hour	kVA	% Load	BTU/Hour
225	25	3990	2500	25	24400
	50	5720		50	34090
	75	8600		75	50240
	100	12635		100	72840
	125	17825		125	101905
	133	19725		133	112570
	150	—		150	137430
300	25	4590	3000	25	34330
	50	7080		50	45210
	75	11230		75	63335
	100	17040		100	88710
	125	24515		125	121340
	133	27255		133	133320
	150	—		150	161360
500	25	7710	3750	25	38600
	50	10340		50	52030
	75	14725		75	74425
	100	20865		100	105770
	125	28760		125	146880
	133	31660		133	160880
	150	—		150	195510
750	25	10170	5000	25	49900
	50	13000		50	66530
	75	17730		75	94260
	100	24350		100	133070
	125	32860		125	182970
	133	35980		133	201290
	150	—		150	—
1000	25	12200	7500	25	62695
	50	17050		50	81890
	75	25130		75	113875
	100	36440		100	158660
	125	47815		125	216235
	133	56315		133	237730
	150	68755		150	—
1500	25	16310	10000	25	79330
	50	23230		50	102360
	75	34770		75	140745
	100	50920		100	194480
	125	71685		125	263580
	133	79305		133	288940
	150	97085		150	—
2000	25	20075			
	50	29070			
	75	44065			
	100	65055			
	125	82045			
	133	101950			
	150	125030			

[1] 5 kV Secondary, 5000 kVA and above.

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Schneider Electric USA, Inc.
1010 Airpark Center Drive
Nashville, TN 37217 USA
1-888-SquareD (1-888-778-2733)
www.schneider-electric.us

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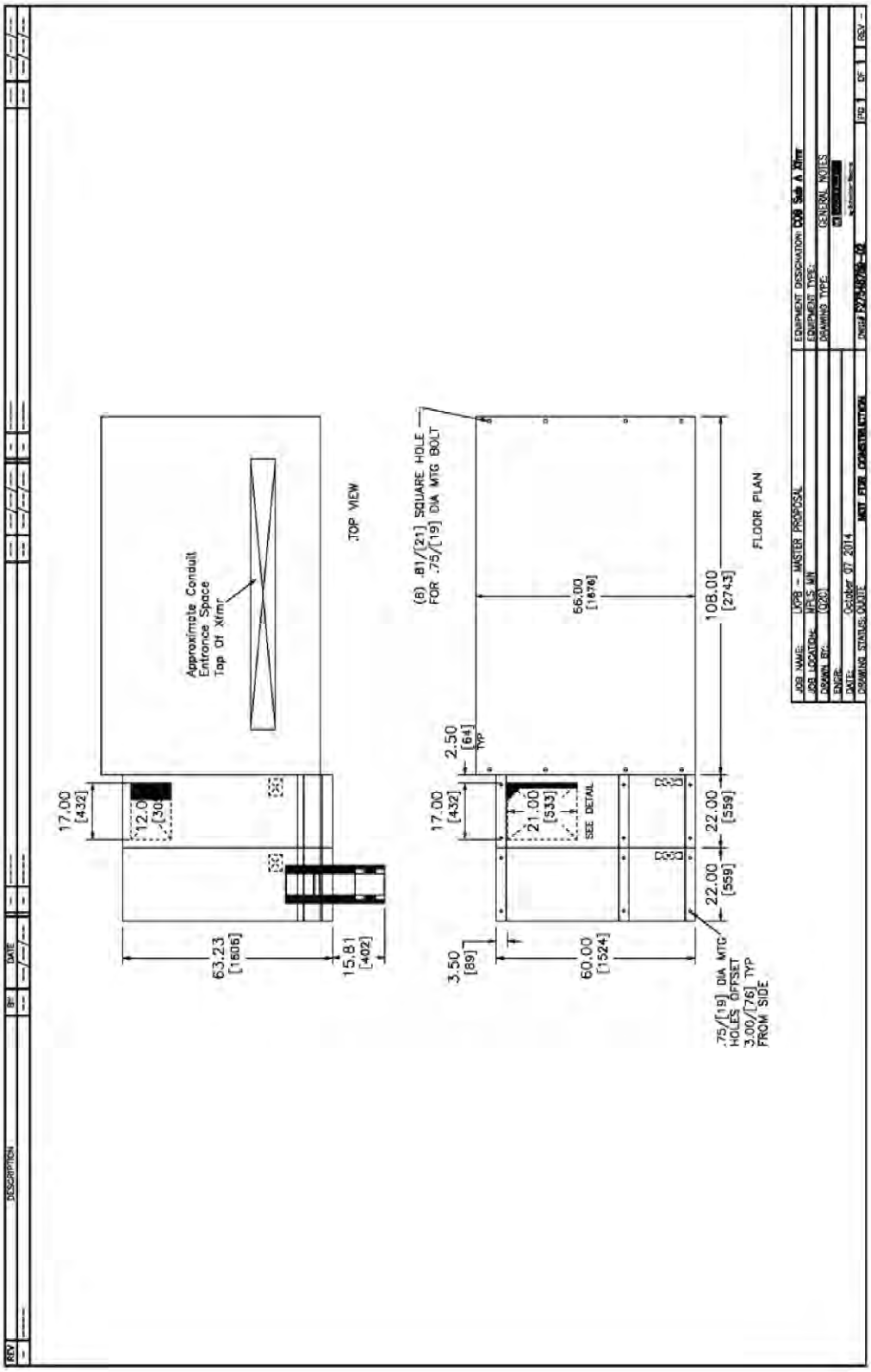
480 Volt Unit Substations 1 and 2



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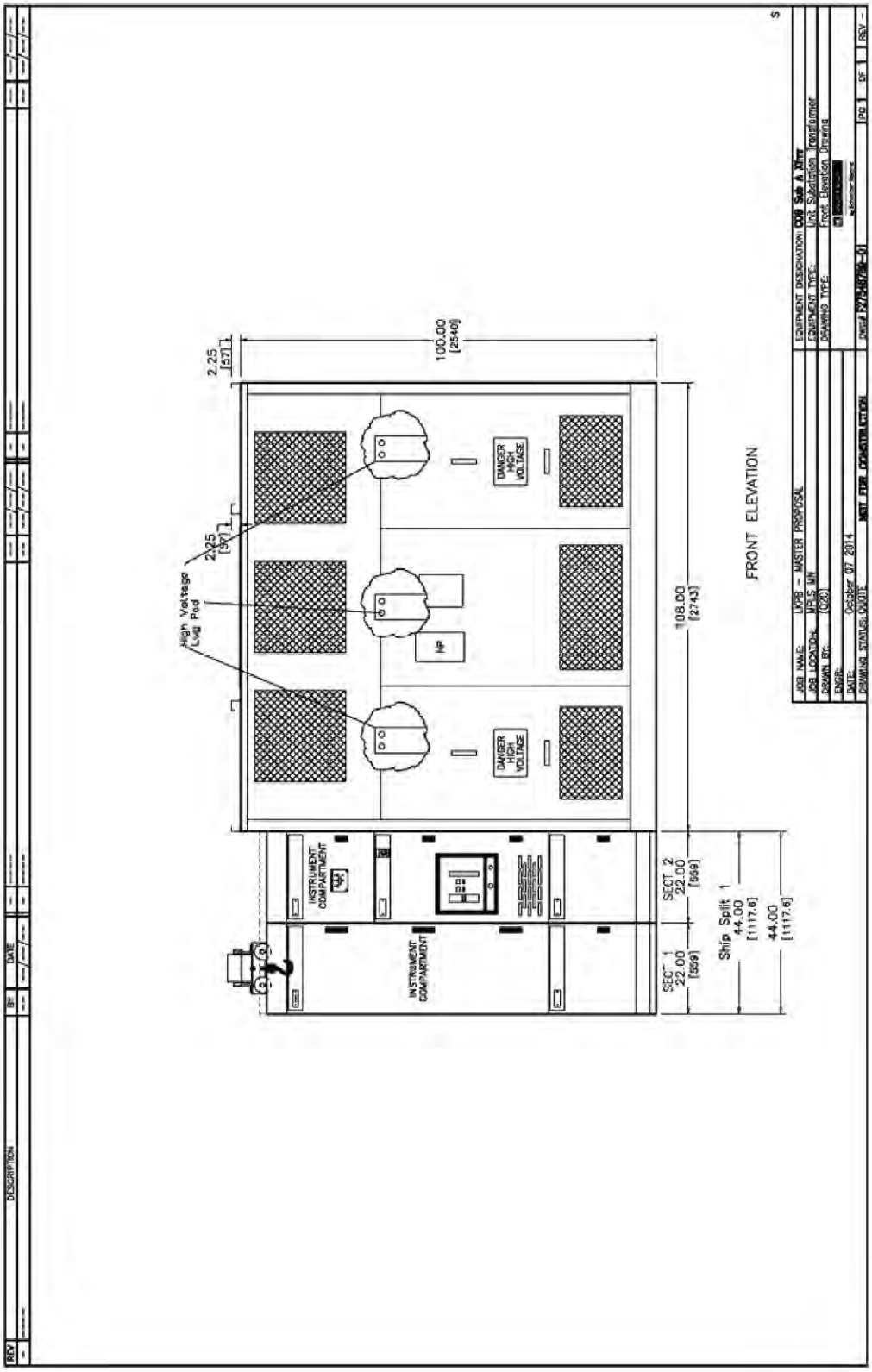
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VOLTAGE
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COMPARTMENT
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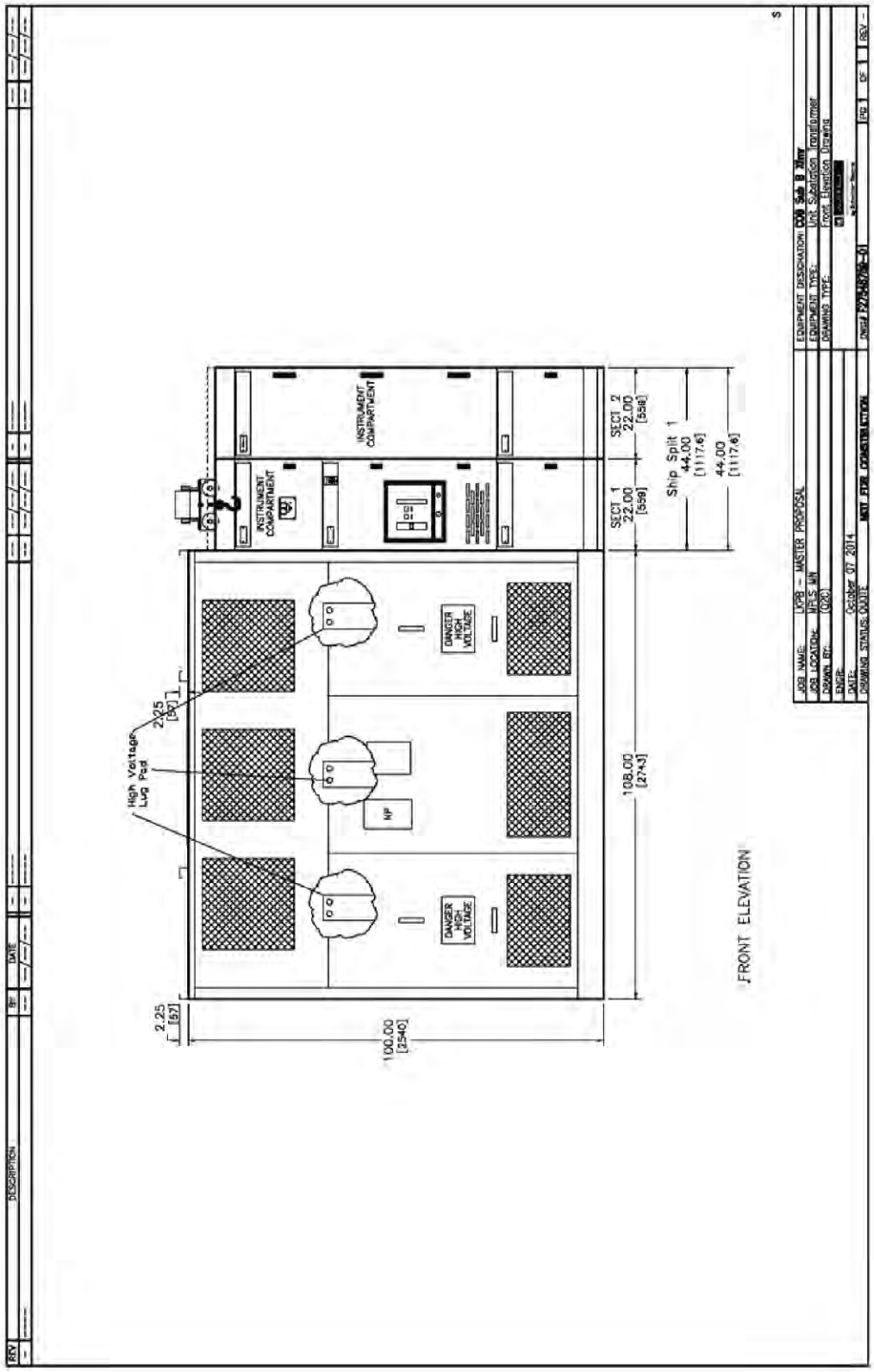
Detail P74-14/16-01
PG 1 OF 1
REV -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OF 1
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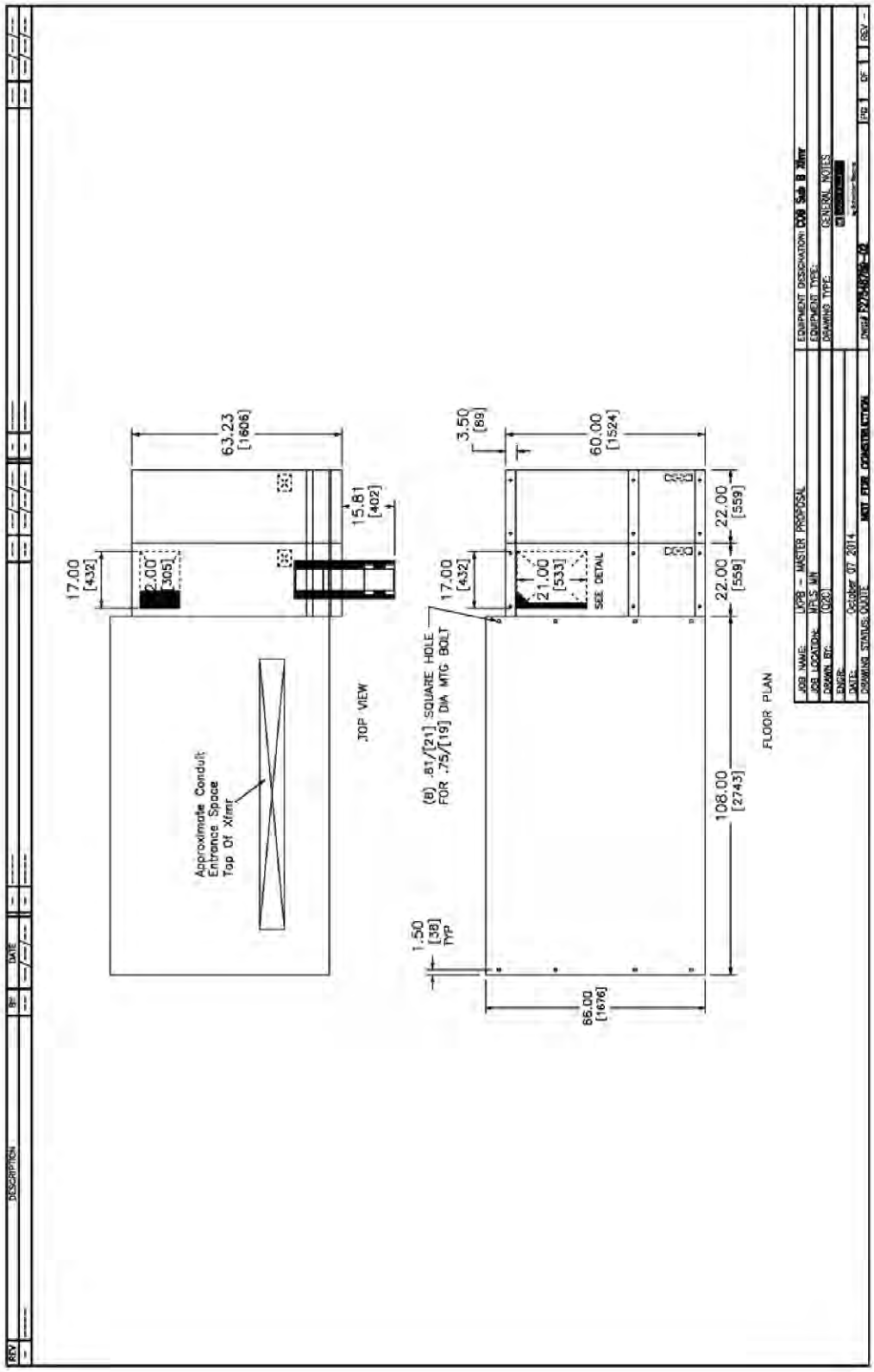
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EQUIPMENT TYPE:
DRAWING TYPE: GENERAL NOTES
Dwg 1 OF 1
REV -

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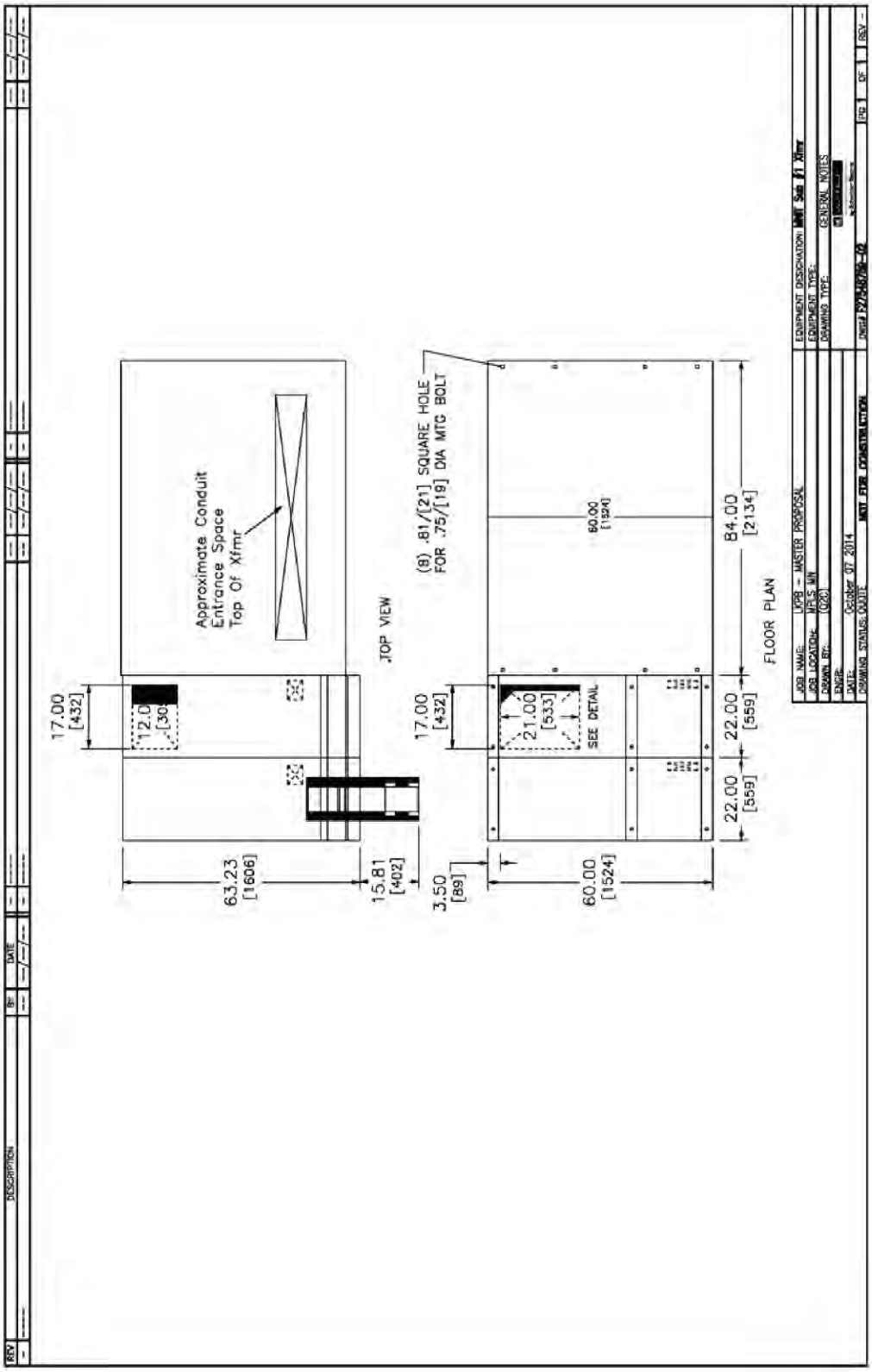
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NOT FOR CONSTRUCTION
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DRAWING TYPE: GENERAL NOTES
PG 1 OF 1
REV -

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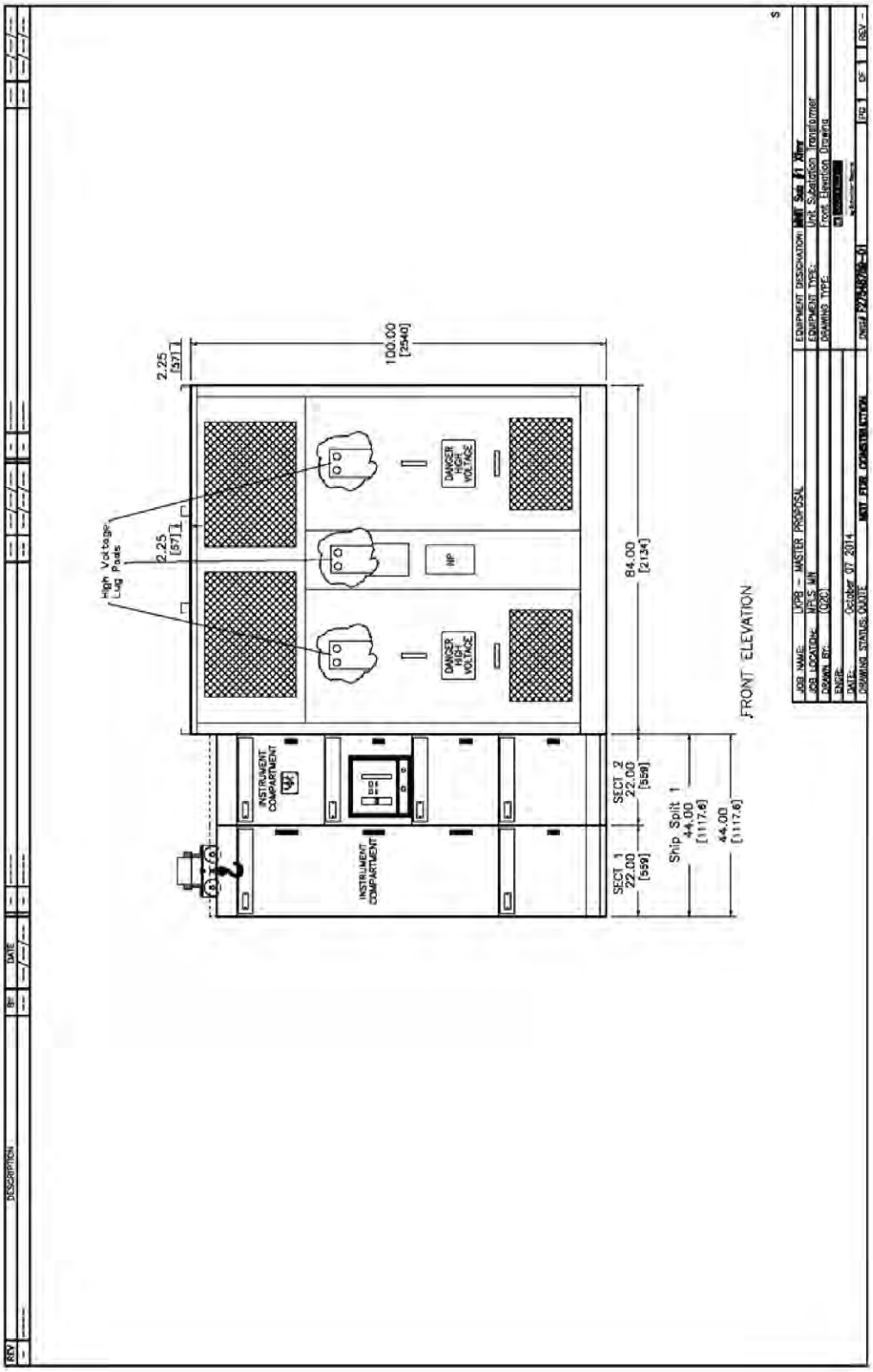
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HP
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DRAWN BY: (02C)
ENGR:
DATE: October 07 2014
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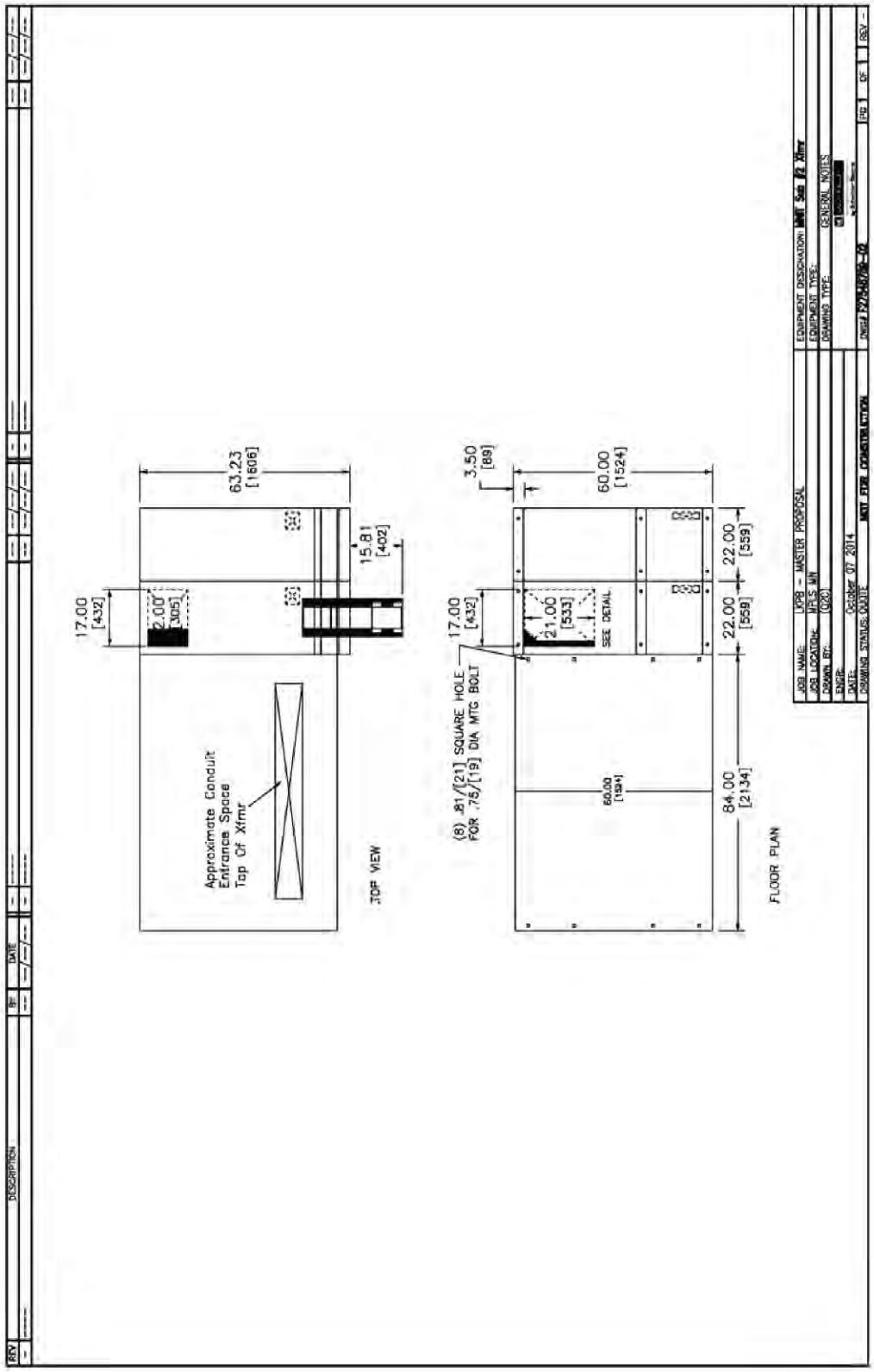
DRAWING TYPE: Front Elevation Drawing
Dwg # P2A-02C-01
REV -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PG 1 OF 1
REV -

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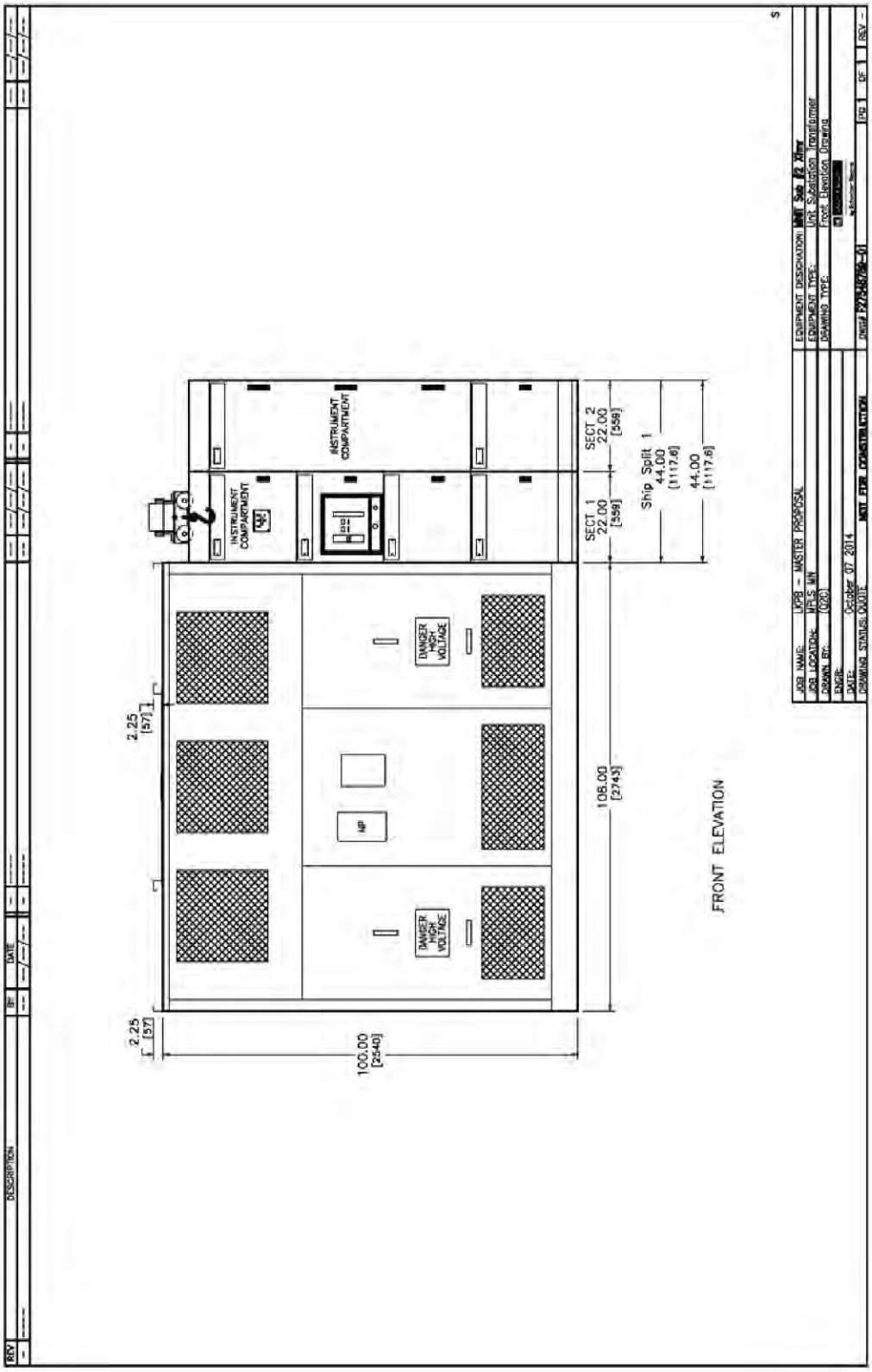
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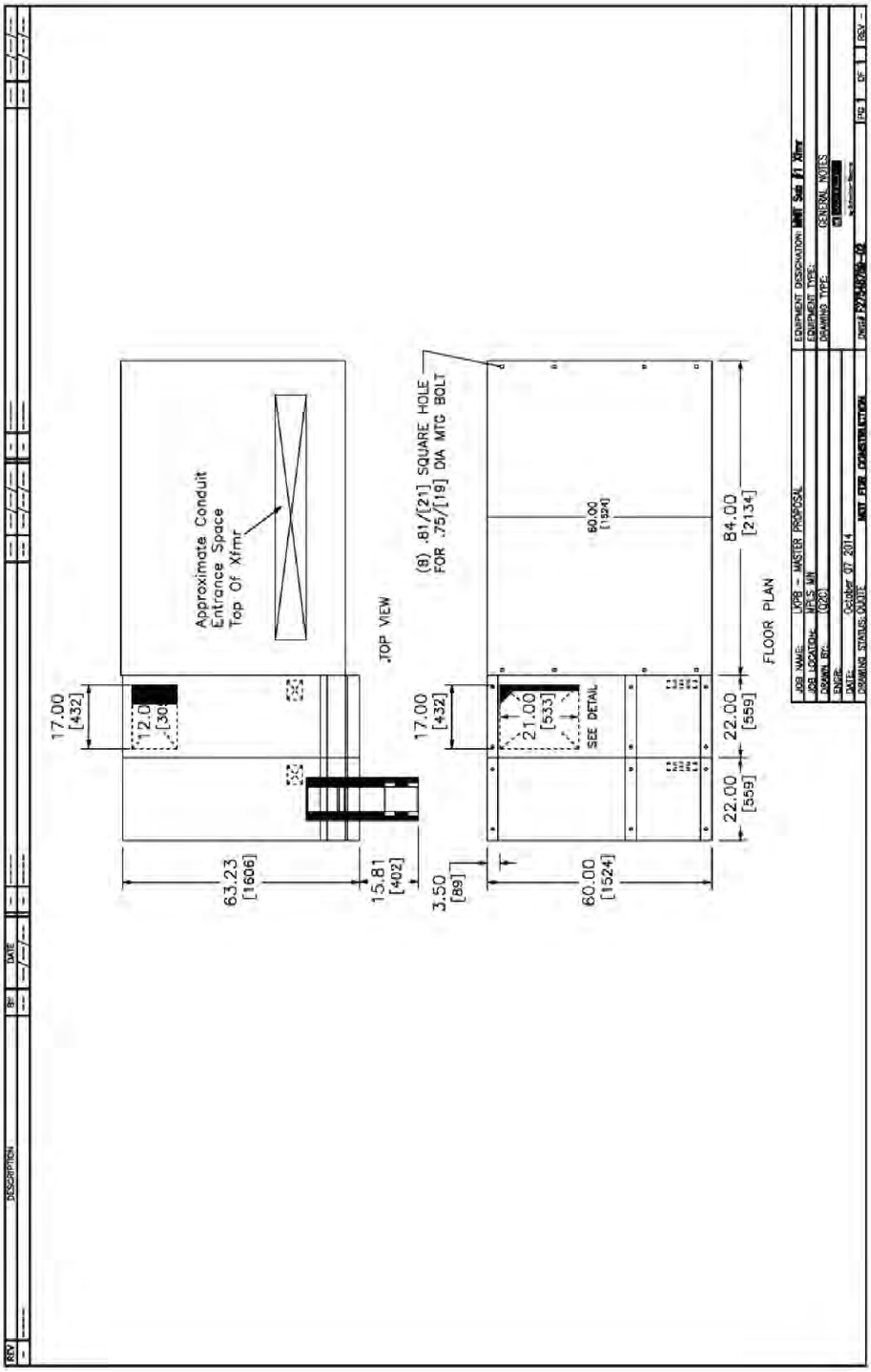
Detail P74-14-01
SHT 1 OF 1
REV -

480 Volt Unit Substations 3 and 4



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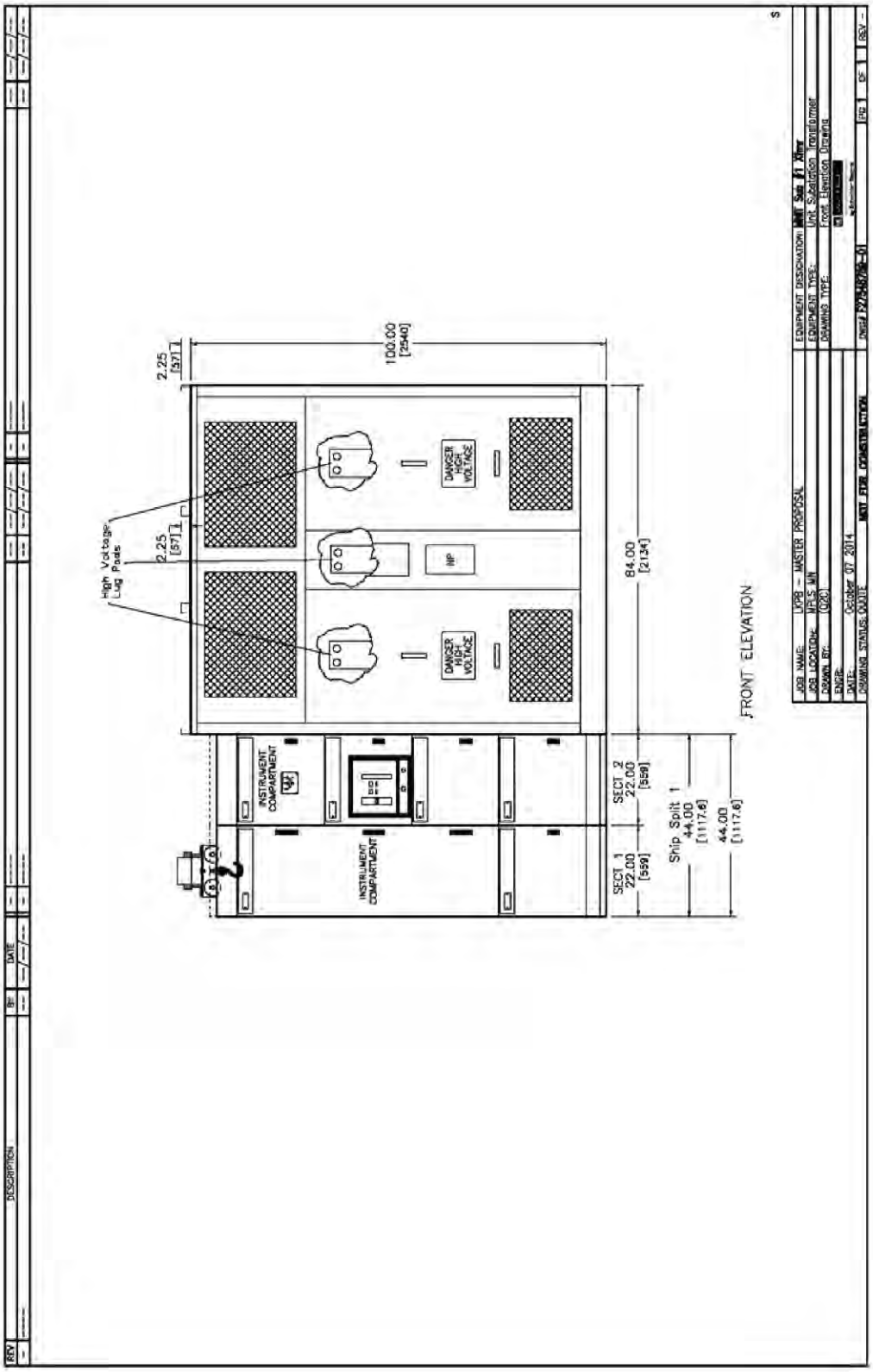
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REV -

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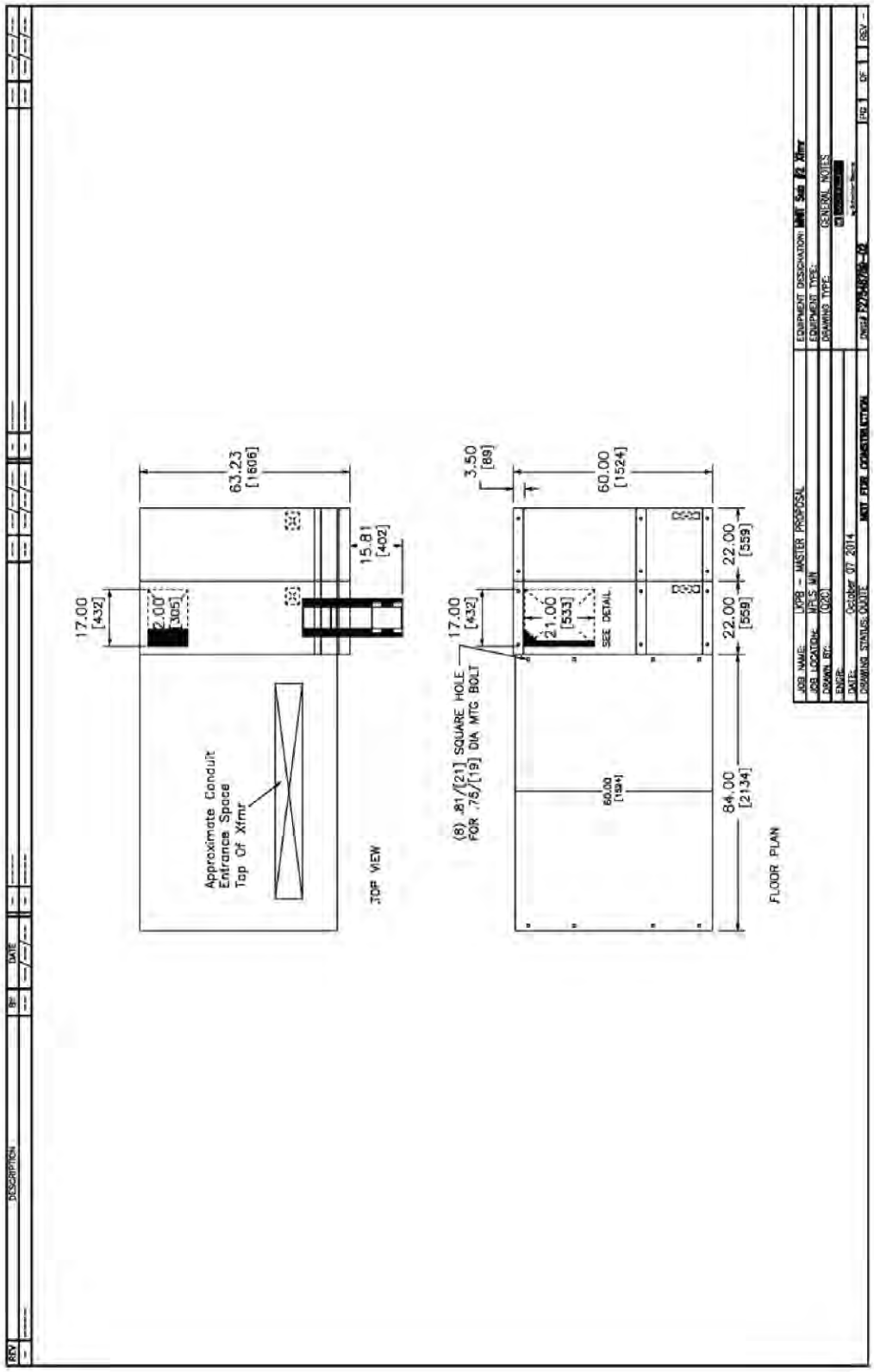
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TOP VIEW
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SEE DETAIL
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PG 1 OF 1
REV -

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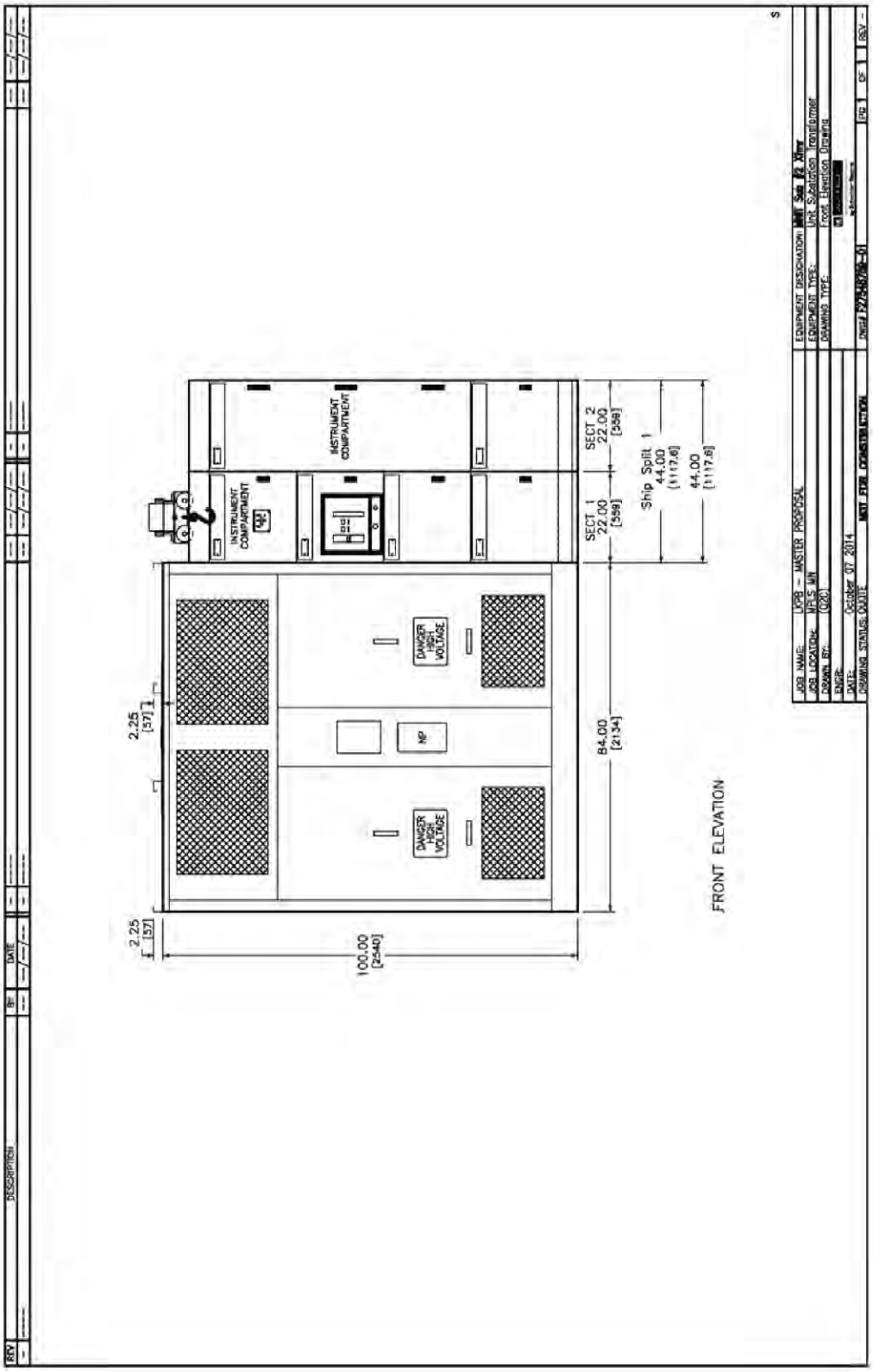
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DRAWN BY: (02C)
ENGR:
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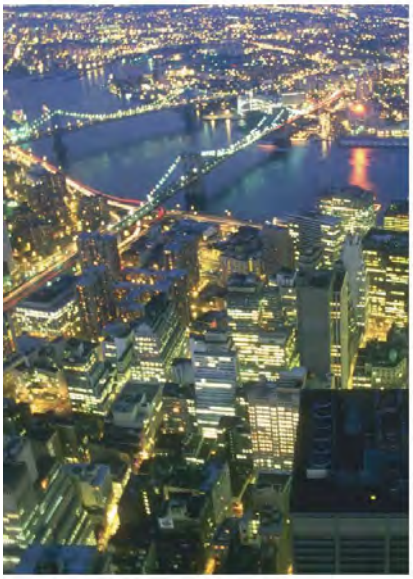
DRAWING STATUS: QUOTE
MST FTR CONSTRUCTION
EQUIPMENT DESIGNATION: MST Sub #2 Xfmr
EQUIPMENT TYPE: Unit Substation Transformer
DRAWING TYPE: Front Elevation Drawing
Dwg# P2-02C-01
REV -

ASCO 7000 Bypass Isolation ATS

Power Switching & Controls
for Business-Critical Continuity

ASCO 7000 SERIES Power Transfer Switches



ASCO®

EMERSON.
Network Power

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ASCO® 7000 Series Power Switching Solutions

Automatic Transfer Bypass-Isolation Switches

Fig. 5: Rated 150-600 Amps

Fig. 6: Rated 600- 1200 Amps

Fig. 7: Rated 800-3000 Amps

Fig. 8: Rated 4000 Amps

ASCO Automatic Transfer & Bypass-Isolation Switches are available in open transition, closed transition and delayed transition designs. The bypass and isolation features allow the primary automatic transfer switch to be inspected, tested, and maintained without any interruption of power to the load. They also provide redundant power transfer in the event the ATS is disabled or removed from service.

- Available 150 to 4000 Amperes.
- Allows bypass-isolation without load interruption.
- Bypass switch and transfer switch have identical electrical ratings.
- Heavy duty mechanical interlocks prevent undesirable operation.
- Bypass contacts carry current only during bypass mode.
- Transfer switch is drawout design for ease of maintenance.
- Bypass and isolation handles are permanently mounted. The bypass switch has dead front quick-make, quick-break operation for transferring of loads between live sources.
- Bypass switch is fully rated for use as a manual 3-position transfer switch.
- Bypass and isolation functions are simple, requiring a total of two operating handles.
- No toggle switches, push buttons, selector switches or levers are required for bypass-isolation operation.
- Mechanical indicators show bypass and transfer switch positions.
- 800 -1200 ampere available in shallow depth, front connected or rear connected designs.

Transfer Switch Drawout Features (150-4000 Amperes)

Fig. 9: Bypass-Isolation Transfer Switch secondary disconnects and optional automatic shutters.

- Automatic secondary disconnects remove all control power as switch is withdrawn.
- Drawout carriage provides for easy transfer switch maintenance and/or removal via commercially available breaker hoists.
- Optional transfer switch lifting yoke kit available
- Optional automatic shutters which close when the transfer switch is withdrawn to provide bus isolation, specify accessory 82C.(1600-4000A only)

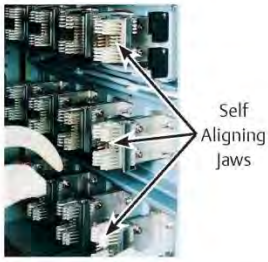

Fig. 10: Bypass-Isolation Transfer Switch self aligning power jaws.

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ASCO® 7000 Series Power Switching Solutions

Bypass and Isolation Handles - Simple as 1, 2, 3

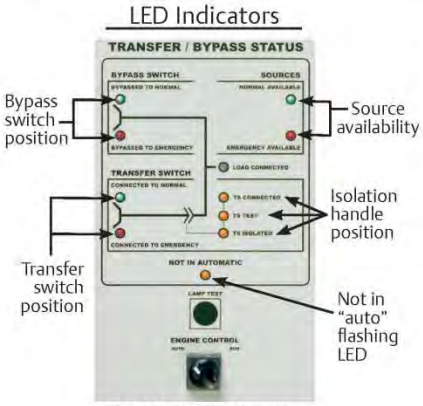
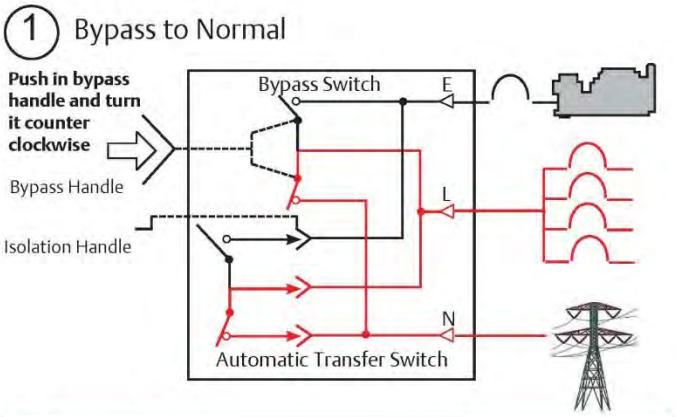
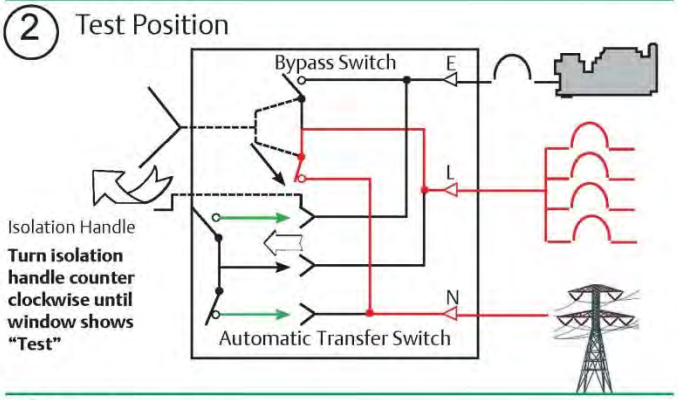


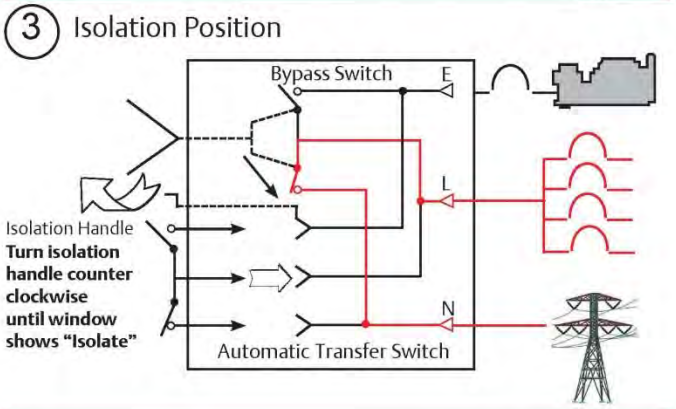
Fig. 11: Transfer Bypass Status Panel*

*Standard on switches up through H 1200A. Specify ACC 82E for G frame 1600-4000A

Fig. 12: Bypass-Isolation Switch user interface







Key:
- Represents Current Flow
- In test position control panel remains energized to allow for electrical operation of a transfer switch.

7

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15 kV Multi-Conductor Cable for Cable Tray Installation

COMPACT STRAND CONSTRUCTION

Product Data
Section 2: Sheet 24

C-L-X® Type MV-105 or MC-HL

15kV Okoguard® Shielded Power Cable-Aluminum Sheath
3 Okopact® (Compact Stranded) Copper Conductors/105°C Rating
133% Insulation Level
For Cable Tray Use-Sunlight Resistant-For Direct Burial

- Uncoated Okopact (Compact Stranded) Copper Conductors
- Extruded Semiconducting EPR Strand Screen
- Okoguard Insulation (EPR)
- Extruded Semiconducting EPR Insulation Screen
- Phase Identification Tape
- Copper Grounding Conductor
- Uncoated Copper Shield
- Fillers and Binder Tape
- Impervious, Continuous, Corrugated Aluminum C-L-X Sheath
- Jacket-Red Low Temperature Okoseal

Insulation

Okoguard is Okonite's registered trade name for its exclusive ethylene-propylene rubber (EPR) base, thermosetting compound, whose optimum balance of electrical and physical properties is unequaled in other solid dielectrics. Okoguard insulation, with the distinctive red color and a totally integrated EPR system, provides the optimum balance of electrical and physical properties for long, problem free service.

Assembly

The Type MV-105 conductors are assembled with fillers, one bare stranded grounding conductor and a binder tape into a round core. A continuously corrugated welded aluminum sheath (C-L-X) encases the cable core. The C-L-X sheath is protected with a low temperature red Okoseal® jacket. The impervious, continuous, corrugated aluminum C-L-X sheath provides complete protection against moisture, liquids and gases in addition to its excellent mechanical strength. In addition, the aluminum sheath has adequate ampacity capability to be used as a grounding conductor in non HL areas. The Okoseal jacket allows the cable to be direct buried in the ground, embedded in concrete or areas subjected to corrosive atmospheres.

Applications

C-L-X power cables are recommended as an economical alternate to a wire in conduit system. They are designed specifically for use as feeders or branch circuits in industrial and utility power distribution systems. C-L-X power cables may be installed in both exposed and concealed work, wet and dry locations, direct burial in the earth, or embedded in concrete. They may be installed on metal racks, troughs, in cable trays or secured to supports not greater than 6 feet apart.

C-L-X Type MC-HL cables are also approved for Classes I, II, and III, Divisions 1 and 2 and Class I, Zones 1 and 2 hazardous locations - NEC Articles 501, 502, 503 and 505.

Specifications

Conductors: Uncoated copper compact stranded per ASTM B-496.

Strand Screen: Extruded semiconducting EPR strand screen meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 and UL 1072.

Insulation: Okoguard meets or exceeds the electrical and physical requirements of ICEA S-93-639/NEMA WC74 and UL 1072. The insulated conductors are tested in accordance with AEIC CS8.

Insulation Screen: Extruded semiconducting EPR insulation screen meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 and UL 1072.

Shield: 5 mil uncoated copper tape with 10% minimum overlap.

Phase Identification: Color coded (black, red, blue) polyester ribbon laid longitudinally under the copper shield tape.

Grounding Conductor: Uncoated copper in accordance with UL 1072.

Assembly: Cabled with fillers and ground wire in the interstices, binder tape overall.

Sheath: Close fitting, impervious, continuous, corrugated aluminum C-L-X per UL 1072; C-L-X is recognized as a grounding conductor by NEC.

Jacket: A low temperature, sunlight resistant, red PVC jacket in accordance with UL 1072. Other color jackets are available.

UL Listed as type MV-105 or MC-HL, sunlight resistant, for use in cable tray, and for direct burial in accordance with UL 1072 and 2225. UL certified to IEEE 1580. CSA Listed to C68.3.

Product Features

- Triple tandem extruded, all EPR system.
- Complete prepackaged, color coded, factory tested wiring system.
- Okoguard C-L-X cables meet or exceed all recognized industry standards (UL, AEIC, NEMA/ICEA, IEEE).
- Passes the vertical tray flame test requirements of IEEE 383 and 1202, UL 1072, ICEA T-29-520 (210,000 BTU/hr.)
- Complies with NEC Sections 310.7 and 300.50 for direct burial.
- Complies with NEC Articles 501, 502, 503 and 505 for hazardous locations.
- Continuous sheath provides grounding safety.
- Excellent corona resistance.
- Screens are clean stripping.
- Exceptional resistance to "treeing".
- Minimum installation temperature of -40°C.
- Improved Temperature Rating.
- ABS listed as CWCMC Type MC-HL
- CSA listed as FT4 and LTGG (-40°C).

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C-L-X Type MV-105 or MC-HL

Product Data
Section 2: Sheet 24

15kV Okoguard Shielded Power Cable-Aluminum Sheath
3 Okopact (Compact Stranded) Copper Conductors/105°C Rating
133% Insulation Level
For Cable Tray Use-Sunlight Resistant-For Direct Burial
Okoguard Insulation: 220 mils (5.59mm)

Catalog Number (1)	Conductor Size (AWG/kcmil)	Conductor Size - mm²	Approx. Diameter over Insulation (in.)	Grounding Conductor Size (AWG/kcmil)	Approx. Core O.D. - Inches	Approx. Core O.D. - mm	C-L-X O.D. - Inches	Jacket Thickness (mils)	Jacket Thickness mm	Approx. O.D. - Inches	Approx. O.D. - mm	Approx. Net Weight lbs./1000'	Approx. Ship Weight lbs./1000'	Ampacities in Air (2)	Ampacities Cable Tray (3)	Ampacities Direct Burial (4)
With Red Okoseal Jacket																
▲ 571-23-3504	2	33.6	0.76	6	1.79	45.5	2.15	60	1.52	2.28	57.9	2420	3147	185	165	200
571-23-3508	1	42.4	0.79	4	1.86	47.3	2.23	60	1.52	2.36	60.0	2706	3404	210	185	225
571-23-3512	1/0	53.5	0.83	4	1.94	49.3	2.32	75	1.91	2.48	63.0	3076	3674	240	215	255
▲ 571-23-3516	2/0	67.4	0.87	4	2.03	51.6	2.41	75	1.91	2.57	65.3	3434	4219	275	245	290
▲ 571-23-3524	4/0	107.0	0.97	3	2.24	57.0	2.63	75	1.91	2.79	70.9	4460	5385	360	320	345
571-23-3528	250	127.0	1.03	2	2.36	60.0	2.76	75	1.91	2.92	74.2	5078	5845	400	350	410
▲ 571-23-3536	350	177.0	1.12	2	2.56	65.0	2.98	75	1.91	3.14	79.8	6264	7305	490	430	495
▲ 571-23-3544	500	253.0	1.24	1	2.81	71.4	3.28	75	1.91	3.46	89.2	8221	9653	600	525	590
▲ 571-23-3548	750	380.0	1.41	1/0	3.19	81.0	3.76	85	2.16	3.94	100.0	11317	13087	745	635	720

Visit Okonite's web site, www.okonite.com for the most up to date dimensions.

▲ **Authorized stock item.** Available from our Customer Service Centers.

Jackets
Optional jacket types available - consult local sales office.

Copper or bronze C-L-X and non-jacketed C-L-X are available on special order.

Aluminum Conductors

(1) Aluminum conductors are available on special order.

Ampacities

(2) Ampacities are in accordance with Table 310.60(B)(71) of the NEC for an insulated three conductor cable, isolated in air, with a conductor operating temperature of 105°C and an ambient air temperature of 40°C.

(3) Ampacities are in accordance with Table 310.60(B)(75) of the NEC for a three conductor Type MV-105 or MC cable installed in uncovered cable tray in accordance with Section 392.80(B) of the NEC with a conductor operating temperature of 105°C and ambient air temperature of 40°C. Where the cable tray is covered for more than six feet with solid unventilated covers, the ampacities shall not be more than 95% of the values shown above.

(4) Ampacities are in accordance with Table 310.60(B)(83) of the NEC for an insulated three conductor cable directly buried in the earth with a conductor operating temperature of 105°C, ambient earth temperature of 20°C, 100% load factor, thermal resistance (RHO) of 90.

Refer to the NEC, IEEE/ICEA S-135 Power Cable Ampacity Tables, or the Okonite Engineering Data Bulletin for installation in duct banks, other ambient temperatures, circuit configurations or installation requirements.

C-L-X® The Okonite Company

THE OKONITE COMPANY
Ramsey, New Jersey 07446

15 kV Single Cable for Conduit Installation

COMPACT STRAND CONSTRUCTION

Product Data
Section 2: Sheet 9

Okoguard®-Okoseal® Type MV-105

15kV Shielded Power Cable

One Okopact® (Compact Stranded) Copper Conductor/105°C Rating
100% and 133% Insulation Level

A Uncoated, Okopact (Compact Stranded) Copper Conductor
B Strand Screen- Extruded Semiconducting EPR
C Insulation-Okoguard EPR
D Insulation Screen- Extruded semiconducting EPR
E Shield-Copper Tape
F Jacket-Okoseal

Insulation

Okoguard is Okonite's registered trade name for its exclusive ethylene-propylene rubber (EPR) based, thermosetting compound, whose optimum balance of electrical and physical properties is unequaled in other solid dielectrics. Okoguard insulation, with the distinctive red color and a totally integrated EPR system, provides the optimum balance of electrical and physical properties for long, problem free service.

The triple tandem extrusion of the screens with the insulation provides optimum electrical characteristics.

Jacket

The Okoseal (PVC) jacket supplied with this cable is mechanically rugged and has excellent resistance to oil, acids and most chemicals.

Applications

Okoguard shielded Okoseal Type MV-105 power cables are recommended for distribution circuits, and for feeders or branch circuits.

Type MV cables may be installed in wet or dry locations, indoors or outdoors (exposed to sunlight), in any raceway or underground duct, directly buried if installed in a system with a grounding conductor in close proximity that conforms with NEC Section 250.4(A)(5), or messenger supported in industrial establishments and electric utilities.

Specifications

Conductor: Annealed uncoated copper compact stranded per ASTM B-496.

Strand Screen: Extruded semiconducting EPR strand screen. Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74, AEIC CS8 and UL 1072.

Insulation: Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8 and UL 1072.

Insulation Screen: Extruded semiconducting EPR insulation screen . Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8 and UL 1072.

Shield: 5 mil bare copper tape helically applied with 10% minimum overlap.

Jacket: Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682 and UL 1072 for polyvinyl chloride jackets.

UL Listed as Type MV-105 and sunlight resistant in accordance with UL 1072 .

Cables listed to CSA C68.3 are also available.

Product Features

- Triple tandem extruded, all EPR system.
- Okoguard cables meet or exceed all recognized industry standards (UL, AEIC, NEMA/ICEA, IEEE).
- 105°C continuous operating temperature.
- 140°C emergency rating.
- 250°C short circuit rating.
- Excellent corona resistance.
- Screens are clean stripping.
- Exceptional resistance to "treeing".
- Moisture resistant.
- Resistant to most oils, acids, and alkalies.
- Sunlight resistant.
- Improved Temperature Rating.

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Okoguard-Okoseal Type MV-105

15kV Shielded Power Cable

One Okopact (Compact Stranded)
Copper Conductor/105°C Rating

Product Data
Section 2: Sheet 9

Catalog Number (1)	Conductor Size AWG or kcmil	Conductor Size -mm²	Approx. Dia. over Insulation (in.)	Approx. Dia. over Screen (in.)	Jacket Thickness - mils	Jacket Thickness - mm	Approx. O.D. - inches	Approx. O.D. - mm	Approx. Net Weight lbs./1000'	Approx. Ship Weight lbs./1000'	Ampacities (2) Conduit in Air	Ampacities (3) Direct Burial	Ampacities (4) Underground Duct	Conduit Size Inches (5)*
Okoguard Insulation: 175 mils (4.45mm), 100% Insulation Level														
115-23-3011	2	33.6	0.67	0.73	60	1.52	0.87	22.1	555	610	165	225	165	3
115-23-3013	1	42.4	0.70	0.76	80	2.03	0.94	23.9	665	720	190	260	185	3
115-23-3015	1/0	53.5	0.74	0.80	80	2.03	0.98	24.8	755	820	215	295	215	3
115-23-3017	2/0	67.4	0.78	0.84	80	2.03	1.02	25.8	865	930	255	335	245	3
115-23-3019	3/0	85.0	0.83	0.89	80	2.03	1.07	27.2	1000	1070	290	380	275	3
115-23-3021	4/0	107.0	0.88	0.94	80	2.03	1.12	28.3	1170	1250	330	435	315	3
115-23-3023	250	127.0	0.93	0.99	80	2.03	1.18	30.0	1325	1405	365	475	345	3½
115-23-3027	350	177.0	1.03	1.07	80	2.03	1.26	32.0	1700	1800	440	575	415	3½
115-23-3031	500	253.0	1.14	1.19	80	2.03	1.38	35.1	2240	2385	535	700	500	4
115-23-3035	750	380.0	1.32	1.37	80	2.03	1.55	39.4	3105	3340	655	865	610	5
115-23-3037	1000	507.0	1.47	1.52	80	2.03	1.71	43.4	3950	4185	755	1005	690	5
Okoguard Insulation: 220 mils (5.59mm), 133% Insulation Level														
▲ 115-23-3111	2	33.6	0.76	0.81	80	2.03	1.00	25.4	670	720	165	225	165	3
115-23-3113	1	42.4	0.79	0.85	80	2.03	1.04	26.4	755	820	190	260	185	3
▲ 115-23-3115	1/0	53.5	0.83	0.89	80	2.03	1.07	27.1	845	915	215	295	215	3
▲ 115-23-3117	2/0	67.4	0.87	0.92	80	2.03	1.11	28.2	950	1020	255	335	245	3
115-23-3119	3/0	85.0	0.92	0.98	80	2.03	1.16	29.3	1100	1180	290	380	275	3½
▲ 115-23-3121	4/0	107.0	0.96	1.02	80	2.03	1.20	30.5	1260	1360	330	435	315	3½
▲ 115-23-3123	250	127.0	1.01	1.07	80	2.03	1.26	32.0	1415	1500	365	475	345	3½
▲ 115-23-3127	350	177.0	1.11	1.16	80	2.03	1.35	34.3	1790	1920	440	575	415	4
▲ 115-23-3131	500	253.0	1.22	1.28	80	2.03	1.47	37.3	2325	2510	535	700	500	4
▲ 115-23-3135	750	380.0	1.40	1.46	80	2.03	1.64	41.7	3220	3455	655	865	610	5
▲ 115-23-3139	1000	507.0	1.54	1.60	110	2.79	1.84	46.7	4075	4340	755	1005	690	6

Visit Okonite's web site, www.okonite.com for the most up to date dimensions.

▲ **Authorized stock item.** Available from our Customer Service Centers.

Aluminum Conductors

(1) Aluminum conductors are available on special order.

Ampacities

(2) Ampacities are in accordance with Table 310.60(C)(73) of the NEC for three single Type MV-105 conductors, or single conductors twisted together (triplexed) and installed in an isolated conduit in air at an ambient temperature of 40°C and a conductor temperature of 105°C.

(3) Ampacities are in accordance with Table 310.60(C)(81) of the NEC for an insulated single conductor directly buried with a conductor temperature rating of 105°C, ambient earth temperature of 20°C, 100% Load Factor, thermal resistance (RHO) of 90, 7 1/2 inch spacing between conductor center lines, and 24 inch spacing between circuits.

(4) Ampacities are in accordance with Table 310.60(C)(77) of the NEC for three single conductors or triplexed cable in one underground raceway, three feet deep with a conductor temperature of 105°C, 100% Load Factor, an ambient earth temperature of 20°C, and thermal resistance (RHO) of 90.

Refer to the NEC, IEEE/ICEA S-135 Power Cable Ampacities, or the Okonite Engineering Data Bulletin for installation in duct banks, multiple point grounded shields, other ambient temperatures, circuit configurations or installation requirements.

(5) Recommended size of rigid or nonmetallic conduit for three conductors based on 40% maximum fill.

*The jam ratio, conduit I.D. to cable O.D. should be checked to avoid possible jamming.

THE OKONITE COMPANY
Ramsey, New Jersey 07446

Dead Break Junctions

CABLE ACCESSORIES

Molded Multi-Point Junctions

Separable Connectors 200A Loadbreak

Elastimold multi-point junctions are available in 2, 3, 4, 5 or 6 point configurations with 15, 25 or 35kV ratings. Units feature modular design flexibility, allowing selection of any combination of 200 Amp deepwell or 600 Amp bushing interfaces located on standard 4" or optional 6 ½" centers. The 6 ½" center spacing is especially well suited for Distributed Switchgear applications including fused elbow, MVI fault interrupter, MVS switch, etc.

Designs incorporate lightweight, damage resistant, EPDM molded rubber construction and corrosion resistant 304 stainless steel mounting brackets. Junctions are maintenance-free, fully shielded, deadfront and submersible. Units are ideally suited for subsurface, padmount, indoor and outdoor vault applications.

Elastimold multi-point junctions provide
a convenient method for connecting, looping and tapping of 200 and 600 Amp elbows and other accessories at a common location where utilization of space, cable training, flexibility and operability are important.

RATINGS OVERVIEW

See page 2 for complete information

CURRENT RATINGS

600 Amp Continuous
25kA sym., 10 cycles

or with 200 Amp Bushing Well versions

200 Amp Continuous
10kA sym..10 cycles

VOLTAGE RATINGS

15kV Class
8.3kV Phase-to-Ground
95kV BIL
34kV AC Withstand
53kV DC Withstand
11kV Corona Extinction

25kV Class
16.2kV Phase-to-Ground
140kV BIL
45kV AC Withstand
84kV DC Withstand
21.5kV Corona Extinction

35kV Class
21.1kV Phase-to-Ground
150kV BIL
50kV AC Withstand
103kV DC Withstand
26kV Corona Extinction

DIMENSIONAL INFORMATION

Figure 1: Multi-Point Junctions with 4" Interface Spacings.

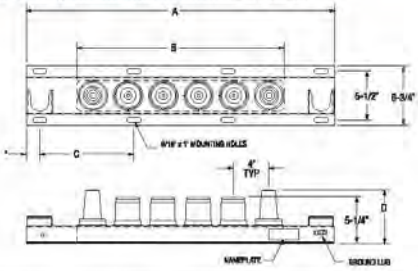
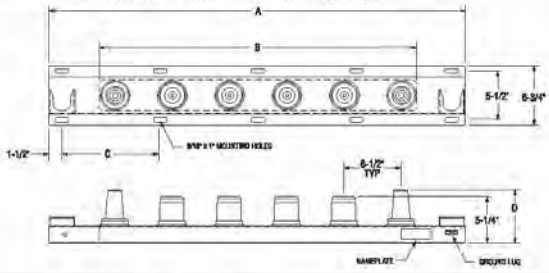
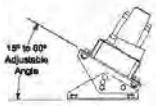


Figure 2: Multi-Point Junctions with 6 ½" Interface Spacings.



Type of Junction	Figure 1				Figure 2			
	A	B	C	number of mounting holes	A	B	C	number of mounting holes
J2	15	7½	6	6	19½	10	8¼	6
J3	19	11½	8	6	26	10	11½	6
J4	24	15½	10	6	32½	23	9¼	8
J5	27	19½	12	6	39	10	12	8
J6	31	23½	9¾	8	45½	36	8¼	10



Optional Tilt Mounting Adapter

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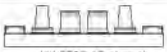
The Elastimold multi-point junctions feature modular design flexibility that permits the specifier to determine the positions of the bushing interfaces and bushing well positions.

Base Catalog Numbers

Illustration (not to scale)	Description	Voltage Class	ELASTIMOLD Part Number 4" Spacing	ELASTIMOLD Part Number 6½" Spacing	Notes
(J2-26-15 shown)	2-point Junction	15kV 25kV 35kV	J2 - __ __ - 15 J2 - __ __ - 25 J2 - __ __ - 35	J2 - __ __ - 15-SV J2 - __ __ - 25-SV J2 - __ __ - 35-SV	N1, 2
(J3-626-35 shown)	3-point Junction	15kV 25kV 35kV	J3 - __ __ __ - 15 J3 - __ __ __ - 25 J3 - __ __ __ - 35	J3 - __ __ __ - 15-SV J3 - __ __ __ - 25-SV J3 - __ __ __ - 35-SV	N1, 2
 (J4-6226-15 shown)	4-point Junction	15kV 25kV 35kV	J4 - __ __ __ __ - 15 J4 - __ __ __ __ - 25 J4 - __ __ __ __ - 35	J4 - __ __ __ __ - 15-SV J4 - __ __ __ __ - 25-SV J4 - __ __ __ __ - 35-SV	N1, 2
(J5-62226-15 shown)	5-point Junction	15kV 25kV 35kV	J5 - __ __ __ __ __ - 15 J5 - __ __ __ __ __ - 25 J5 - __ __ __ __ __ - 35	J5 - __ __ __ __ __ - 15-SV J5 - __ __ __ __ __ - 25-SV J5 - __ __ __ __ __ - 35-SV	N1, 2
(J6-622226-15 shown)	6-point Junction	15kV 25kV 35kV	J6 - __ __ __ __ __ __ - 15 J6 - __ __ __ __ __ __ - 25 J6 - __ __ __ __ __ __ - 35	J6 - __ __ __ __ __ __ - 15-SV J6 - __ __ __ __ __ __ - 25-SV J6 - __ __ __ __ __ __ - 35-SV	N1, 2

ORDERING INFORMATION

To specify and order Elastimold Multi-Point Junctions:

1. Use Table 1 to construct a catalog number describing the required junction.

Table 1. Catalog Number Construction

J □ - □□□□□□ - □□ - □□ - □□□

Multi-Point Junction

Number of Points	
2	2 Points
3	3 Points
4	4 Points
5	5 Points
6	6 Points

Interface Identification * and Positioning	
2	200 Amp Deepwell Interface
6	600 Amp Bushing Interface
B	Blank Position

* When there is a 200 Amp Interface on one side of the junction and a 600 Series Interface on the other side, always start with the 200 Amp side.

Voltage Class	
15	15kV
25	25kV
35	35kV

Interface Spacing	
Blank	Standard spacing – 4" centers
SV	Optional 6½" centers

Options	
Blank	No tilt mounting bracket
TMA	Tilt Mounting Adapter. Bolts to the bottom of the standard mounting bracket to provide 15, 30, 45 or 60 degree adjustable angle mounting. (Two Tilt Mounting Adapters are required for each installation.)
L	Left parking stand only
R	Right parking stand only
N	No parking stand

Ordering Example A

To order a 4-point, 15kV junction with 4" spacings and 600 series interfaces on the outside ways and 200 Amp wells on the inside ways specify: Catalog Number J4-6226-15.

Ordering Example B

To order a 6-point, 25kV junction with 6½" spacings and 600 series interfaces on the ways 1, 3, 4, 6 and 200 Amp wells on the ways 2 and 5 specifiy: Catalog Number J6-626626-25-SV.

N1. The 6½" wide spacing is necessary if the junction is to be used to connect with a single-phase MVS Molded Vacuum Switch or MVI Molded Vacuum Interrupter.

N2. Also available with a shorter bracket by reducing the number of parking stands, see R, L, N above.

200 Ampere Dead Break Connectors

CABLE ACCESSORIES

200 Amp Deadbreak

Separable Connectors 200A Loadbreak

200 Amp deadbreak connectors and accessories provide a quick disconnect feature for cable and equipment connections on power distribution systems.

All deadbreak connectors must be DE-ENERGIZED before operating and must be mechanically secured with bails when connected. Components can be isolated with insulated caps, plugs and parking bushings.

All deadbreak elbows are equipped with test points as standard. Optional accessories allow system grounding, bypass and lightning surge protection. Additional connecting points and taps can be provided by use of junctions or feed-thrus.

RATINGS OVERVIEW

See page 2 for complete information.

CURRENT RATINGS
200A Continuous
10kA sym. 10 Cycles

VOLTAGE RATINGS
15kV Class
8.3kV Phase-to-Ground
14.4kV Phase-to-Phase
95kV BIL
34kV AC Withstand
53kV DC Withstand
11kV Corona Extinction

25kV Class
15.2kV Phase-to-Ground
26.3kV Phase-to-Phase
125kV BIL
40kV AC Withstand
78kV DC Withstand
19kV Corona Extinction

200 AMP DEADBREAK SEPARABLE CONNECTOR COMPONENTS

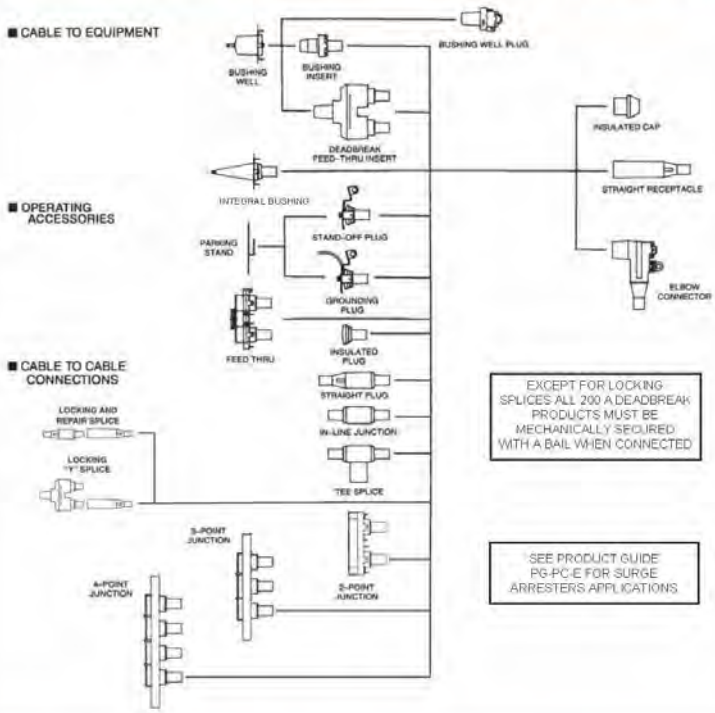


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Illustration (not to scale)	Description	Voltage Class	ELASTIMOLD Part Number	Notes
	Elbow Connector w/ Test Point	15/25kV	**156LR-W5X** Use Tables W1 and X1	N1,2
	Direct Test Elbow Connector	15/25kV	**156DLR-W5X** Use Tables W1 and X1	N1,2,22
	Bail Assembly for 156LR Elbow	15/25kV	**150BA**	
	Bushing Insert	15/25kV	**K1501A1**	N3
	Feed-thru Insert	15/25kV	**K1502A1**	N3,4
	Insulated Plug	15/25kV	**K150DP**	N3
	Insulated Cap	15/25kV	**K150DR**	N3
	Insulated Parking Bushing	15/25kV	**K151SOP**	N3
	Grounding Plug	15/25kV	**151GP**	N3
	Feed-Thru	15/25kV	**K1501FT**	N3,6
	2-Point Junction	15/25kV	**K1501J2-U**	N3,6
	3-Point Junction	15/25kV	**K1501J3-U**	N3,6
	4-Point Junction	15/25kV	**K1501J4-U**	N3,6
	Elbow Probe	15/25kV	**156LRF**	
	Straight Receptacle	15/25kV	**K151SR-W0X** Use Tables W1 and X1	N3,12,13, 17,18
	Straight Plug	15/25kV	**K151SP-W0X** Use Tables W1 and X1	N3,12,13, 19
	Tee Splice	15/25kV	**K150T**	N3
	In-Line Junction	15/25kV	**K150S**	N3
	Locking Splice/ Repair Splice	15/25kV	**K151LS-W0X** Use Tables W1 A and X1	N8,9,13, 15,16,17, 20,23
	Locking "Y" Splice	15/25kV	**K151LY-W0X** Use Tables W1 A and X1	N8,9,13, 15,17,21
	BAIL	15/25kV	**150TB1**	N5
	BAIL	15/25kV	**150TB2**	N5
	BAIL	15/25kV	**150TB3**	N5

Illustration (not to scale)	Description	Voltage Class	ELASTIMOLD Part Number	Notes
	BAIL	15/25kV	**150TB4**	N5
	BAIL	15/25kV	**150TB5**	N5
	Contacts: Long Bi-Metal Copper	15/25kV 15/25kV	**02500X** **02702X**	N7
	Elbow Cable Entrance Insulating Plug	15/25kV	**10EP-W** Use Table W6	N10
	Cable Entrance Insulating Plug	15/25kV	**152EA-W** Use Table W6	N11
	Cable Size Adapter	15/25KV	**160CA-W** Use Table W6 EB-FA Only	N14

N1. Includes bail assembly.
N2. W5X indicates that the part number includes a 02500X bi-metal compression lug, which is rated for either aluminum or copper conductor, as standard. For an all-copper lug, replace W5X with W2X in Table X1 to specify the all-copper 02702X lug.
N3. Bails are required but not included. Order separately. Consult factory for bails not listed for a specific application.
N4. Fully rotatable for 360° positioning. Includes bail assembly to secure feed-thru insert to bushing well. Elbows bail assemblies are required but not included with the feed-thru insert.
N5. Refer to factory for application details.
N6. Center-to-center spacing equals 4 inches.
N7. Copper lug for copper cable only.
N8. To order cable legs for different cable sizes, list each leg size "W" and "X". Example: K151LY-A1240-A1240-B1220. See Tables W1 and X1 for sizes.
N9. To order locking contacts for K151LS and K151LY, order 01401X (Al) or 01402X (Cu) for plug contact. Order 01301X (Al) or 01302X (Cu) for receptacle. See Table X1 for sizes.
N10. For use with 156LR elbows.
N11. For use with K151SR, K151SP, K151LS, K151LY receptacles, plugs and splices.
N12. Also available as housing only. Specify K151BSP-W or K151BSR-W.
N13. Also available in EB-FA sizes per table W6 by using 160CA cable adapter with C size plugs & receptacles.
N14. 160CA cable adapter can only be used with C size plugs & receptacles.
N15. Bails are not required for locking splices.
N16. When used as a repair splice, the assembled length allows 4" for cable replacement/repair.
N17. Straight receptacles are also available with test point. Specify K152SR-W0X part number.
N18. W0X indicates that the part number includes a 01500X universal aluminum compression lug, which is rated for either aluminum or copper, as standard. For an all-copper lug, replace W0X with W2X in Table X1 to specify the all-copper 01502X lug.
N19. W0X indicates that the part number includes a 01600X universal aluminum compression lug, which is rated for either aluminum or copper, as standard. For an all-copper lug, replace W0X with W2X in Table X1 to specify the all-copper 01602X lug.
N20. W0X indicates that the part number includes a 01400X universal aluminum compression lug, which is rated for either aluminum or copper, as standard. For an all-copper lug, replace W0X with W2X in Table X1 to specify the all-copper 01402X lug.
N21. W0X indicates that the part number includes a 01300X universal aluminum compression lug, which is rated for either aluminum or copper, as standard. For an all-copper lug, replace W0X with W2X in Table X1 to specify the all-copper 01302X lug.
N22. Direct Test Connectors, along with a 200TC-X series meter adapter, a properly rated voltage meter and Hot-line Stick provides a means for direct conductor voltage testing. See page 7 for meter adapters.
N23. Gains approximately 4" of repair length.

Refer to the **W** and **X** tables on pages 38 and 39 for sizing to cable insulation diameter and conductor size.

For cable shield adapters and jacket seals, see page 28.

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Appendix D – Basis of Design Specific Lists

Appendix D – Basis of Design List

Appendix D contains an initial list of equipment and processes integrated into the project. The list was developed from owner requirements, industry standard practices, and necessities driven by engineering design. Along with this Schematic Design report, this list defines the basis of design from which the commissioning agent may use to commission this project. This list will likely grow as the project progresses through construction documents.

Arc Fault Labeling

a) Obtain the fault current report from the engineer and verify the appropriate equipment labeling against the level of available energy. Refer to labeling specifications for label requirements.

Electrical Services Switch Over Plan

a) Develop a detailed switchover plan for changing building electrical services from the existing to the new. This plan will likely contain several phases that need refinement as the project progresses.

b) Review the plan with the owner and engineer prior to each phases implementation to incorporate any last minute modifications.

c) Review the plan with the workforce

Low Voltage Transformers

a) Verify the transformer construction, verifying that the %Z, power rating, dB ratings, efficiency, temperature ratings, transformer composition, and factory tests meet the specifications.

b) Verify the transformer installation methods meet the specifications. Clearances, and isolation methods are particularly important sound transmission limiting.

c) Measure the sound levels created by the low voltage transformers to ensure noise transmission does not transfer into the tenant workspace. Measure the appropriate frequency inside the electrical space, outside the electrical space at the door and surrounding walls.

Mechanical Systems Controls

a) Verify the interface between the existing building control system and the new equipment provided for the lower level main electrical room and the upper floor electrical closets. Control points and sequences are defined in the mechanical specifications.

Medium Voltage Cables

a) Verify the cable material makeup and construction, verifying that it meets the specifications.

b) Observe the cable installation to verify that installation did not exceed the manufacturer's recommended pulling tensions based on the type of cable pulling attachment. Cable pulling tension shall be monitored during installation with a recording dynometer to assure tension does not exceed maximum sidewall bearing pressure during pulls around a bend.

c) Perform high potential testing on the cables according to the specifications.

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Medium Voltage Switches

a) Verify the switch construction, ensuring that equipment ratings meet the specifications, specified accessories and functions are provided, factory tests and onsite tests are performed.

Medium Voltage Transformers

a) Verify the transformer construction, ensuring that the %Z, BIL rating, power rating, dB ratings, efficiency, temperature ratings, transformer composition, and factory tests meet the specifications.

Selective Coordination

a) Verify proper equipment settings or equipment provided to ensure coordination defined by the engineer's coordination report.

Switch Gear

a) Verify that equipment ratings meet the specifications, specified accessories and functions are provided, factory tests and onsite tests are performed.

b) Verify that the equipment and installation meets UL 1558 requirements.

Switchboards

a) Verify that equipment ratings meet the specifications, specified accessories and functions are provided, factory tests and onsite tests are performed.

b) Verify that the equipment and installation meets UL 891 requirements.

Systems Grounding

a) Verify the electrical grounding system connections as defined by the engineer and as required by the National Electrical Code.

b) Review the electrical grounding system resistance data to ensure compliance with the National Electrical Code and the specifications.

c) Review the measurement data for the step and touch potential on the 13.8 kV system. Compare the measurement data with the specified system design to ensure compliance.

Transfer Switch Testing

a) Perform live testing on the existing transfer switches following the electrical services switch over. Verify that that systems transfer to backup power system and return to normal utility power as originally installed.

b) Verify that generator interface occurs based on the new electrical service connections to transfer switches. Verify electrical system monitoring circuits, alarm circuits, power circuits, etc. are operational.

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Appendix E – Recommended Electrical System Switchover – Existing to New

I. Exhibit E: System Switchover - Existing to New Outline

A. Systems Migration

1. Phase I Recommended Procedure

a) New electrical service equipment must be active before any existing equipment can switch to the new system. Based on how the existing system is configured, both of the new double ended switchgear (COB – 1&2, COB – 3&4) must energize to begin switchover. The gear need only receive power from one of the unit substations serving the respective lineups, but connecting power to all four unit substations is recommended. This will provide flexibility during the electrical system migration.

b) Two campus loop outages will be required in order to activate the four unit substations. The electrical contractor must connect to the spare barrels on loops S1 and S2. Coordinating with PMD, affected campus buildings must receive notice that campus loop outages will occur and the campus electricians must transfer other buildings to one of two loops prior to deactivating the second loop. The same process must occur prior to connecting to the first loop.

c) Prior to deactivating, disconnecting, and/or temporarily using the existing equipment, it must be tested and evaluated for use. If an existing switching mechanism did not receive maintenance recently, we recommend maintenance to ensure use during the transition period.

d) It is recommended that the electrical system switchover begins by moving all of the equipment currently connected to existing unit substation #3. The quantities of loads are few and the connections relatively easy to migrate. The following are the recommended migration efforts.

(1) ATS #4 (serving Mech-B) would move off from unit substation #3 and onto the new COB unit substation #3.

(2) ATS #7 (serving CEH-F5-DP1 in Rm B2) would move off from unit substation #3 and onto the new COB unit substation #3.

(3) MCC-1 & MCC-2A would move off from unit substation#3 and onto COB unit substation #2.

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2. Phase II Recommended Procedure

a) This phase primarily moves equipment off from unit substation #4, allowing it to shutdown at the end of the phase. The following are the recommended migration efforts.

(1) ATS #6 (serving DP-B & UPS-B) would move off from existing unit substation #4 and onto the COB unit substation #4.

(2) The following items will move from existing unit substation #4 to a new 600 ampere distribution board located in the new electrical room. These items are smaller feeders (e.g. 400 amperes) and do not merit draw out switchgear connections.

(a) The feeder for panels H17, H18, H20

(b) The feeders for panels H13, H14, H15

(c) The feeder for panel H12

(d) The feeders for the two Ramp exhaust fans

(e) Replace the existing Ramp transformer with a smaller transformer (30 kVa or 45 kVa) and move to the feeder.

(3) Move the feeder for Panel B-3B-1 onto the new COB unit substation #1

(4) Demolish ATS #1 and connect the feeder for the existing distribution board to COB unit substation #3

3. Phase III Recommended Procedure

a) This phase primarily moves equipment off from unit substations #1 and #2, allowing both to shutdown at the end of the phase. The following equipment will transfer over to the new electrical services.

(1) The feeder for ATS-5 to COB unit substation #4

(2) The feeder for ATW-8 (parking ramp emergency loads) to COB unit substation #2.

(3) The feeder for existing bus duct C can be eliminated after the existing tenant panels are connected to the new riser D

(4) The feeder for existing bus duct D can be eliminated after the existing tenant panels are connected to the new riser D

(5) Move the feeder for MCC-2b to COB unit substation #2

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(6) Move the feeder for ATS-3 (serving UPS-A) to COB unit substation #4

(7) Move the feeder for ATS-9 (serving Mech-A) to COB unit substation #4

(8) The feeder for existing bus duct B can be eliminated after the existing tenant panels are connected to the new riser D

(9) The feeder for existing bus duct A can be eliminated after the existing tenant panels are connected to the new riser D

4. Phase IV Recommended Procedure

a) Now that all unit substations are off line, the existing 13.8 kV feeder may be taken off the existing G&W switches PSS-1 & PSS-2 and the cables removed from the conduits between them and the manhole. This will involve another pair of campus coordinated outages on campus loops S1 & S2. The electrical contractor must disconnect the cables from loops S1 and S2 in the manhole east of the building. Coordinating with PMD, affected campus buildings must receive notice that campus loop outages will occur and the campus electricians must transfer other buildings to between the loops prior to deactivating and disconnecting each respective loop.

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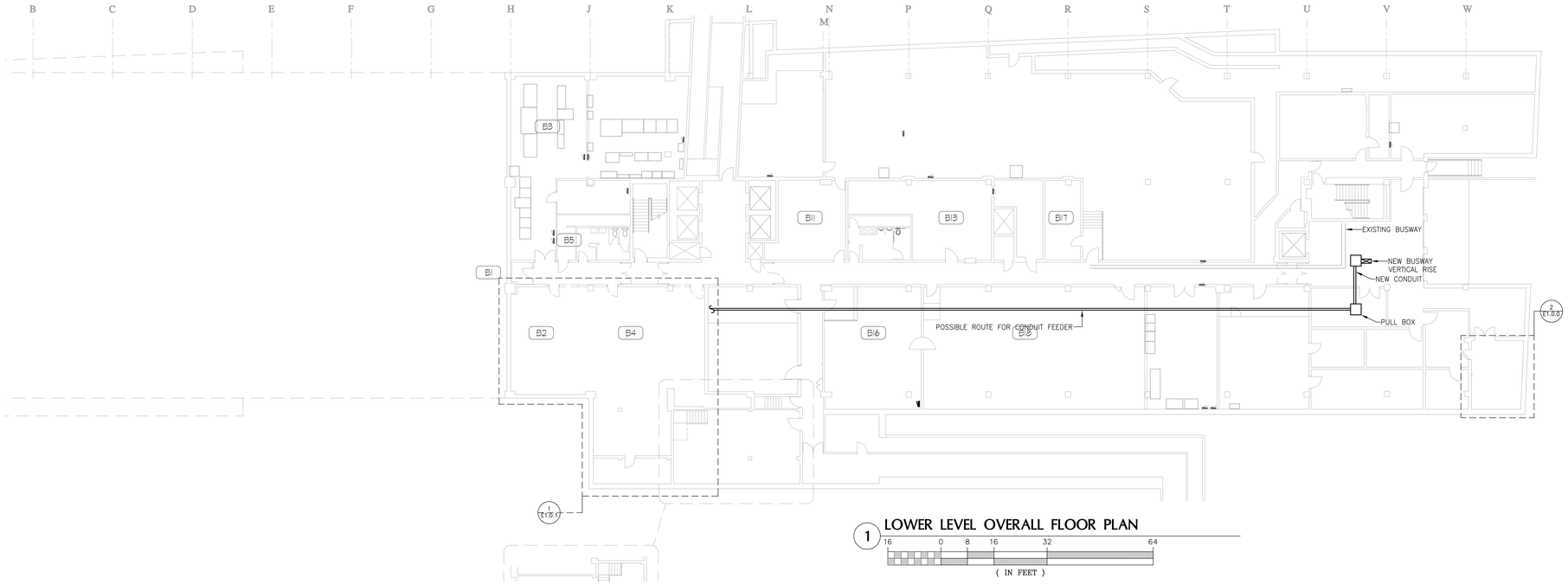

1 LOWER LEVEL OVERALL FLOOR PLAN

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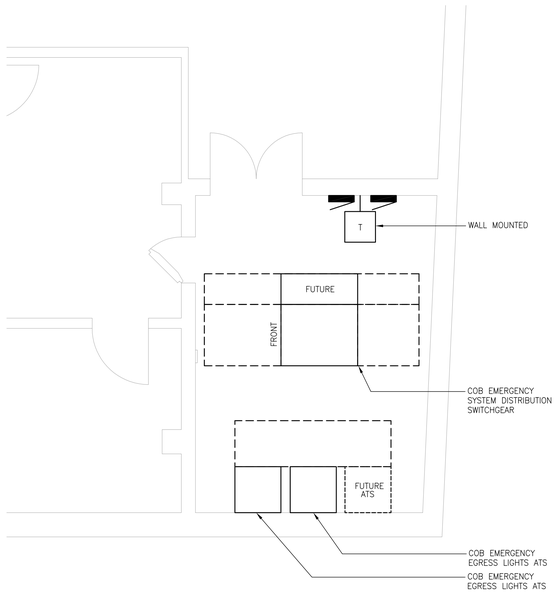

2 COB – EMERGENCY DISTRIBUTION ROOM

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(IN FEET)

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LOWER LEVEL PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
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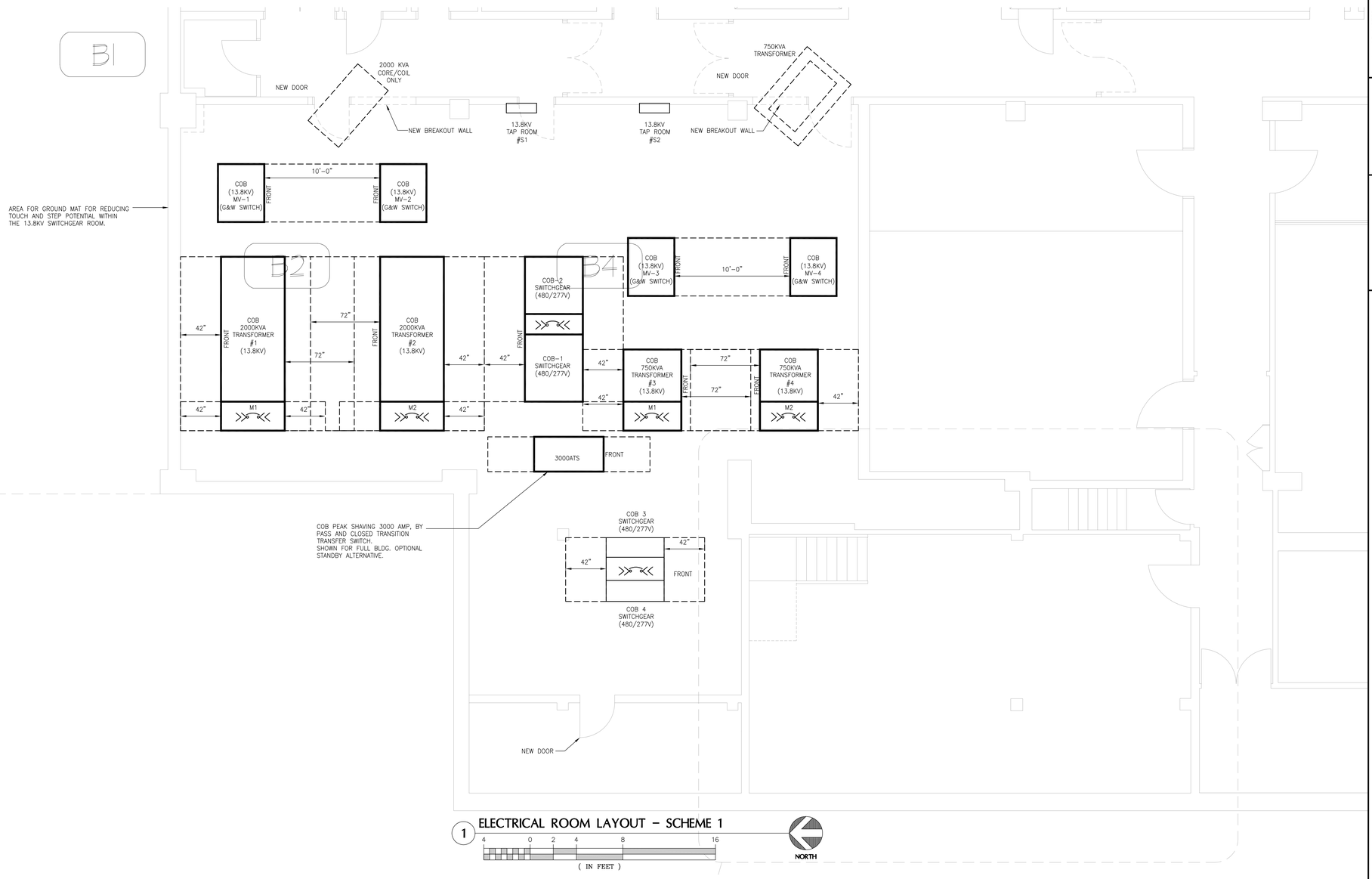

1 ELECTRICAL ROOM LAYOUT – SCHEME 1

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NEW ELECTRICAL ROOM LAYOUT
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
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drawing number
E1.0.1

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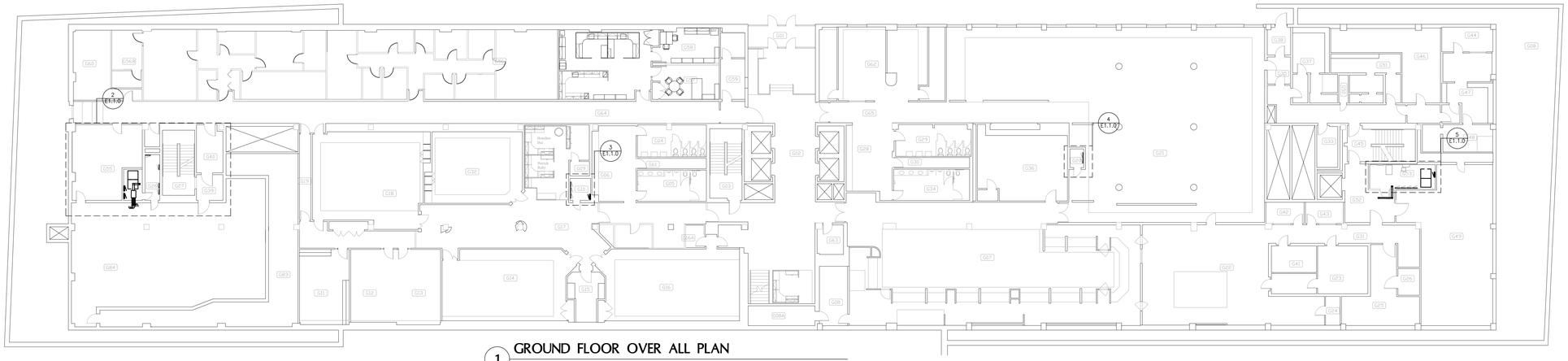

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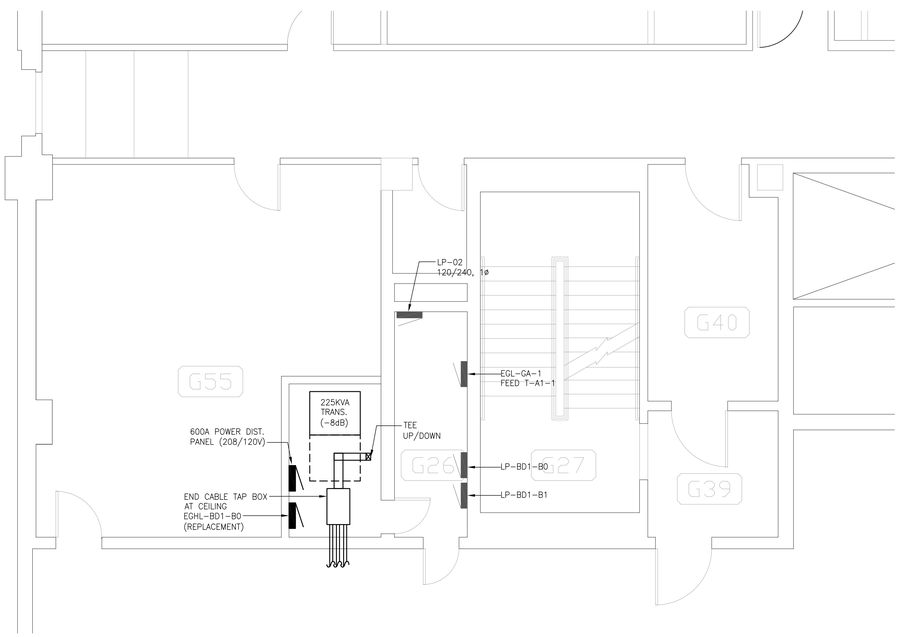

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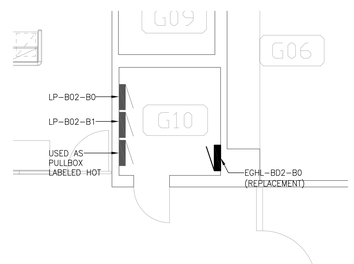

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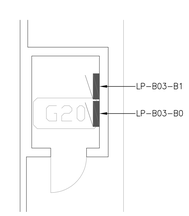

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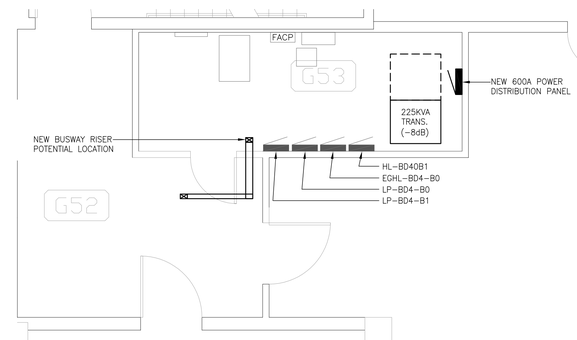

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GROUND LEVEL PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
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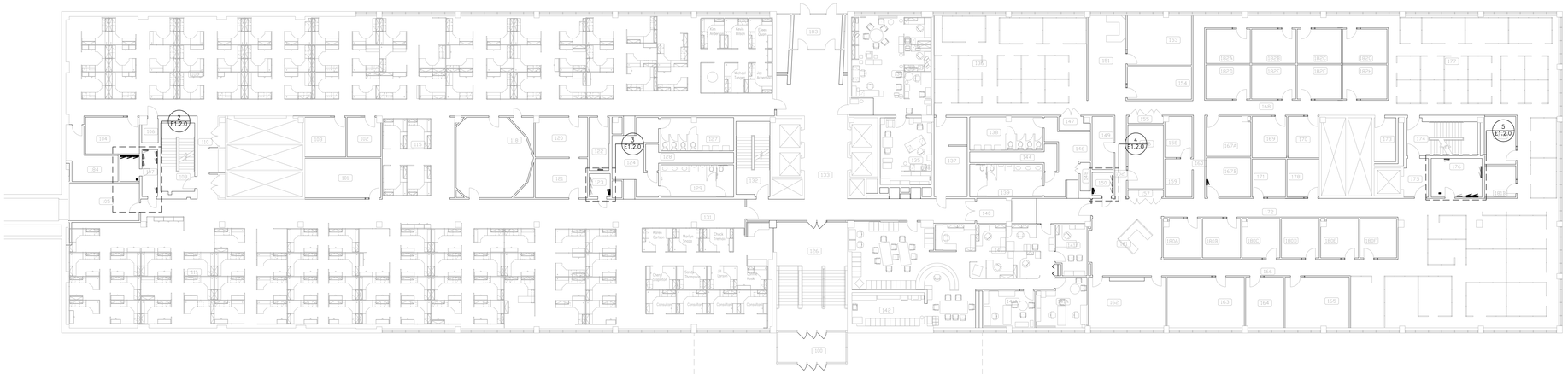

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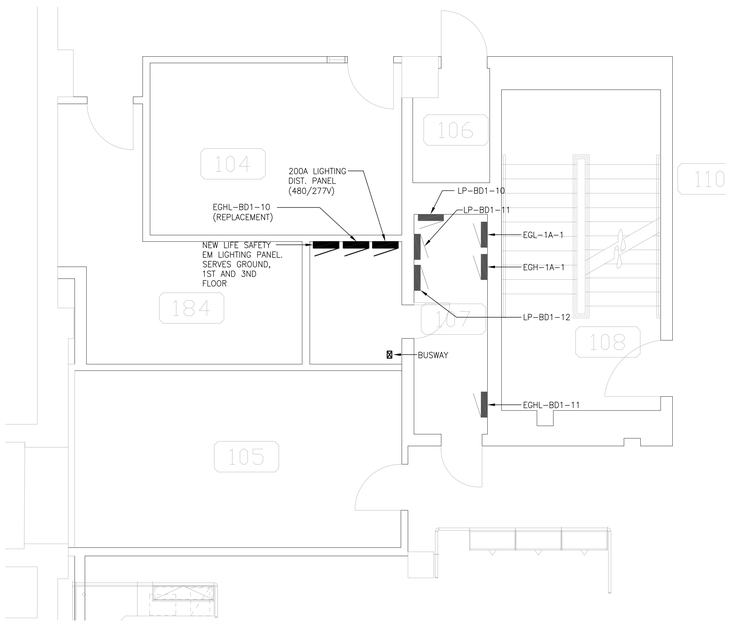

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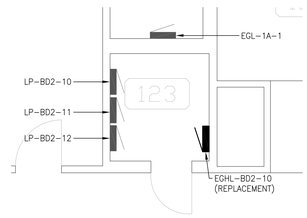

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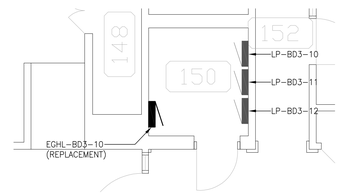

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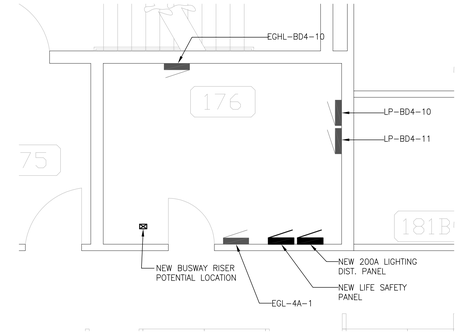

5 ELECTRICAL DISTRIBUTION – D RISER CLOSET

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FIRST FLOOR PLAN – ELECTRICAL
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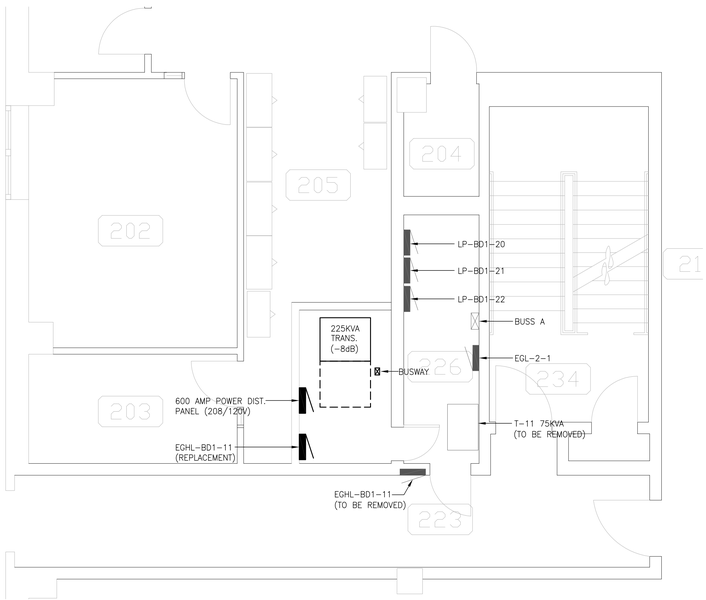

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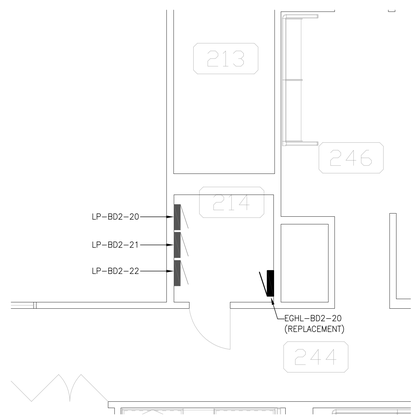

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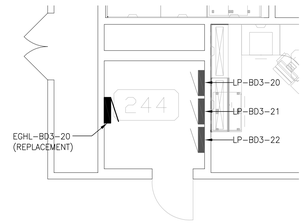

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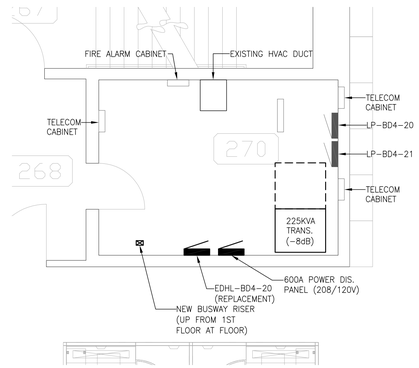

5 ELECTRICAL DISTRIBUTION – D RISER CLOSET

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SECOND FLOOR PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
E1.3.0

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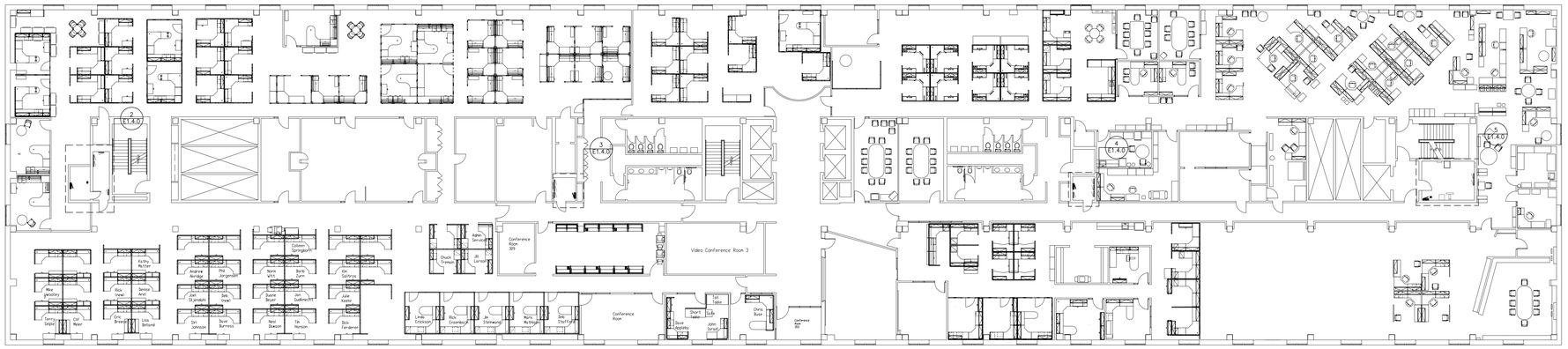

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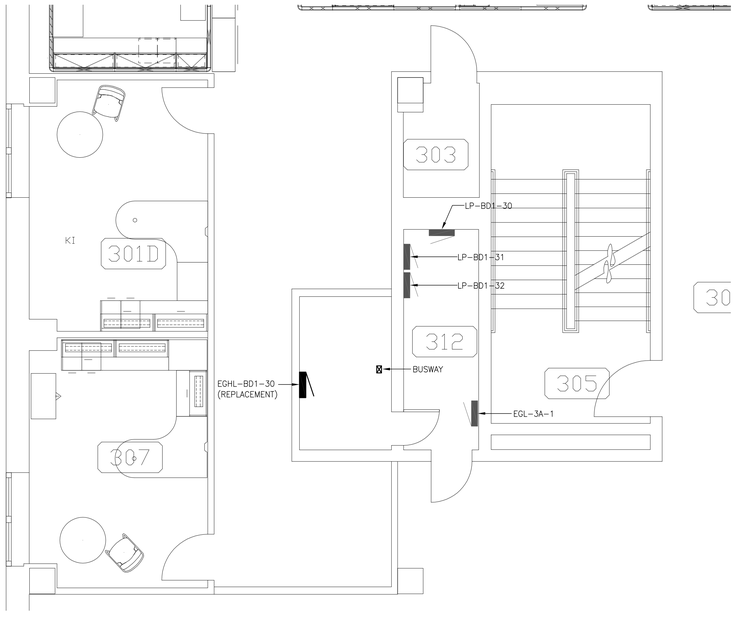

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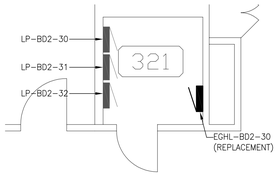

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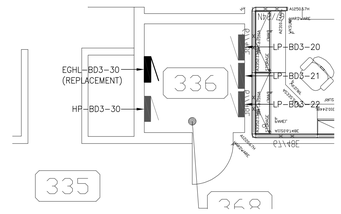

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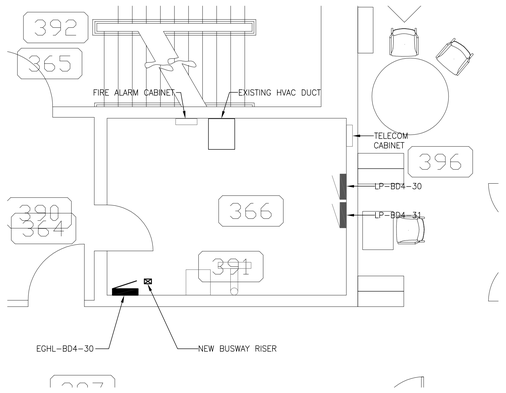

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THIRD FLOOR PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

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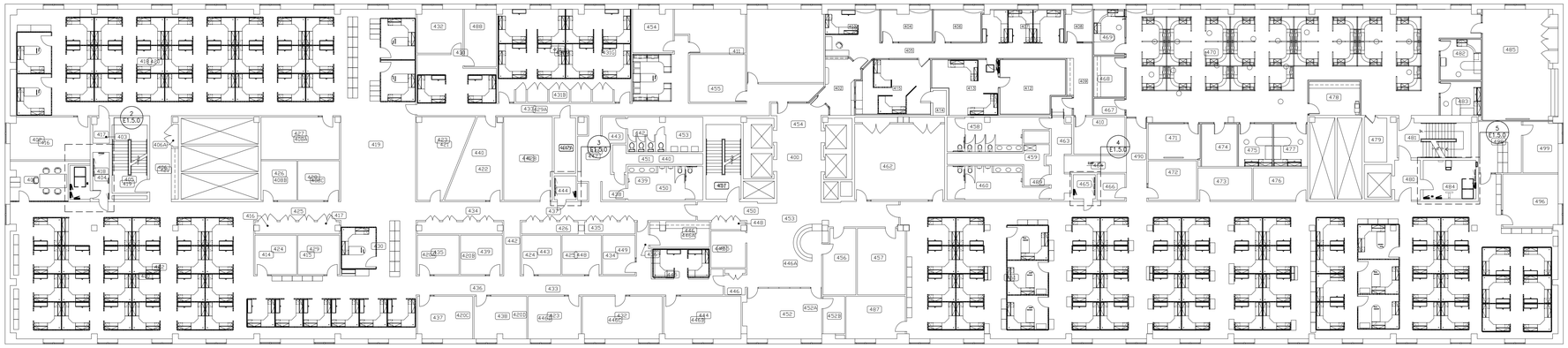

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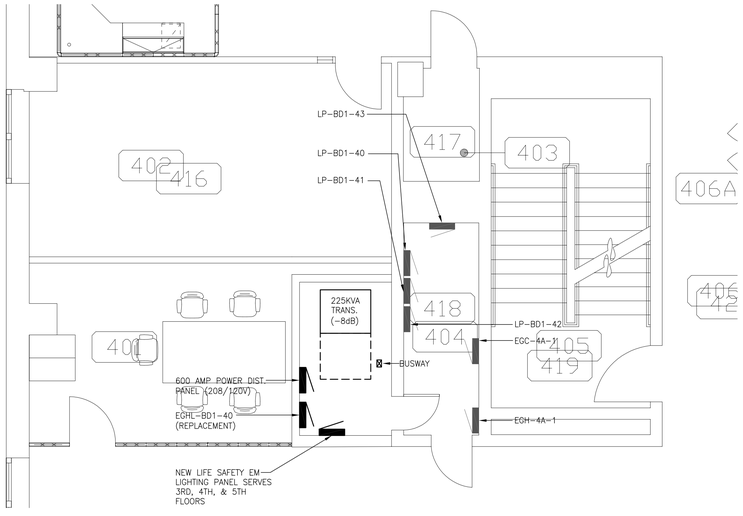

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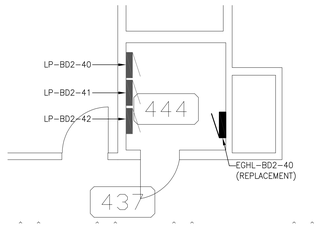

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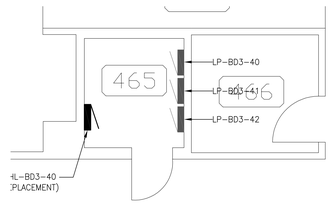

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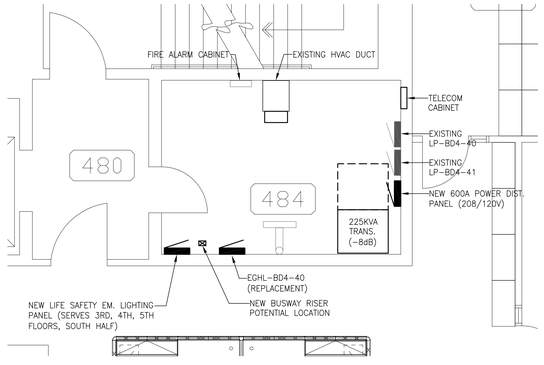

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(IN FEET)

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BUDGET DOCUMENTS
MARCH 13, 2015

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ALLEN V. THIESEN

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drawn by: ASQ
checked by: AVT
date: 03/13/15
project no: 2014.079.00

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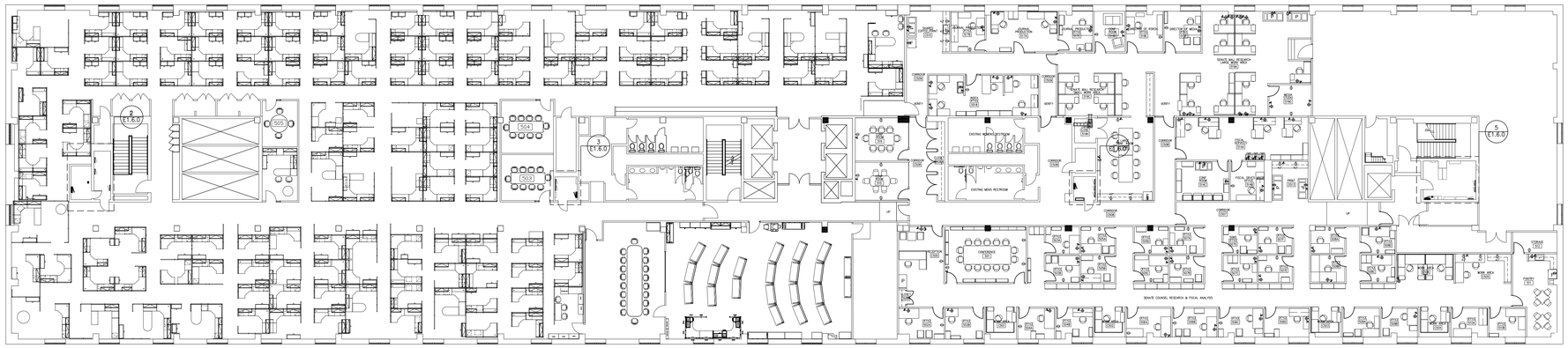
FOURTH FLOOR PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
E1.5.0

Mar 13, 2015 – 10:20am Alex
J:\2014\2014079.00\CAD\Sheets\E\E1.5.0 FOURTH FLOOR PLAN – ELECTRICAL.dwg



1 FIFTH FLOOR OVER ALL PLAN

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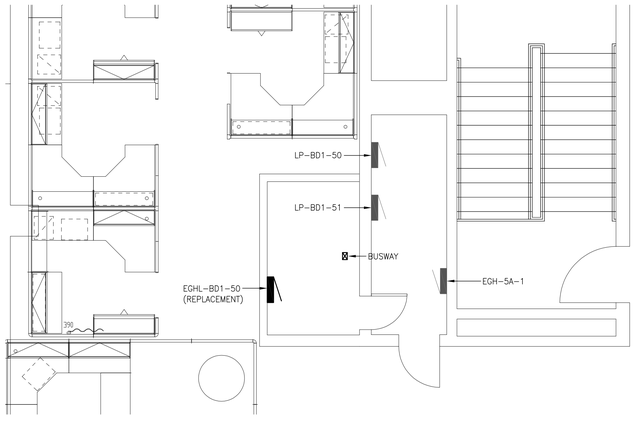
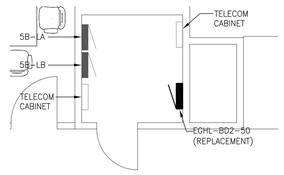
(IN FEET)



2 ELECTRICAL DISTRIBUTION – A RISER CLOSET

4 0 2 4 8 16

(IN FEET)



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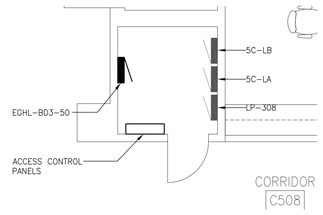
(IN FEET)



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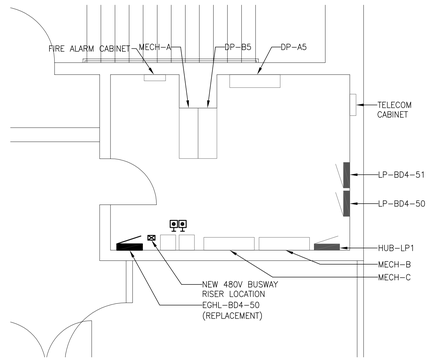
(IN FEET)



5 ELECTRICAL DISTRIBUTION – D RISER CLOSET

4 0 2 4 8 16

(IN FEET)

SCHEMATIC DESIGN
BUDGET DOCUMENTS
MARCH 13, 2015

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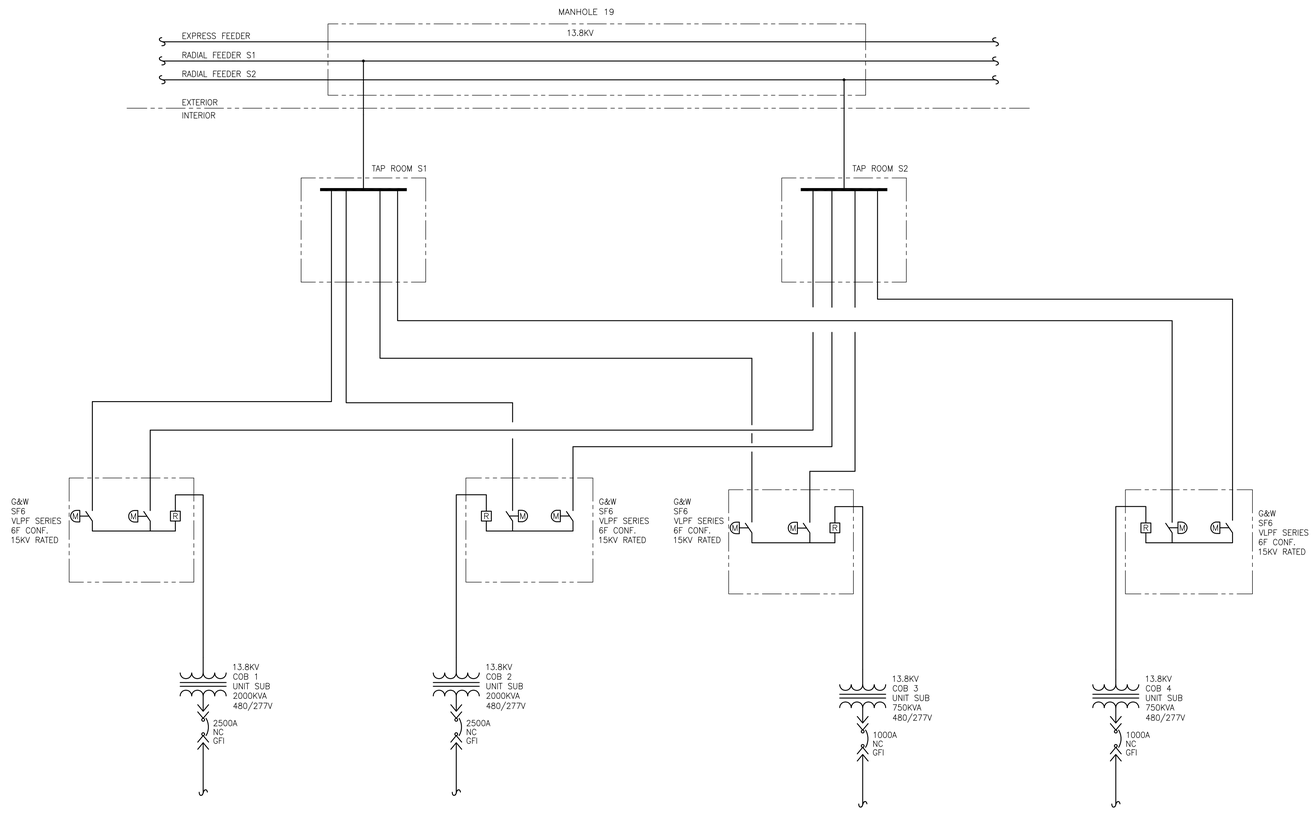
FIFTH FLOOR PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
E1.6.0



1 COB – 13.8KV DISTRIBUTION

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BUDGET DOCUMENTS
MARCH 13, 2015

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13.8KV DISTRIBUTION ONE-LINE
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ST. PAUL, MINNESOTA

drawing number
E3.0.0

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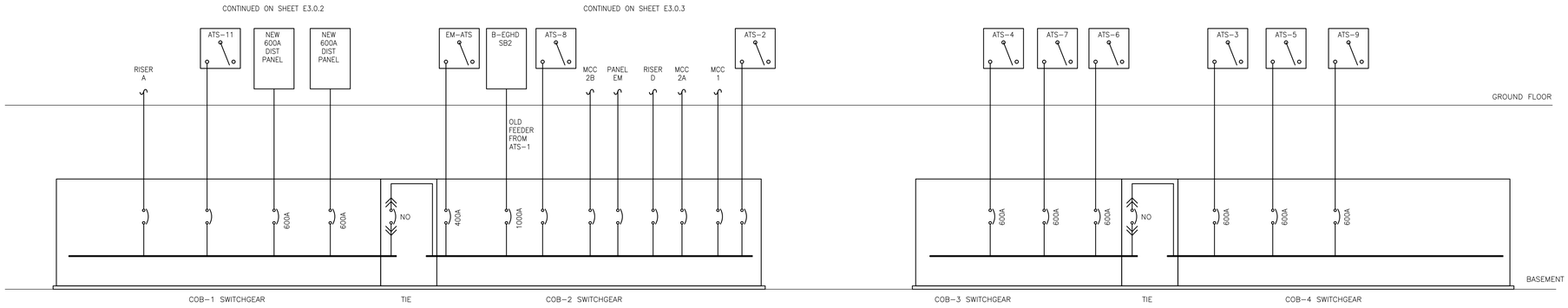

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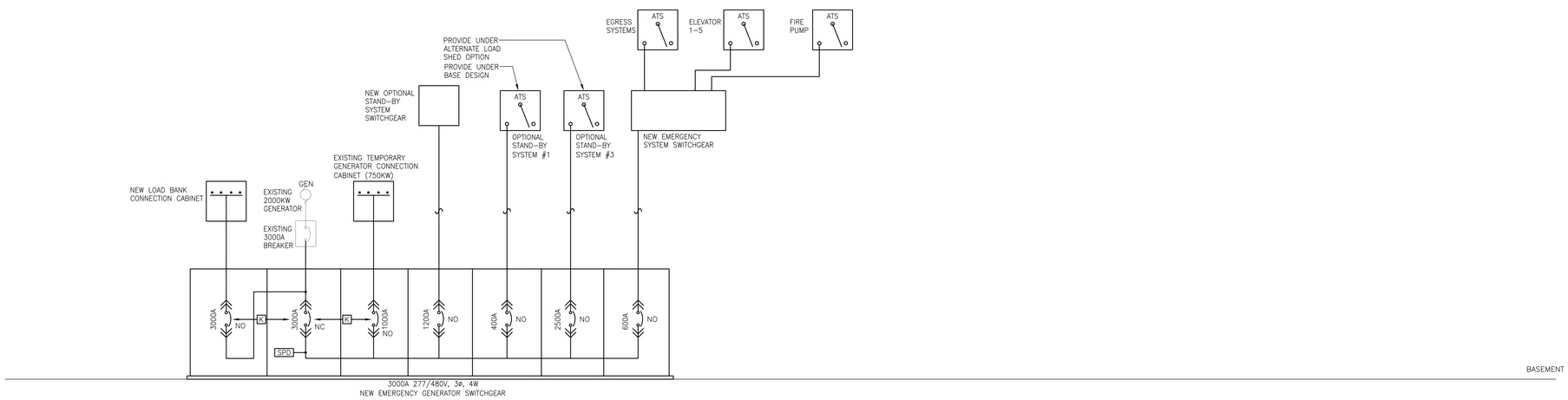

2 ONE-LINE DIAGRAM - COB - BACKUP RISER SYSTEM SWITCHGEAR NEW

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NORMAL RISER SYSTEM SWITCHGEAR NEW
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ST. PAUL, MINNESOTA

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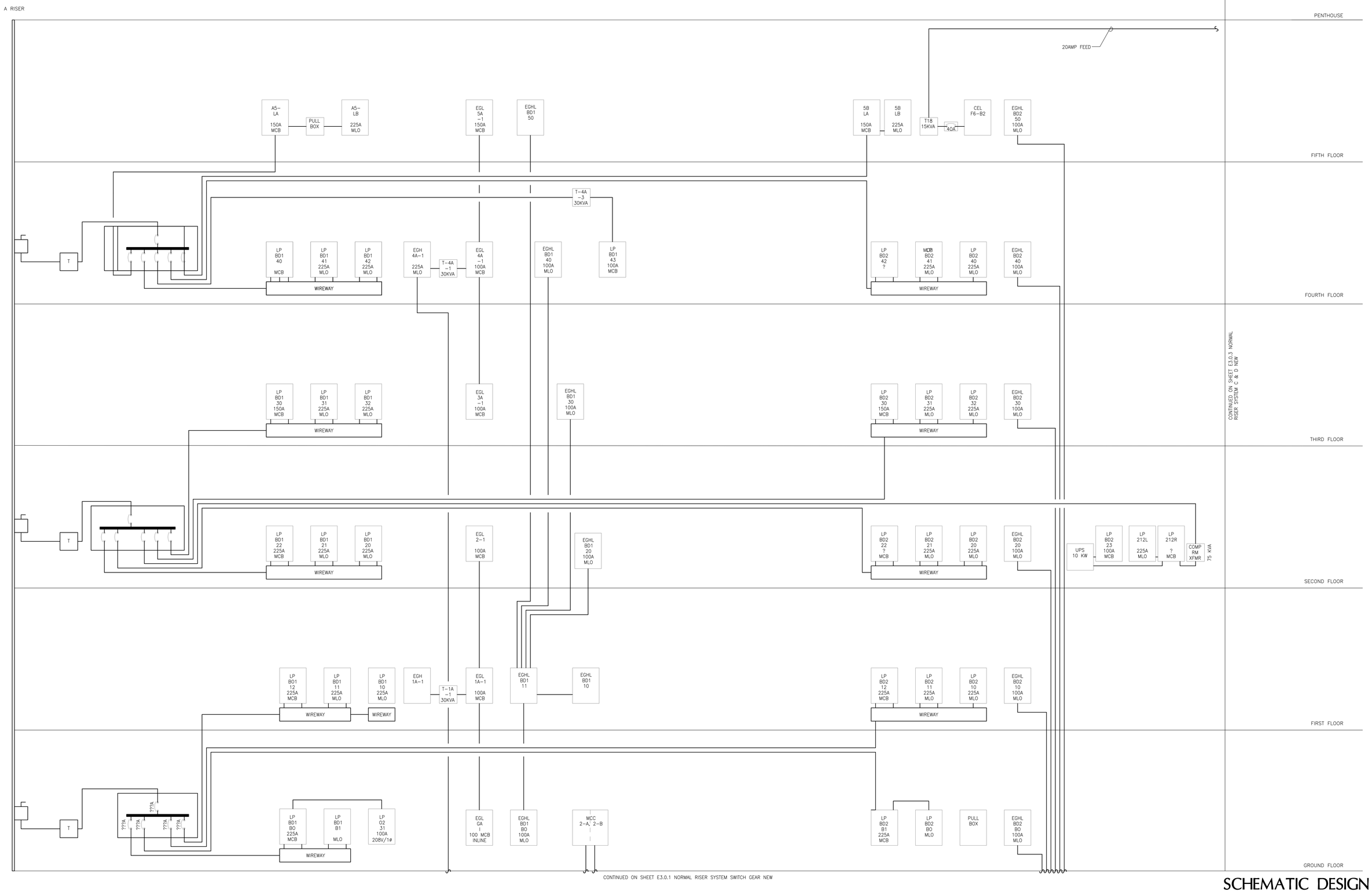

1 ONE-LINE DIAGRAM - NORMAL RISER SYSTEM A & B NEW

NOT TO SCALE

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MARCH 13, 2015

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NORMAL RISER SYSTEM A & B NEW
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ST. PAUL, MINNESOTA

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E3.0.2

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1 ONE-LINE DIAGRAM - NORMAL RISER SYSTEM C & D NEW

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BUDGET DOCUMENTS
MARCH 13, 2015

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NORMAL RISER SYSTEM C & D NEW
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ST. PAUL, MINNESOTA

drawing number
E3.0.3

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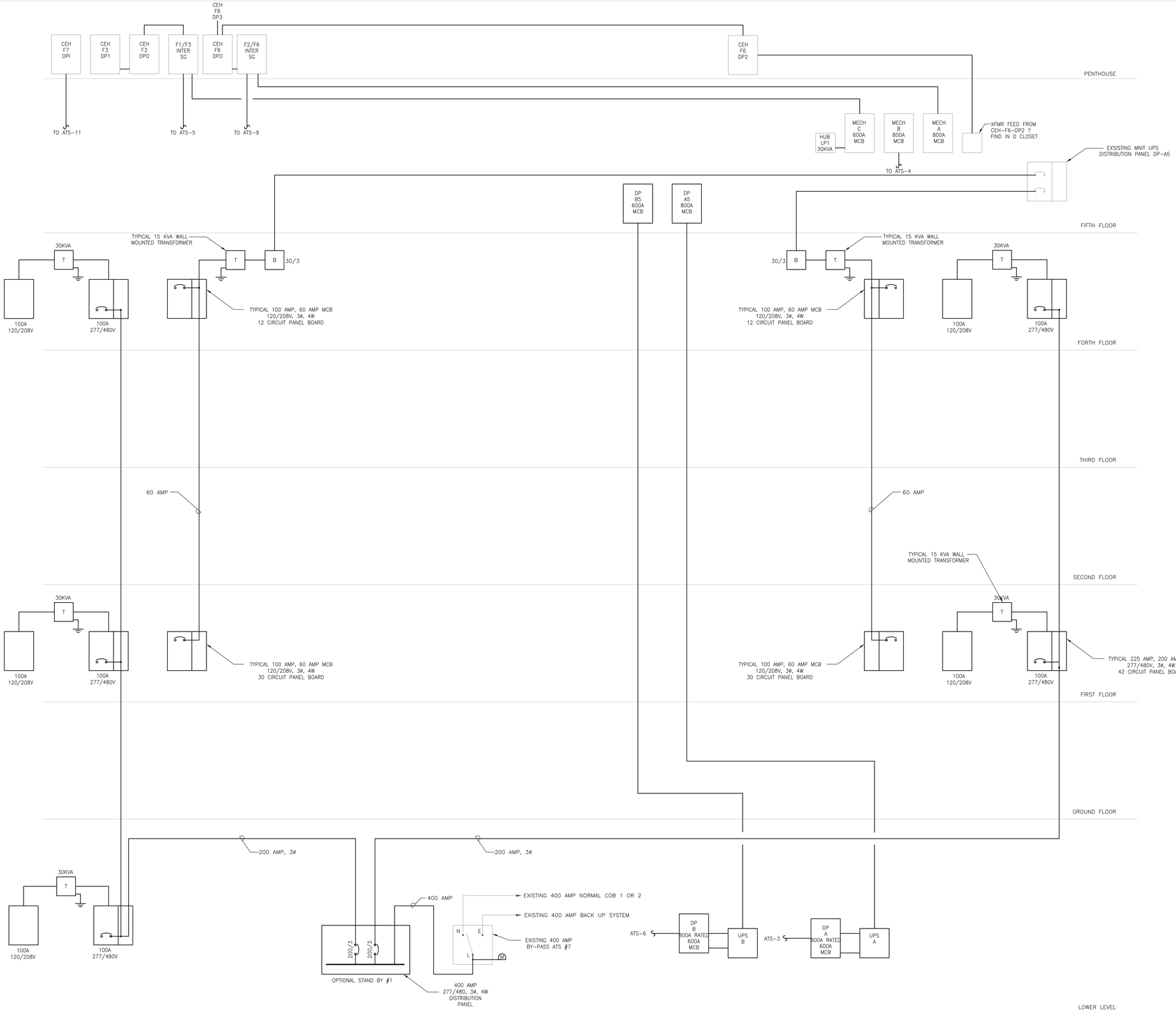

1 ONE-LINE DIAGRAM - COB - OPTIONAL STANDBY AND UPS SYSTEMS

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OPTIONAL STANDBY AND UPS SYSTEMS
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ST. PAUL, MINNESOTA

drawing number
E3.0.4

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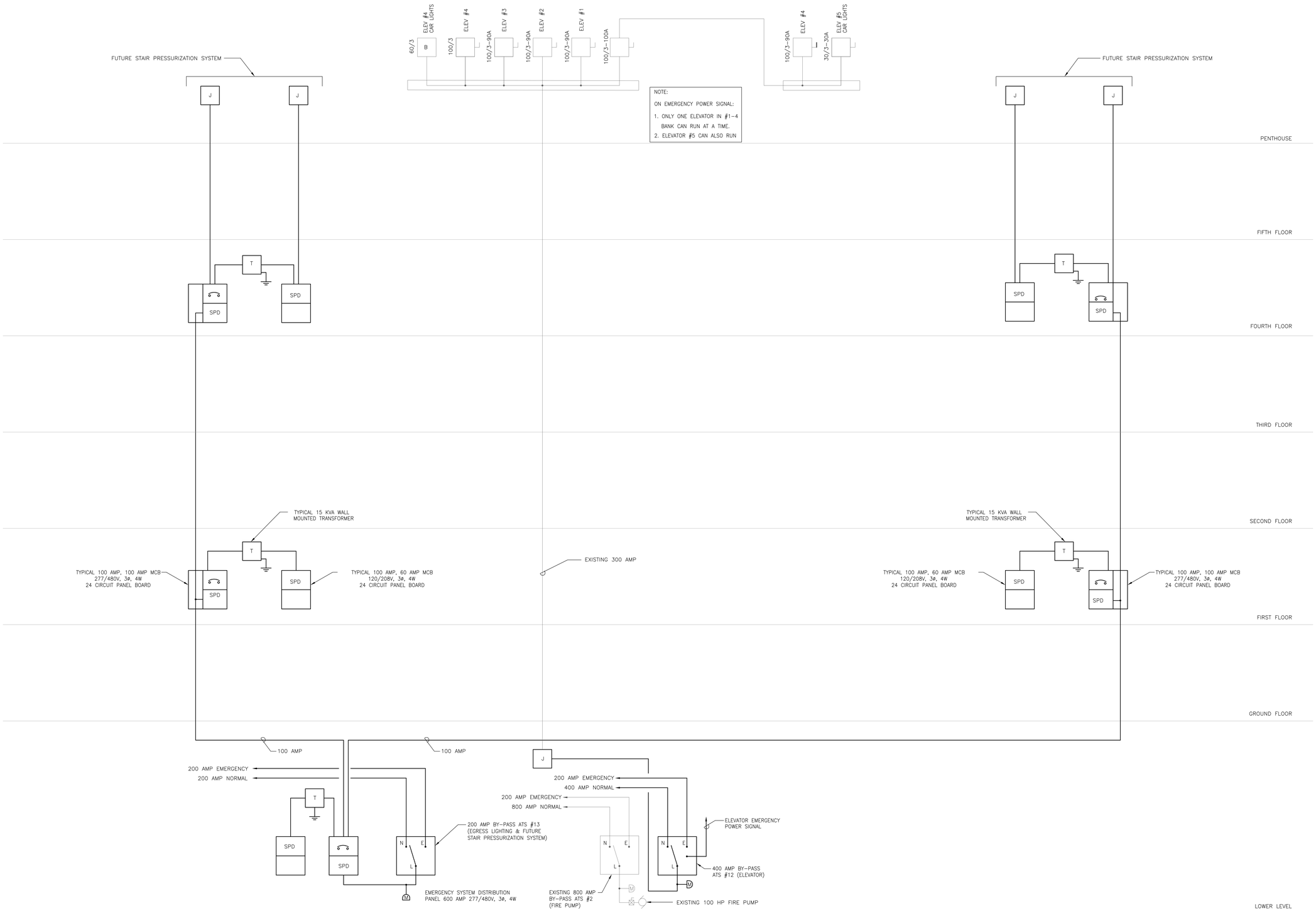

1 ONE-LINE DIAGRAM - EMERGENCY SYSTEM

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BUDGET DOCUMENTS
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EMERGENCY SYSTEM - RISER
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ST. PAUL, MINNESOTA

drawing number
E3.0.5

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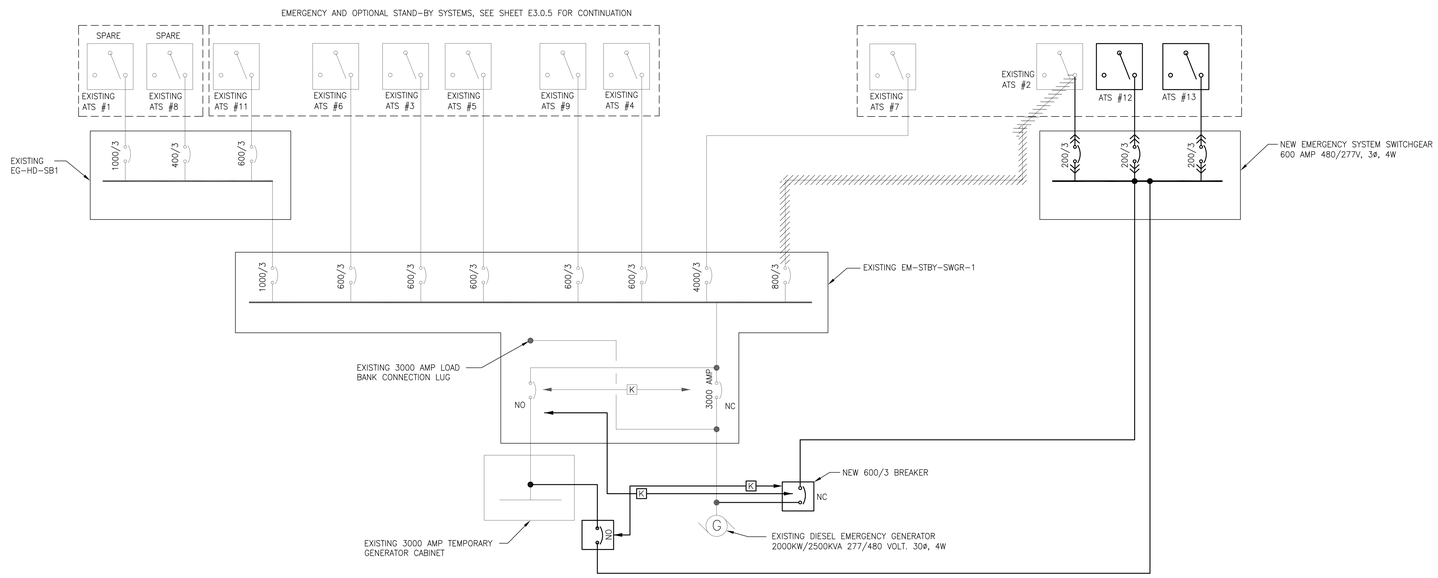

1 EMERGENCY GENERATOR SYSTEM-ONE LINE DIAGRAM

NOT TO SCALE

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BUDGET DOCUMENTS
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EMERGENCY GENERATOR SYSTEM – ONE LINE DIAGRAM
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ST. PAUL, MINNESOTA

drawing number
E3.0.6

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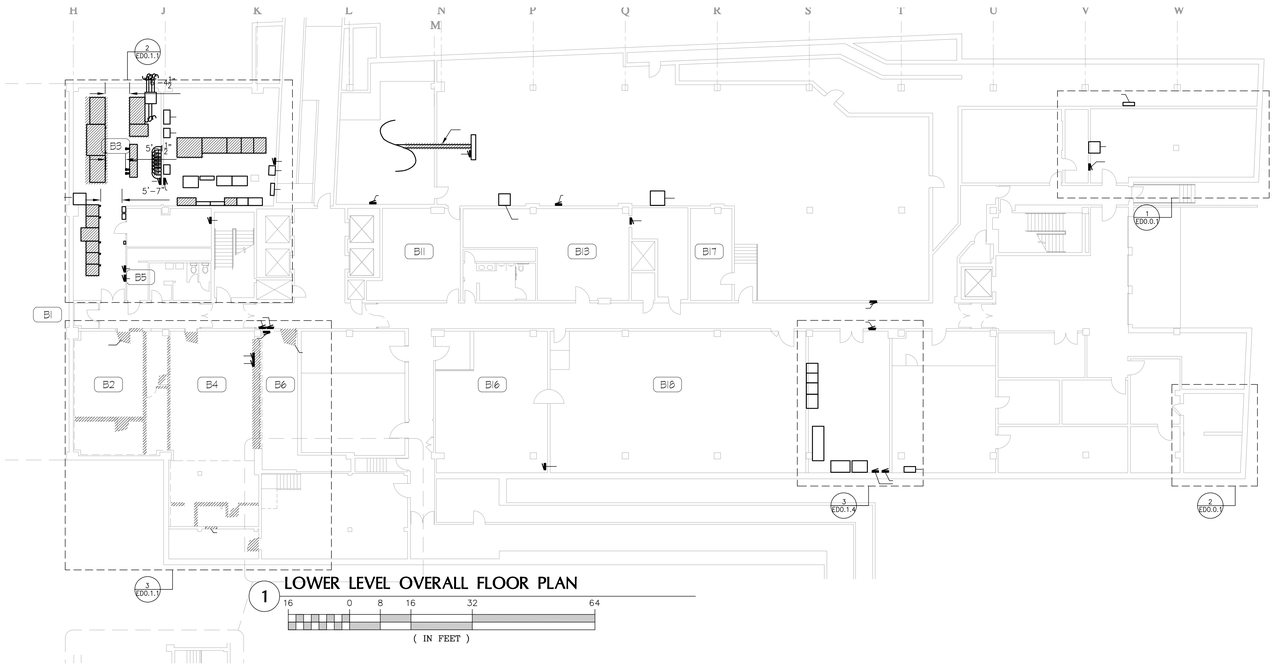

1 LOWER LEVEL OVERALL FLOOR PLAN

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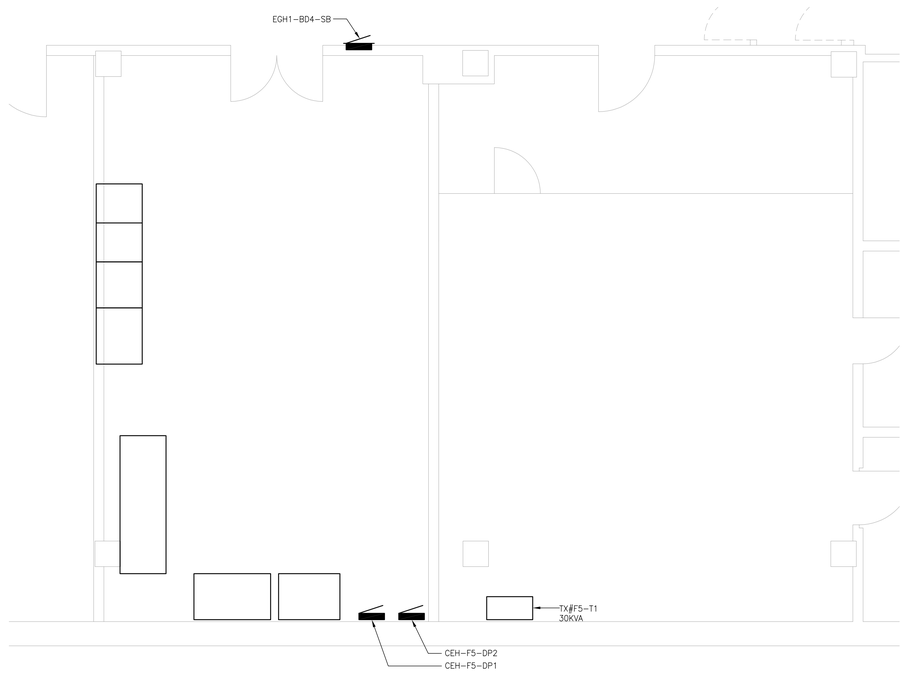
(IN FEET)



3 UPS ELECTRICAL ROOM B20

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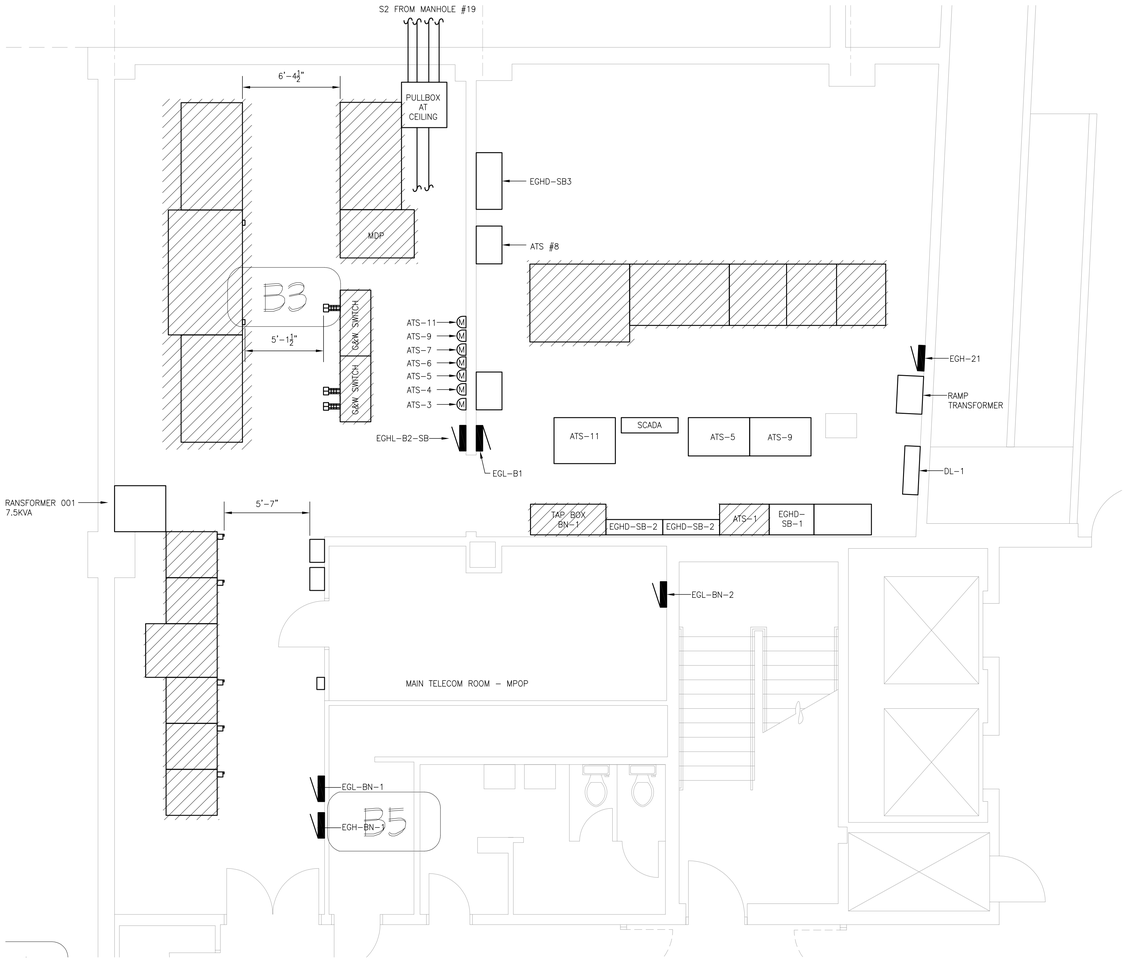
(IN FEET)



2 MAIN ELECTRICAL ROOM

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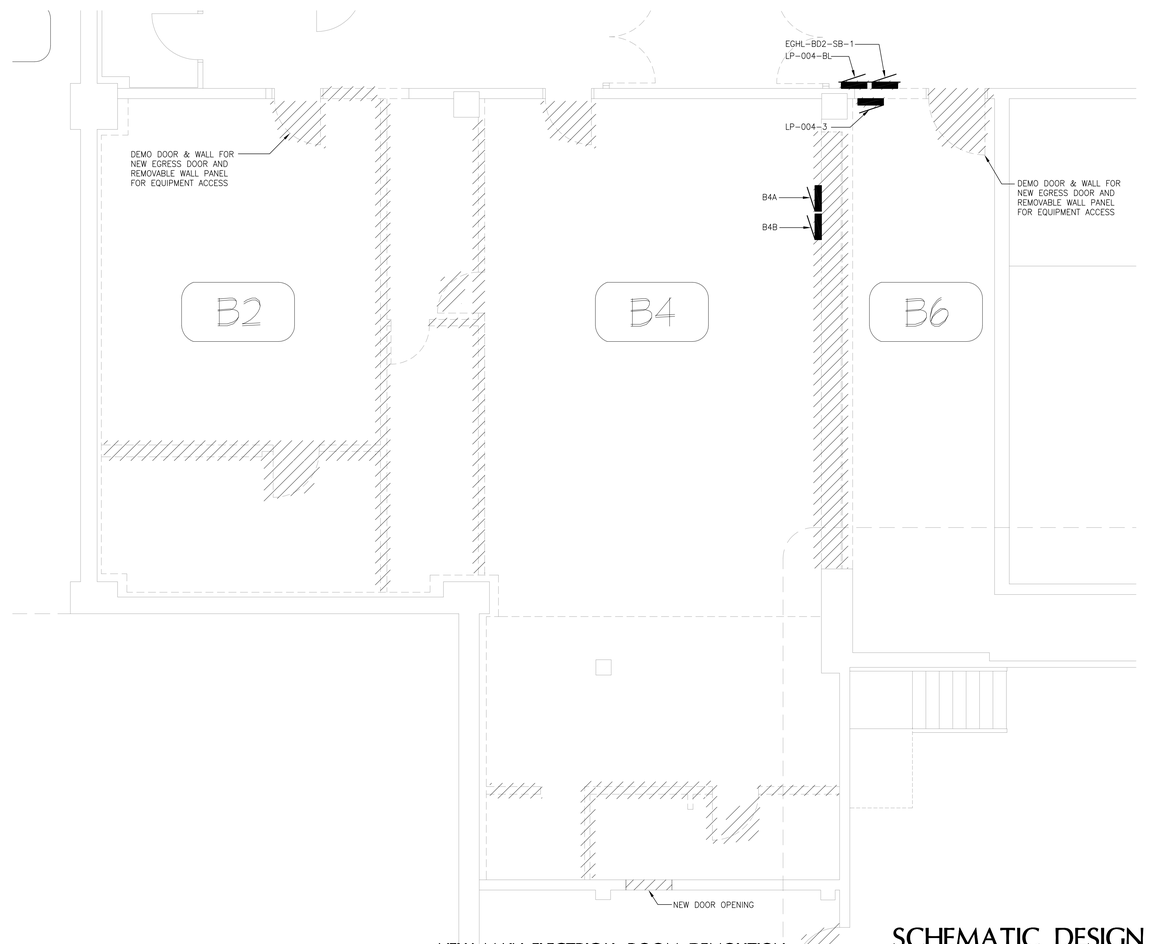
(IN FEET)



4 NEW MAIN ELECTRICAL ROOM–DEMOLITION

4 0 2 4 8 16

(IN FEET)

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BUDGET DOCUMENTS
MARCH 13, 2015

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LOWER LEVEL DEMOLITION PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
ED0.0.0

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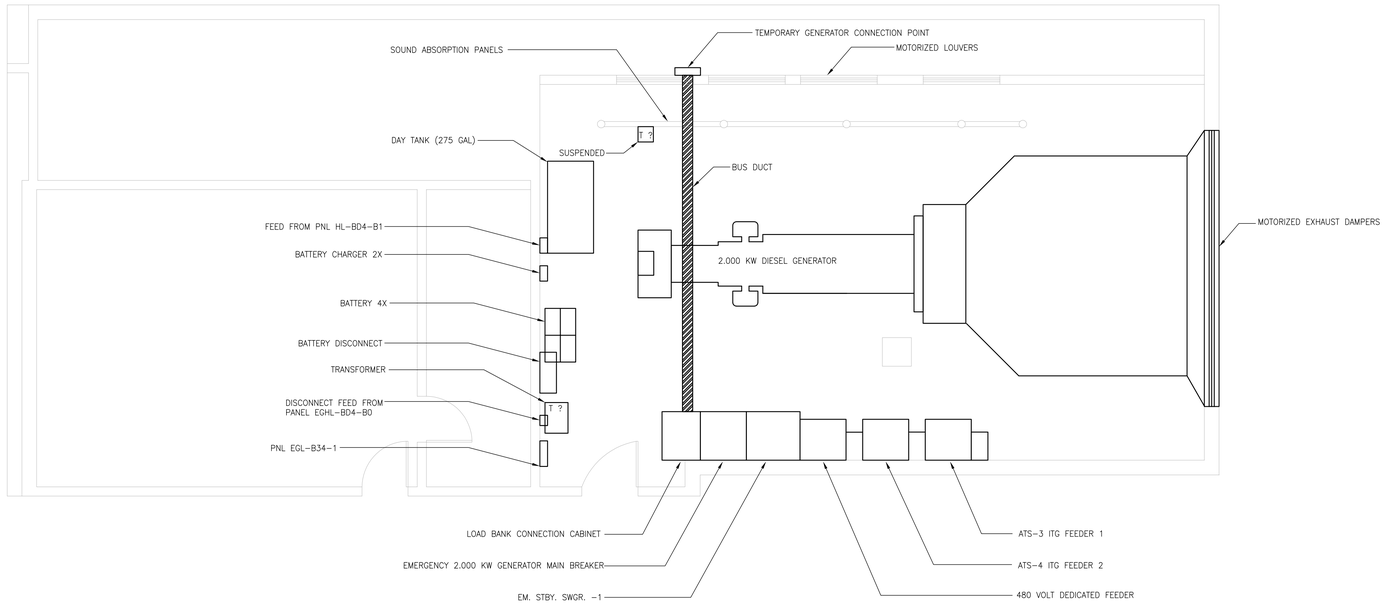
J:\2014\201407900\CAD\Sheets\E\ED0.0.0 LOWER LEVEL DEMOLITION PLAN – ELECTRICAL.dwg



1 ENGINE GENERATOR ROOM - DEMOLITION (B27)

4 0 2 4 8 16

(IN FEET)

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BUDGET DOCUMENTS
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BASEMENT ENGINE GENERATOR ROOM
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
ED0.0.1

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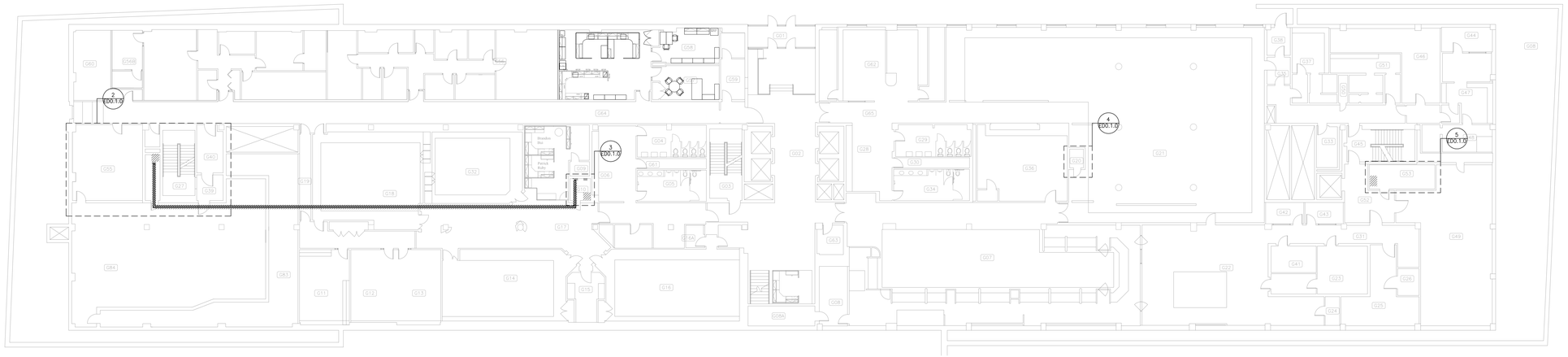

1 GROUND LEVEL OVERALL FLOOR PLAN

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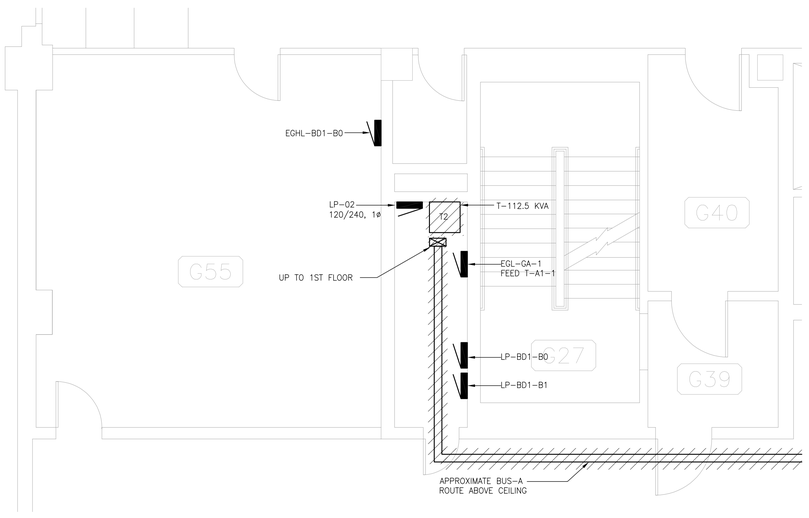

2 ELECTRICAL DISTRIBUTION – A RISER – CLOSET

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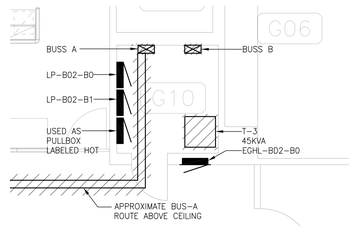

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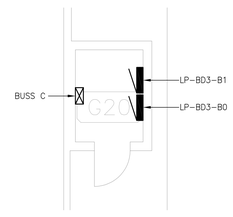

4 ELECTRICAL DISTRIBUTION – C RISER – CLOSET

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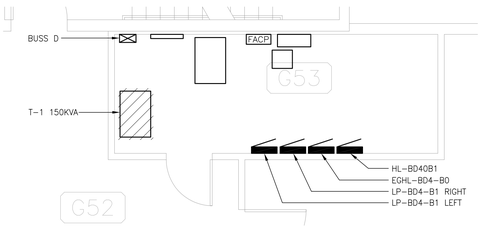

5 ELECTRICAL DISTRIBUTION – D RISER – CLOSET

4 0 2 4 8 16
(IN FEET)

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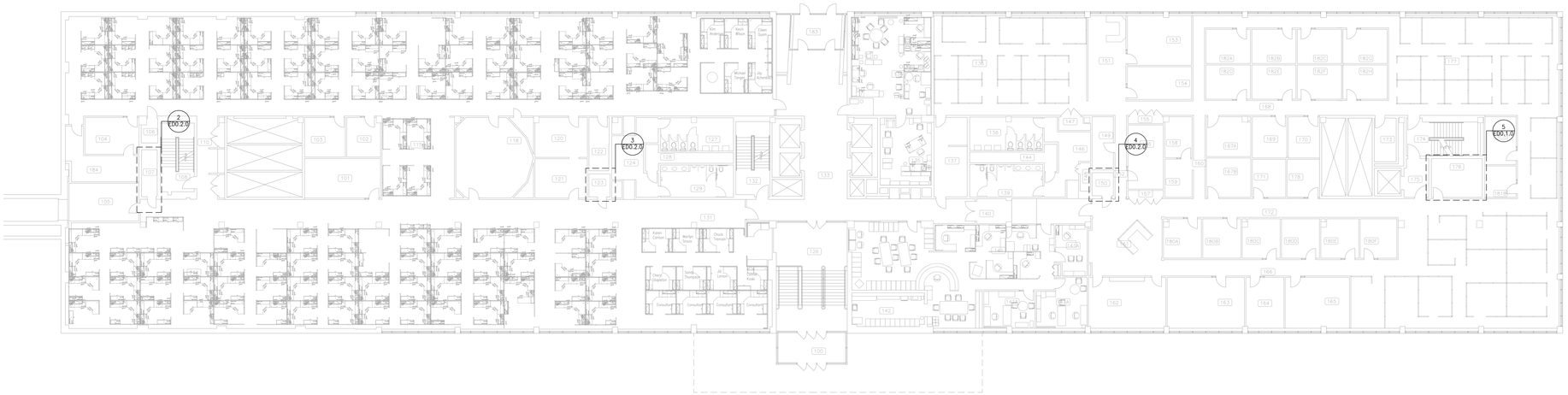
GROUND LEVEL DEMOLITION PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
ED0.1.0

Mar 13, 2015 – 10:19am Alex
J:\2014\201407900\CAD\Sheets\E\ED0.1.0 GROUND LEVEL DEMOLITION PLAN – ELECTRICAL.dwg



1 FIRST FLOOR OVERALL FLOOR PLAN

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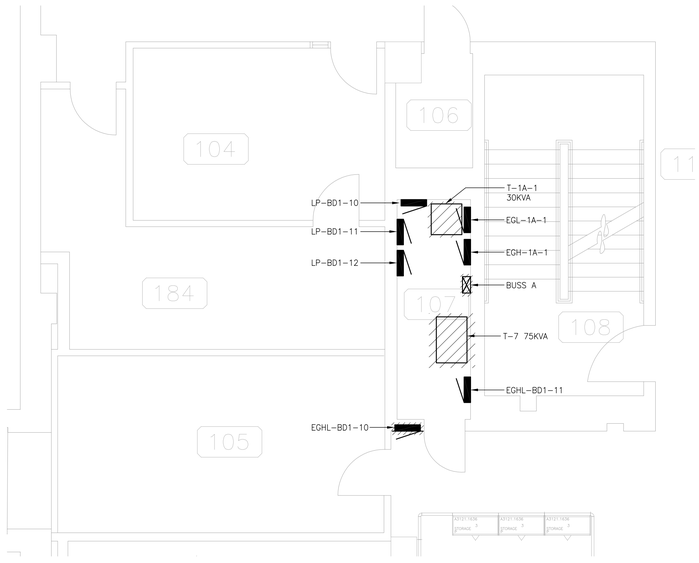
(IN FEET)



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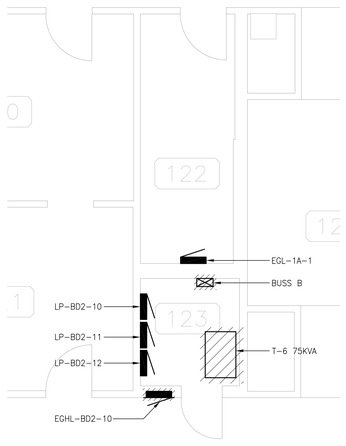
(IN FEET)



3 ELECTRICAL DISTRIBUTION – B RISER – CLOSET

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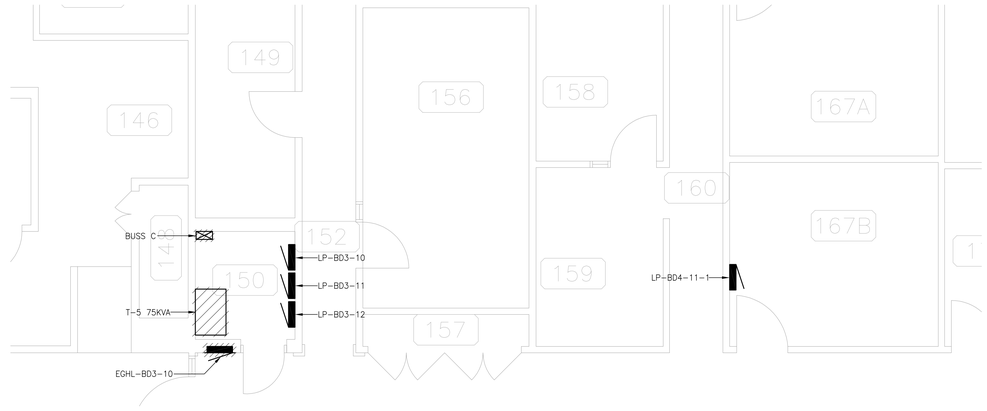
(IN FEET)



4 ELECTRICAL DISTRIBUTION – C RISER – CLOSET

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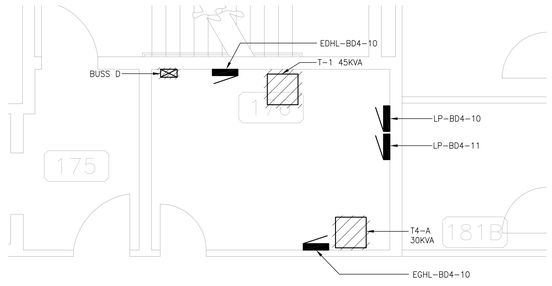
(IN FEET)



5 ELECTRICAL DISTRIBUTION – D RISER – CLOSET

4 0 2 4 8 16
(IN FEET)

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BUDGET DOCUMENTS
MARCH 13, 2015

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FIRST FLOOR DEMOLITION PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
ED0.2.0

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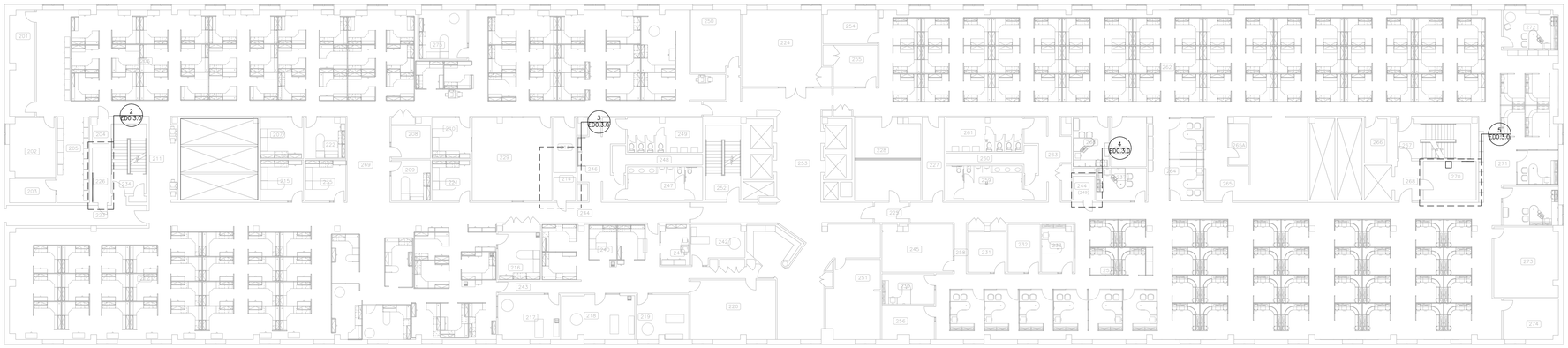

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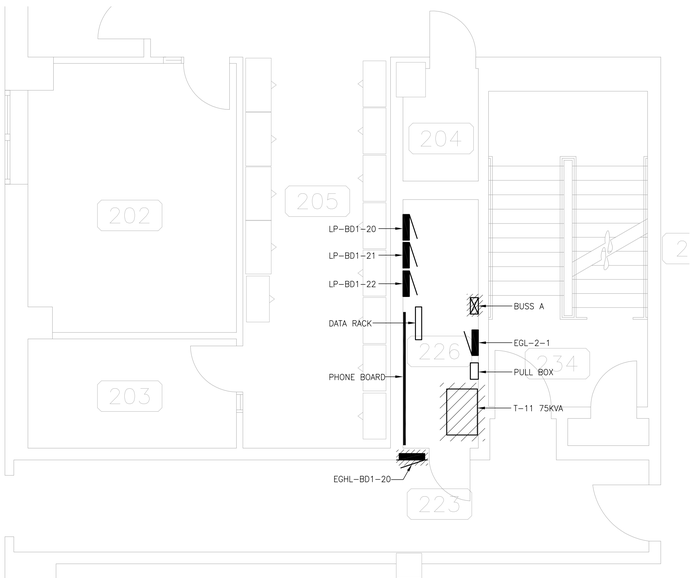

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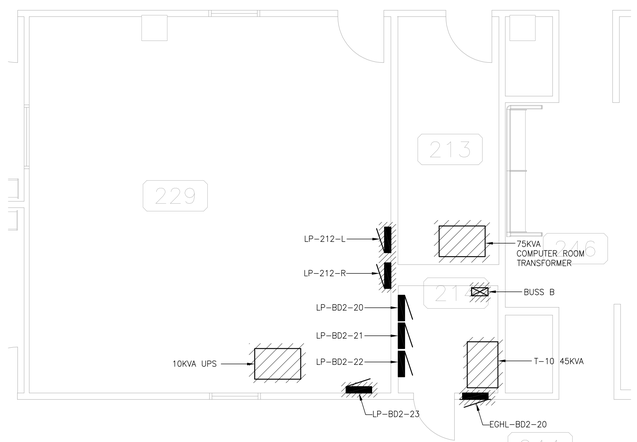

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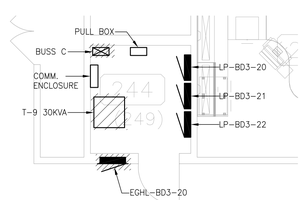

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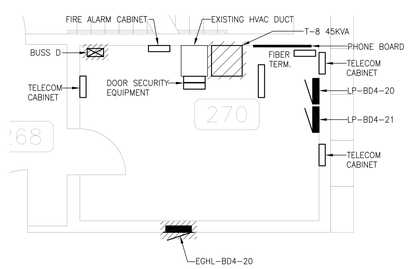

5 ELECTRICAL DISTRIBUTION – D RISER – CLOSET

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SECOND FLOOR DEMOLITION PLAN – ELECTRICAL
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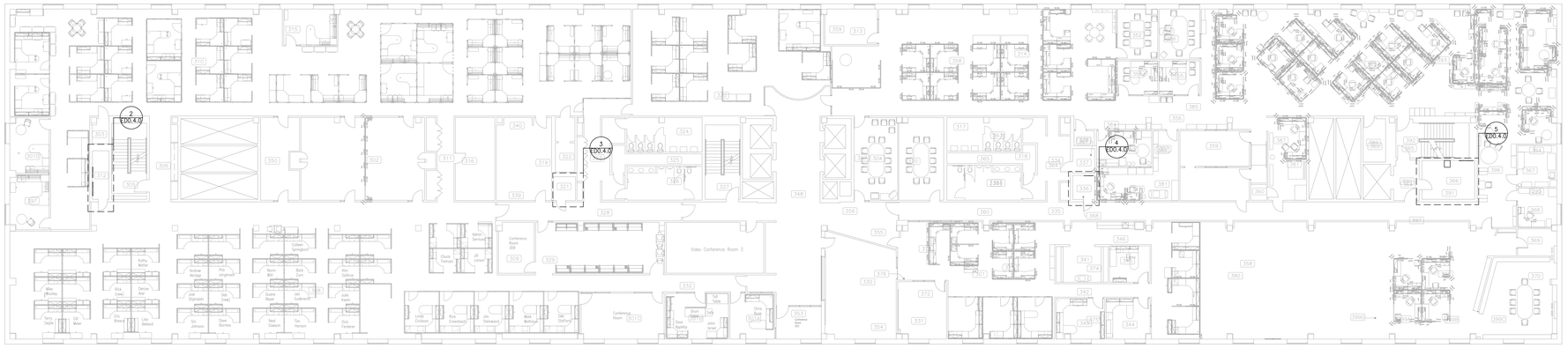

1 THIRD FLOOR OVERALL FLOOR PLAN

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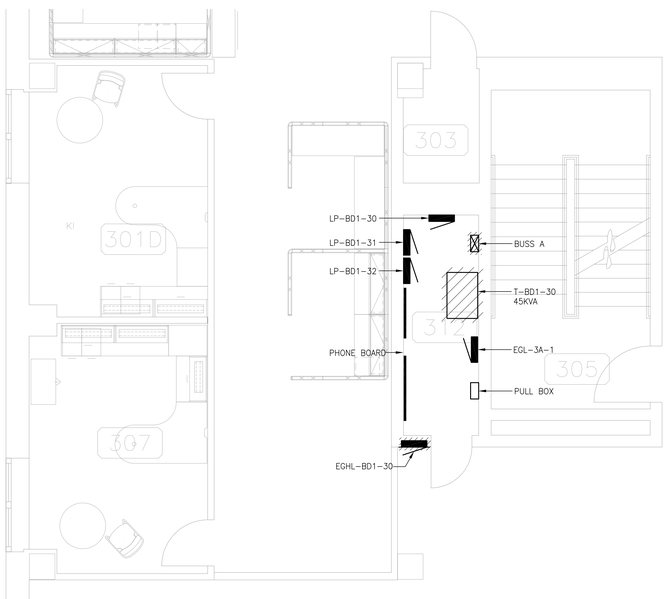

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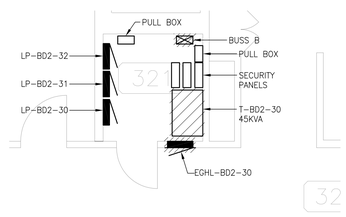

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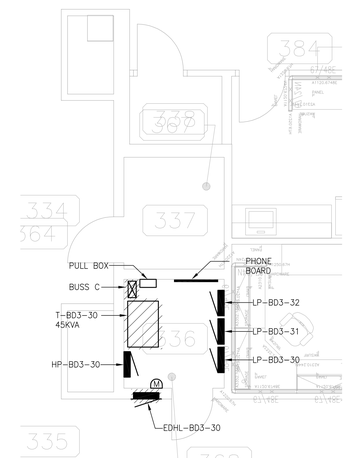

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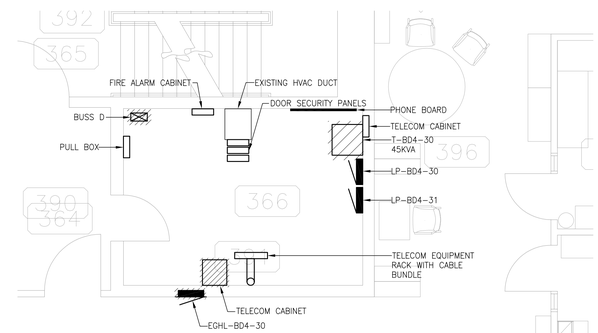

5 ELECTRICAL DISTRIBUTION – D RISER – CLOSET

4 0 2 4 8 16
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THIRD FLOOR DEMOLITION PLAN – ELECTRICAL
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ST. PAUL, MINNESOTA

drawing number
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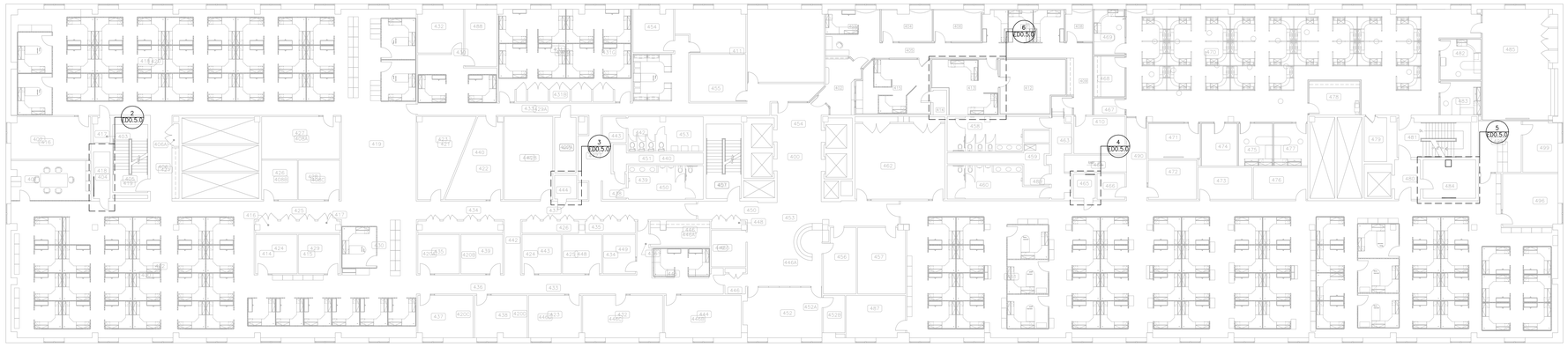

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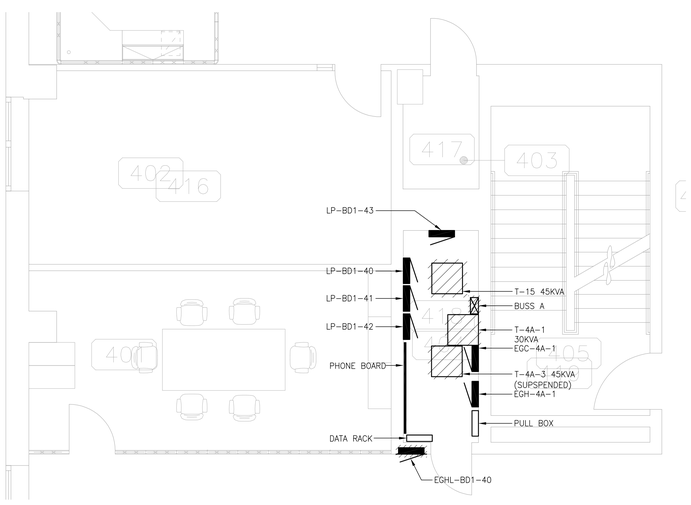

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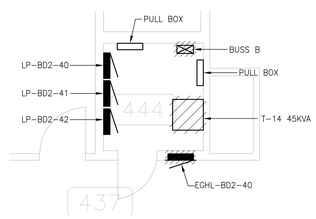

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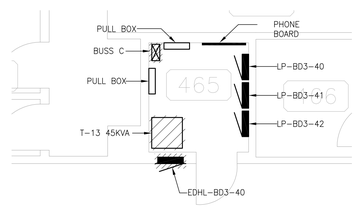

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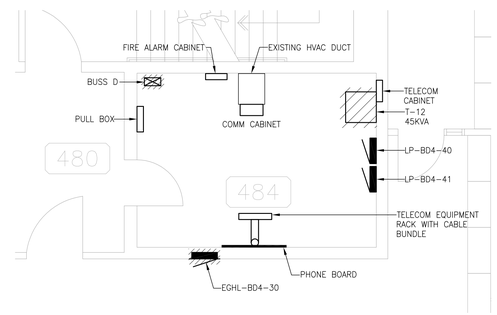

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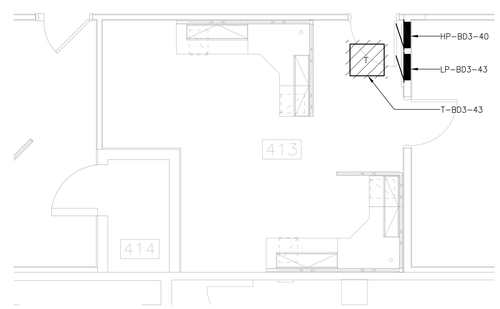

6 ELECTRICAL DISTRIBUTION – ROOM 413

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(IN FEET)

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FOURTH FLOOR DEMOLITION PLAN – ELECTRICAL
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
ED0.5.0

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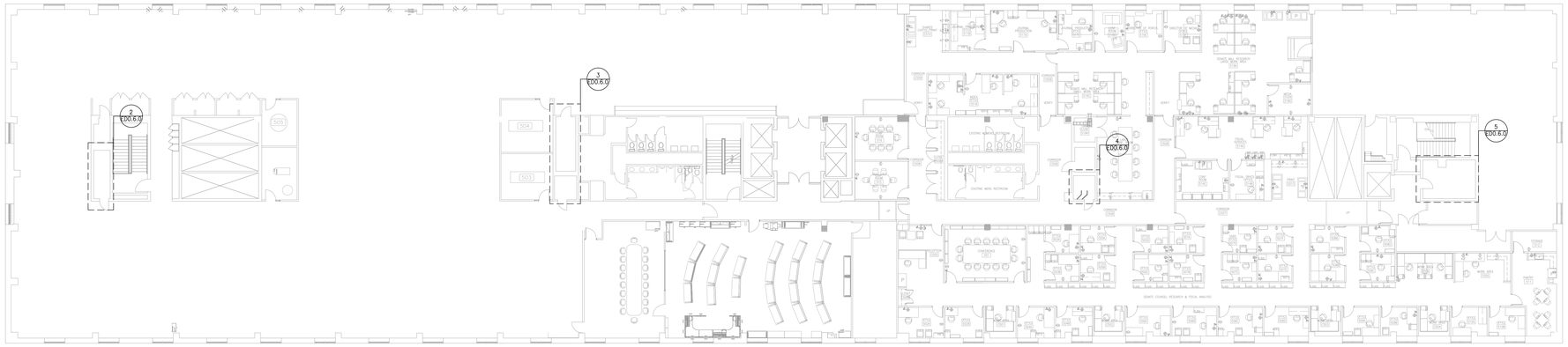

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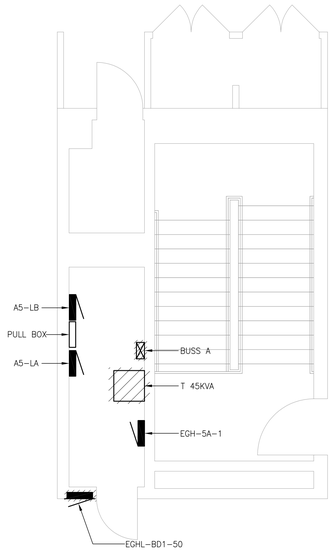

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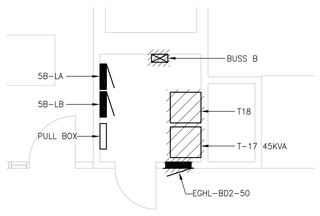

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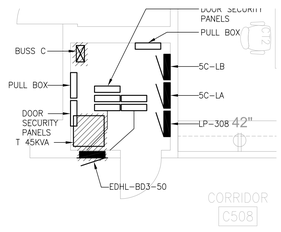

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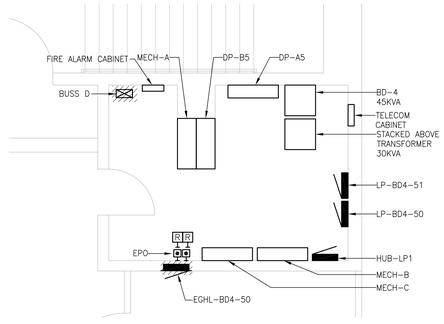

5 ELECTRICAL DISTRIBUTION – D RISER – CLOSET

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FIFTH FLOOR DEMOLITION PLAN – ELECTRICAL
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ST. PAUL, MINNESOTA

drawing number
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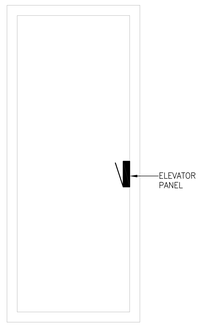

2 SOUTH PENTHOUSE UPPER LEVEL

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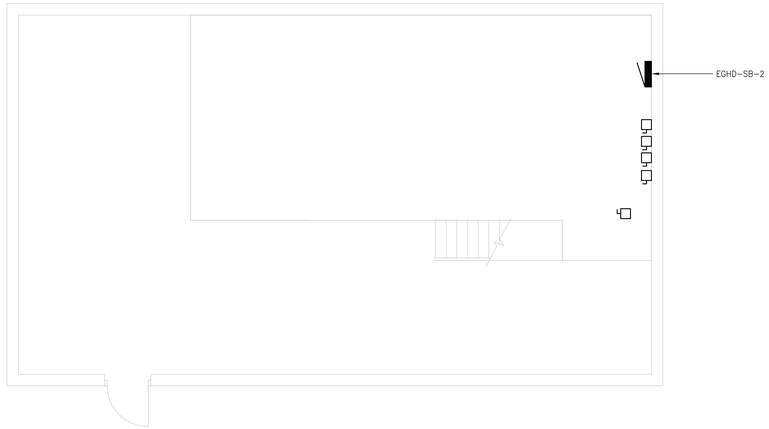

1 ELEVATOR PENTHOUSE – POWER DEMOLITION PLAN

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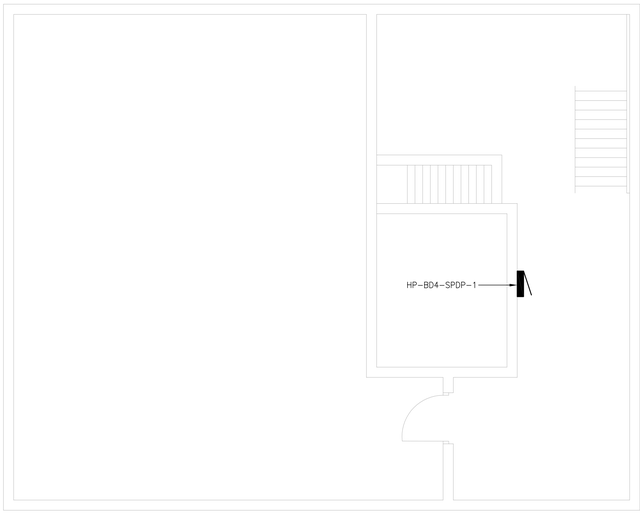

1 SOUTH PENTHOUSE LOWER LEVEL

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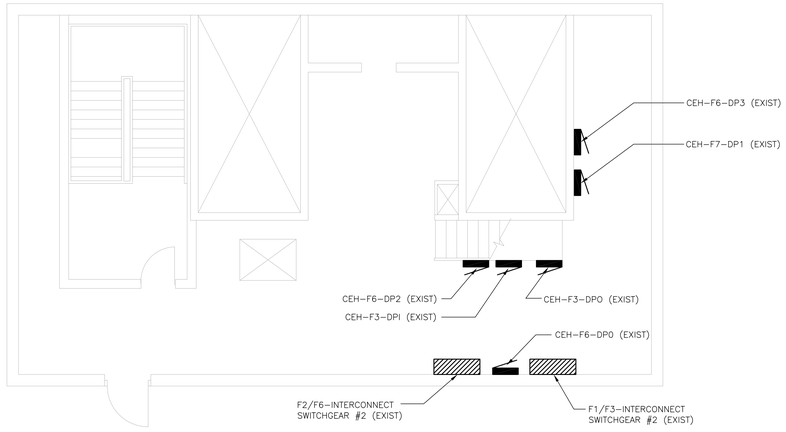

2 MIDDLE PENTHOUSE – POWER DEMOLITION PLAN

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PENTHOUSE PLANS – ELECTRICAL
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ST. PAUL, MINNESOTA

drawing number
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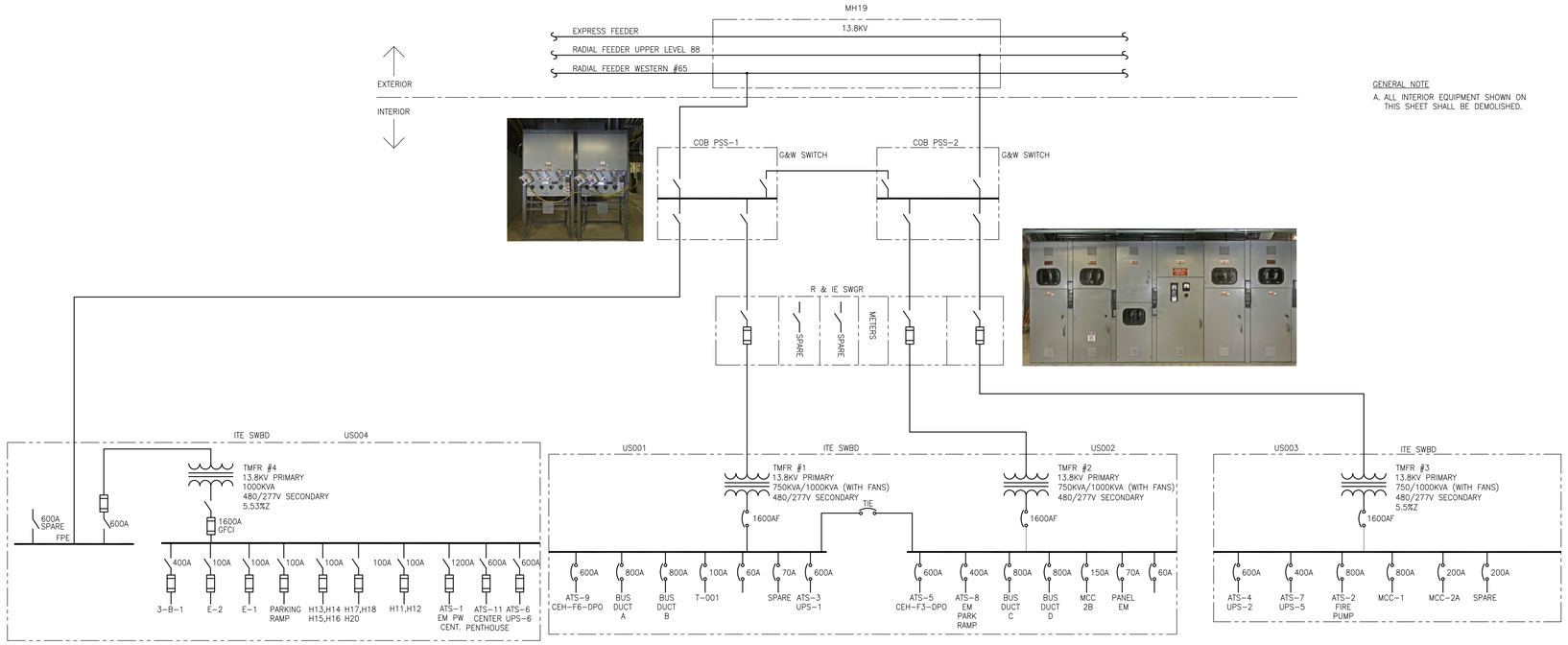
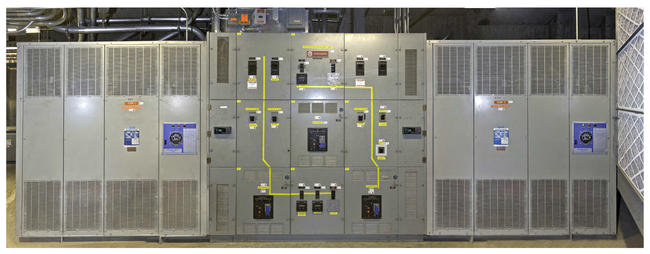


GENERAL NOTE

A. ALL INTERIOR EQUIPMENT SHOWN ON THIS SHEET SHALL BE DEMOLISHED.

1 EXISTING ELECTRICAL SERVICE EQUIPMENT
NO SCALE

2 US 004



3 US 001

4 US 002

5 US 003

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EXISTING PARTIAL ONE-LINE
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

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ED1.1.0

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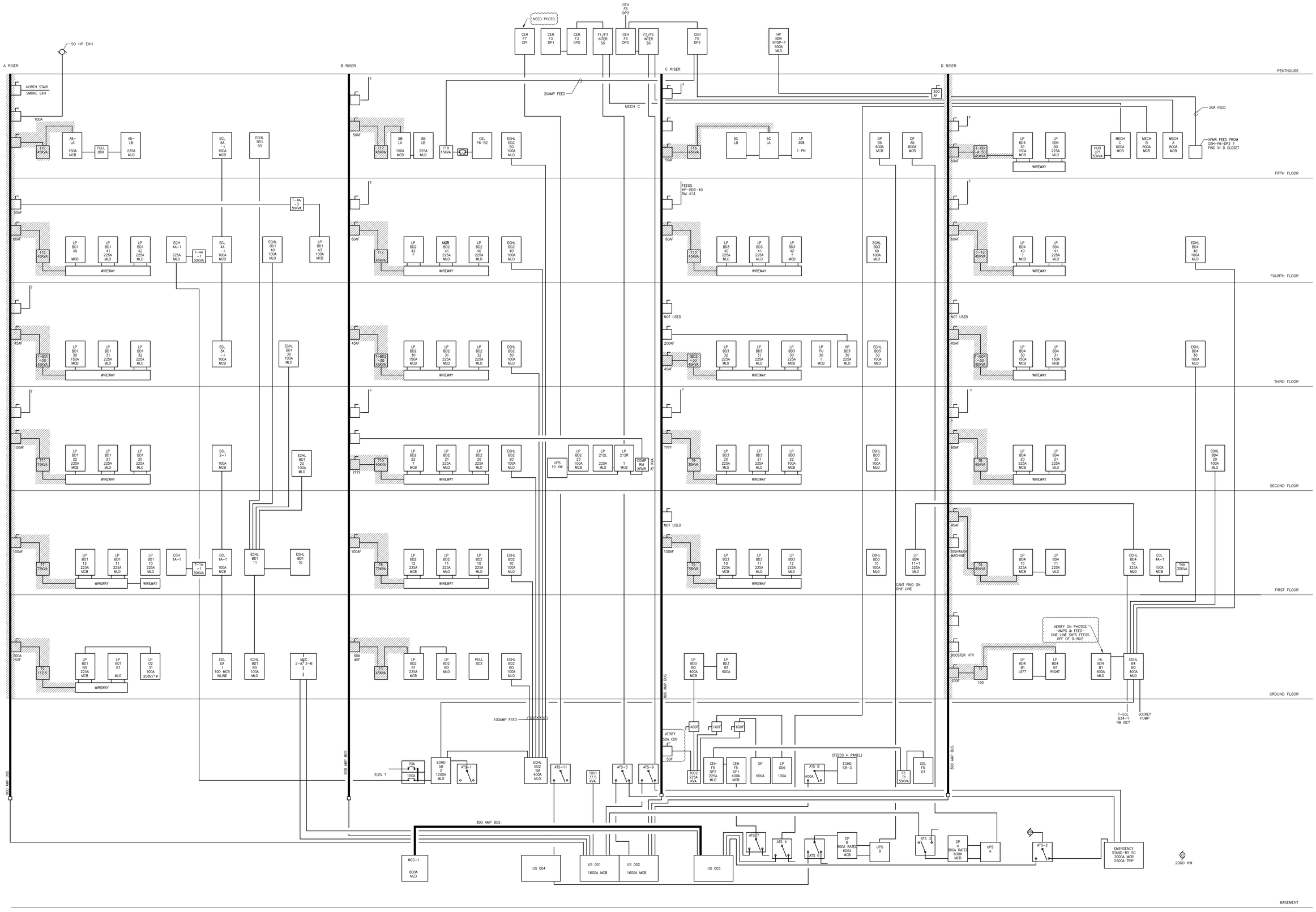

1 ONE-LINE DIAGRAM - RISER DIAGRAM - DEMOLITION

NOT TO SCALE

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RISER DIAGRAM - DEMOLITION
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ST. PAUL, MINNESOTA

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ELECTRICAL SYMBOL LEGEND

ELECTRICAL SYMBOL GENERAL NOTES

1. THESE SYMBOLS COMPRISE A STANDARD LIST. NOT ALL SYMBOLS MAY APPEAR ON THIS PROJECT.
2. ALL MOUNTING HEIGHTS ARE TO CENTER OF DEVICE ABOVE FINISHED FLOOR. MOUNTING HEIGHTS INDICATED ON ARCHITECTURAL WALL ELEVATIONS OR AS NOTED SPECIFICALLY ON THE DRAWINGS SHALL TAKE PRECEDENCE OVER MOUNTING HEIGHTS LISTED BELOW.
3. THIN LINE SYMBOLS, OR SHADED SYMBOLS INDICATE EXISTING DEVICES.
4. SLASHED SYMBOL INDICATES TO BE REMOVED.
5. HALF-SHADED LIGHT FIXTURE INDICATES FIXTURE CONNECTED TO EMERGENCY POWER SOURCE.

ELECTRICAL ABBREVIATIONS

AB	ABOVE BACKSPLASH
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
ARCH	ARCHITECT/ARCHITECTURAL
@	AT
ATS	AUTOMATIC TRANSFER SWITCH
BATT	BATTERY
BPI	BASE POWER IN
C	CONDUIT
CAB	CABINET
CB	CIRCUIT BREAKER
CCT	CIRCUIT OR CIRCUITS
CLG	CEILING
CMT	CONDUIT EMPTY
CONN	CONNECTION, CONNECTOR OR CONNECT
CONTR	CONTRACTOR
COOR	COORDINATE
DC	DIRECT CURRENT
DED	DEDICATED CIRCUIT, AN INDIVIDUAL DEVICE ON A CIRCUIT BY ITSELF
DN	DOWN
DWG	DRAWING
EA	EACH
EH	ELECTRIC HEATER
ELECT	ELECTRICAL
EM	EMERGENCY CIRCUIT
EQUIP	EQUIPMENT
ER	EXISTING TO REMAIN
EXIST	EXISTING
EWC	ELECTRIC WATER COOLER
F	FUSE
FA	FIRE ALARM
FACP	FIRE ALARM CONTROL PANEL
FDR	FEEDER
FIN	FINISHED
FLR OR FL	FLOOR
FSEC	FOOD SERVICE EQUIPMENT CONTRACTOR
FUT	FUTURE
FIXT	FIXTURE, LTG
FRZ	FREEZER
GND	GROUND
GFI	GROUND FAULT CIRCUIT INTERRUPTER
GFP	GROUND FAULT PROTECTION
GRC	GALVANIZED RIGID CONDUIT
HP	HORSEPOWER
HTG	HEATING
HTR	HEATER
IG	ISOLATED GROUND
JB OR J	JUNCTION BOX
KO	KNOCK OUT
KW	KILOWATTS
KVA	KILOVOLT AMPERE
LCP	LIGHTING CONTROL PANEL
LOC	LOCATION
LTG	LIGHTING, LIGHTS OR LIGHT
LTFC	LIQUIDTIGHT FLEXIBLE CONDUIT
MAN	MANUAL
MC	MOMENTARY CONTACT
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MIN	MINIMUM
MLO	MAIN LUGS ONLY
MTR	MOTOR
MSB	MAIN SWITCHBOARD
MS	MOTOR STARTER
MTC	EMPTY CONDUIT
MTD	MOUNTED
MT	EMPTY
NEC	NATIONAL ELECTRICAL CODE
NIC	NOT IN CONTRACT
NF	NON FUSED
NL	NIGHT LIGHT
PH	PHASE
PNL	PANEL
PR	PAIR
PRI	PRIMARY
PTR	PRINTER
PVC	POLYVINYL CHLORIDE
PWR	POWER
RA	RESCUE ASSISTANCE
REC	RECEPTACLE
REF	REFRIGERATOR
ROR	RATE OF RISE
SEC	SECONDARY
SMR	SURFACE METAL RACEWAY
SPD	SURGE PROTECTIVE DEVICE
SPEC	SPECIFICATION
SURF	SURFACE
SUSE	UL SERVICE ENTRANCE LISTED
SW	SWITCH
SWBD	SWITCHBOARD
TEL	TELEPHONE
TERM	TERMINAL
TRANSF	TRANSFORMER
TV	TELEVISION
TYP	TYPICAL
UL	UNDERWRITERS LABORATORIES
UNO	UNLESS NOTED OTHERWISE
V	VOLTS
VFD	VARIABLE FREQUENCY DRIVE
W	WATTS
WP	WEATHERPROOF
W/	WITH
XFMR	TRANSFORMER

SYMBOL	DESCRIPTION	MTG HT
2	ELECTRICAL NOTE (see electrical notes on same sheet) unless otherwise noted.	
A / 2	fixture type (capitol letter-see fixture schedule) circuit number	
a b a	switch identification (lower case letter) Letters indicate double switching. Switch nearest door to control outboard lamp(s), other switch to control inboard lamp(s).	
	SURFACE POINT SOURCE LIGHT FIXTURE (stem indicates wall mounted)	
	RECESSED POINT SOURCE LIGHT FIXTURE	
	POLE LIGHT, ARM MOUNTED (open circle indicates number & orientation of luminaire)	
	POLE LIGHT, POLE TOP MOUNTED	
	BATTERY EMERGENCY LIGHTING UNIT (triangles indicate lighting heads)	
	RECESSED BATTERY EMERGENCY LIGHTING UNIT (triangles indicate concealed lighting heads)	
	REMOTE EMERGENCY LIGHTING UNIT (triangles indicate lighting heads, stem indicates wall mounted)	
	RECESSED BATTERY EMERGENCY LIGHTING UNIT (triangles indicate exposed lighting heads)	
	SURFACE OR PENDANT FLUORESCENT FIXTURE (shown to scale, stem indicates wall mounted)	
	RECESSED FLUORESCENT FIXTURE (shown to scale)	
	TRACK LIGHTS & TRACK	
	BARE LAMP FLUORESCENT STRIP (length shown to scale)	
	EXIT SIGN (stem = wall mtd, shaded quadrants = faces, provide arrows where shown)	
	COMBINATION EXIT & EMERGENCY LIGHTING HEADS (stem = wall mtd, shaded quadrants = faces, provide arrows where shown)	
	WALL WASH LIGHT FIXTURE (shaded portion indicates orientation away from wall)	
	RECESSED ACCENT LIGHT FIXTURE (arrow indicates orientation)	
J	CEILING JUNCTION BOX (stem = wall mtd, B=blank cover	
	SINGLE RECEPTACLE	
D	DUPLEX RECEPTACLE (D=dedicated circuit)	18"
	SWITCHED DUPLEX RECEPTACLE	18"
	DUPLEX RECEPTACLE, EMERGENCY POWER	18"
	FOUR-PLEX RECEPTACLE	18"
	FOUR-PLEX RECEPTACLE, EMERGENCY POWER	18"

SYMBOL	DESCRIPTION	MTG HT
	GFI DUPLEX RECEPTACLE	18"
	GFI DUPLEX RECEPTACLE, EMERGENCY POWER	18"
	CEILING OR COUNTERTOP RECEPTACLE	
1,3	SPLIT WIRED RECEPTACLE (numbers indicate circuits)	18"
F	FLOOR OUTLET (P=pokethru, F=flush, S=surface pedestal, additional symbol indicates type)	
R	250 VOLT RECEPTACLE (R=range, DR=dryer, W=welder)	
	PARTITION WHIP or EQUIPMENT CONNECTION	
	CABLE TRAY	
#6 / L2 1,3,5	HOMERUN TO PANEL #L2,CCT,#1,3,5 (Cross marks indicate number of wires. Number at cross marks indicates wire size if different than specified minimum Mark with dot indicates grounding conductor. Wire counts shown on homerun only. Contractor to provide proper amount of wires for circuiting and control intent.)	
	CONDUIT EXPLOSION PROOF SEAL	
	CONDUIT CONCEALED IN WALL OR CEILING	
	CONDUIT CONCEALED IN/UNDER FLOOR	
	CONDUIT RUN EXPOSED	
	CONDUIT TURNED UP	
	CONDUIT TURNED DOWN	
	CONDUIT STUBBED OUT & BUSHED	
	FLEXIBLE CONDUIT	
	EXISTING CONDUIT	
UE	UNDERGROUND ELECTRIC (OE = overhead elec.)	
UT	UNDERGROUND TELEPHONE (OT = overhead tel.)	
LV	LOW VOLTAGE RACEWAY AND CABLE	
MH	MAINTENANCE HOLE	
HH	HAND HOLE	
	TRANSMISSION POLE	
	ELECTRIC DUCT HEATER	
EH	ELECTRIC HEATER	
	UNDERFLOOR DUCT & JUNCTION BOX (number of lines indicate number of ducts)	
	SURFACE RACEWAY (see spec. for type)	
	TELE/POWER POLE	
M	CLOCK OUTLET (M=master, D=digital, A=analog)	86"
	PANELBOARD, SURFACE	
	PANELBOARD, FLUSH	
	SWITCHBOARD (shown to scale)	
	TELEPHONE TERMINAL CABINET	
	CONTROL/SPECIAL CABINET	
NF	DISCONNECT SWITCH (NF=non-fused)	60"
	MAGNETIC STARTER	60"
	COMBINATION STARTER/DISCONNECT	60"
VFD	VARIABLE FREQUENCY DRIVE	
	START/STOP STATION	46"
EF2	MOTOR CONNECTION (letters indicates motor name, see schedules on me sheet)	
a	SWITCH (small letter indicates light fixtures controlled, 2=2-pole,3=3-way,4=4-way, K=keyed, MC=momentary contact, L=low voltage, P=pilot lighted toggle, D=door)	46"
a,b L	LIGHTING SYSTEM CONTROL DEVICE (small letter indicates light fixtures controlled)	
a,b LD	LIGHTING SYSTEM CONTROL DEVICE/DIMMING (small letter indicates light fixtures controlled)	
OS S	WALL SWITCH OCCUPANCY SENSOR (S= built in light level sensor)	46"
OS S	CEILING MOUNTED OCCUPANCY SENSOR (stem indicates wall mounted, S= built in light level sensor)	
M	MANUAL STARTER	
	INDICATES ALL DEVICES UNDER ONE COVER PLATE	
	PILOT LIGHT IN SEPARATE GANG	46"
600 D	DIMMER (number indicates size in watts when noted)	46"
T	TIME CONTROL SWITCH	58"
V	VARIABLE SPEED CONTROLLER	46"
R	RELAY	
C	CONTACTOR	
P	PHOTOCELL OR PHOTO SENSOR CONTROL	
	INTERCOM OUTLET, DESK (W=wall mtd at 46")	18"
C TV	TELEVISION OUTLET (C=camera, R=remote control, CC=closed circuit, A=antenna)	18"
	TELEPHONE OUTLET, DESK (W=wall mtd at 46")	18"
	DATA OUTLET, DESK (W=wall mounted at 46")	18"
	VOICE AND DATA IN ONE GANG (W=wall mounted at 48")	18"
T	THERMOSTAT, ELECTRIC	46"

SYMBOL	DESCRIPTION	MTG HT
T	TRANSFORMER, POWER (shown to scale)	
D	DAMPER MOTOR, ELECTRIC	
M	METER, POWER	
	GROUNDING ELECTRODE	
CT	CURRENT TRANSFORMER CABINET	
A	AQUASTAT	
B	CIRCUIT BREAKER	
PE	PNEUMATIC-ELECTRIC SWITCH	
F	FIRE ALARM MANUAL STATION	48"
H F	AUTOMATIC HEAT DETECTOR, 135° ROR (H indicates 200°F)	
S D	DUCT SMOKE DETECTOR & SAMPLING TUBE	
S	AREA SMOKE DETECTOR	
F	FIRE ALARM HORN	90"
F	FIRE ALARM BELL	90"
F	FIRE ALARM VISUAL ONLY	90"
F	FIRE ALARM CHIME	90"
F	FIRE ALARM COMBINATION HORN/VISUAL	90"
S F	FIRE ALARM COMBINATION SPEAKER/VISUAL	90"
F	FIRE ALARM COMBINATION CHIME/VISUAL	90"
F F	FLOW SWITCH	
S F	SUPERVISORY SWITCH (gate valve)	
F	FIRE FIGHTER INTERCOM JACK	46"
D F F	MAGNETIC DOOR HOLDER,WALL(F=floor mounted)	
D S F	MAGNETIC DOOR HOLDER/CLOSER COMBINATION AT DOOR HEAD. (S=built in smoke detector)	
FACP	FIRE ALARM CONTROL PANEL	
FAAP	FIRE ALARM ANNUNCIATOR PANEL	
EOL	END OF LINE DEVICE	
R F	FAN RELAY	
F	FIRE ALARM REMOTE TEST, RESET AND PILOT	
	BELL	
	CHIME	
	PUSHBUTTON	46"
C T	TRANSFORMER, CONTROL	
	BUZZER	
AMP	AMPLIFIER	
AMP	IN-WALL AMPLIFIER	
S S	SPEAKER, CEILING (stem indicates wall mounted , S=surface enclosure)	
S	PROJECTOR TYPE SPEAKER	
M	MICROPHONE OUTLET	18"
P	PROJECTOR OUTLET	18"
A	AUDIO OUTLET	18"
V	VIDEO OUTLET (SAT = SATELLITE CONNECTION)	18"
V	VOLUME CONTROL	46"
SSCP	SECURITY SYSTEM CONTROL PANEL	
OS M	SECURITY SYSTEM OCCUPANCY SENSOR (stem indicates wall mounted)	
C D	DOOR SECURITY CONTACTS	
M D	MAGNETIC DOOR LOCK	
S D	ELECTRIC DOOR STRIKE	
L D	ELECTRIC DOOR LOCK	
K	SECURE ACCESS KEY SWITCH or PAD	46"
C K	CARD KEY ACCESS SWITCH	46"

SPECIAL PURPOSE RECEPTACLE

TYPE	DESCRIPTION	MTG HT
A	20A, 250V, 1ø, AC, 2-POLE, 3-WIRE, GND NEMA 6-20R	
B	20A, 125/250V, 1ø, AC, 3-POLE, 4-WIRE, GND NEMA 14-20R	
C	20A, 250V, 3ø, AC, 3-POLE, 4-WIRE, GND NEMA 15-20R	
D	30A, 125V, 1ø, AC, 2 POLE, 3-WIRE, GND NEMA 5-30R	
E	30A, 250V, 1ø, AC, 2-POLE, 3-WIRE, GND NEMA 6-30R	
F	30A, 125/250V, 1ø, AC, 3-POLE, 4-WIRE, GND NEMA 14-30R	
G	30A, 250V, 3ø, AC, 3-POLE, 4-WIRE, GND NEMA 15-30R	
H	50A, 125V, 1ø, AC, 2-POLE, 3-WIRE, GND NEMA 5-50R	
J	50A, 125/250V, 1ø, AC, 3-POLE, 3-WIRE, GND NEMA 16-50R	
K	50A, 125/250V, 3ø, AC, 3-POLE, 4-WIRE, GND NEMA 14-50R	
L	50A, 250V, 3ø, AC, 3-POLE, 4-WIRE, GND NEMA 15-50R	

SUPPLEMENTAL LIST OF DRAWINGS

ET0.0.0	ELECTRICAL TITLE AND SYMBOLS
ED0.0.0	LOWER LEVEL DEMOLITION PLAN – ELECTRICAL
ED0.0.1	BASEMENT ENGINE GENERATOR ROOM
ED0.1.0	GROUND LEVEL DEMOLITION PLAN – ELECTRICAL
ED0.2.0	FIRST FLOOR DEMOLITION PLAN – ELECTRICAL
ED0.3.0	SECOND FLOOR DEMOLITION PLAN – ELECTRICAL
ED0.4.0	THIRD FLOOR DEMOLITION PLAN – ELECTRICAL
ED0.5.0	FOURTH FLOOR DEMOLITION PLAN – ELECTRICAL
ED0.6.0	FIFTH FLOOR DEMOLITION PLAN – ELECTRICAL
ED0.7.0	PENTHOUSE PLANS – ELECTRICAL
ED1.1.0	EXISTING PARTIAL ONE-LINE DIAGRAM
ED1.1.1	RISER DIAGRAM – DEMOLITION
E1.0.0	LOWER LEVEL PLAN – ELECTRICAL
E1.0.1	NEW ELECTRICAL ROOM LAYOUT
E1.1.0	GROUND LEVEL PLAN – ELECTRICAL
E1.2.0	FIRST FLOOR PLAN – ELECTRICAL
E1.3.0	SECOND FLOOR PLAN – ELECTRICAL
E1.4.0	THIRD FLOOR PLAN – ELECTRICAL
E1.5.0	FOURTH FLOOR PLAN – ELECTRICAL
E1.6.0	FIFTH FLOOR PLAN – ELECTRICAL
E3.0.0	13.8KV DISTRIBUTION SYSTEM
E3.0.1	NORMAL RISER SYSTEM SWITCHGEAR NEW
E3.0.2	NORMAL RISER SYSTEM A & B NEW
E3.0.3	NORMAL RISER SYSTEM C & D NEW
E3.0.4	OPTIONAL STANDBY AND UPS SYSTEMS
E3.0.5	EMERGENCY SYSTEM – RISER
E3.0.6	EMERGENCY GENERATOR SYSTEM – RISER

SCHEMATIC DESIGN
BUDGET DOCUMENTS
MARCH 13, 2015

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA
DATE: 03/13/15 REG. No.: 23791
ALLEN V. THEISEN

scale: AS NOTED
drawn by: ASQ
checked by: AVT
date: 03/13/15
project no: 2014.079.00

revisions:

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ELECTRICAL SYMBOLS
CAPITOL COMPLEX CENTENNIAL OFFICE BUILDING ELECTRICAL UPGRADES
ST. PAUL, MINNESOTA

drawing number
ET.0.0.0

Mar 13, 2015 – 10:18am Alex
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