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U.S. DEPARTMENT OF ENERGY

WASTE ISOLATION PILOT PLANT

ELECTRICAL SYSTEM (ED00)

SYSTEM DESIGN DESCRIPTION (SDD)

SDD ED00

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For

U.S. Department of Energy

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CHANGE HISTORY

REV. NO.	REV. DATE	PAGES/SECTIONS AFFECTED	APPROVED BY
0	7/91	Sections 1.0, 2.0, & 3.3	ECP 1-ED91-059 ECO No. 5576
1	3/92	Pages 2-65 add para. 2.12	ECP 1-ED92-055 ECO No. 6084
1	9/92	Page 2-32, revise para. 2.5.11.1	ECP 1-ED91-219 ECO No. 5835
2	9/92	Sections 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, & App.	ECP 1-ED91-059 ECO No. 6383
3	5/97	All Sections	ECP 1-ED92-006 ECO No. 5980 ECP 2-ED92-064 ECO No. 6715 ECP 1-ED94-003 ECO No, 7203 ECP 2-ED95-012 ECO No. 7592 ECP 2-ED95-013 ECO No. 7963 ECP 2-ED94-085 ECO No. 8234 ECP 1-ED95-104 ECO No. 8250 ECP 1-ED93-083 ECO No. 8261 ECP 1-ED96-056 ECO No. 8541 ECO No. 8549
4	8/99	All Sections	ECP 1-ED98-030 ECO No. 9530
5	8/01	ED00 Design Requirements All Sections – Format Changes	ECO No. 9723

REV. NO.	REV. DATE	PAGES/SECTIONS AFFECTED	APPROVED BY
6	12/03	Changes to fourth paragraph of Section 3.2.2.2.1, superseded by deletion of this paragraph in ECO No. 10670 General clarifications to entire document. Update "Design" to "Functional: Class; delete equipment brand names; delete SDD v. Spec. redundant information throughout. Update lighting information for systems ED07, ED16, and ED17. Delete reference to lightning rods in Section 16.0.	ECO No. 8968 ECO No. 10670 ECO No. 10670, Add. 1 ECO No. 10670, Add. 2 ECO No. 10720
7	01/06	New revision to incorporate ECO 11320.	
8	04-06	Changes to SDD to incorporate a new Portable Substation and a new Switching Station in the U/G.	ECO No. 11119
9	02/10	Changes to Subsystem ED11: add line to Table ED10-1; Step 12.1; Step 12.4 add bullet Changes to Section 11.1, Table ED 10-1, 12.1, 12.4 to remove 74P-PC10/1 and add 74P-PC10/5 and 10/6 Change to 12.1 ED11 change from eight to ten	ECO No. 11574 ECO No. 12313 ECO No. 12090

SUMMARY

The Electrical System (SDD ED00) distributes and controls the electrical power required for the equipment and process loads, both on the surface and underground, that operate and monitor the various systems that constitute the WIPP facility within and adjacent to the WIPP facility. It is designed to provide: normal power to all WIPP electrical equipment, backup power to selected equipment, grounding for electrically energized equipment and other plant structures, lightning protection for the plant, illumination for the plant surface facility and for related underground operations, and conditions needed to maintain the plant in a safe shutdown mode.

Subsystem Categories

The equipment which comprises the Electrical System has been broken down into seventeen subsystems. These groupings contain equipment or materials which fulfill equivalent functions and involve similar specification, engineering, procurement and operational activities and are as listed in the following:

Subsystem Designation	Subsystem Content
	Surface
ED01	115 kV SYS./Electrical Utility Co.
ED02	13.8 kV Switchgear & Equipment
ED03	4,160 V & 2,400 V Switchgear
ED04	480 V Switchgear
ED05	480 V Motor Control Centers
ED06	Low Voltage Power & Distribution (<600V)
ED07	General Lighting, Receptacle & Utilization Equipment
ED08	Central Uninterruptible Power Supply (UPS)
ED09	Backup Diesel Generators
	Underground
ED10	13.8 kV Switchgear Equipment
ED11	480 V Switchgear & Portable Power Centers (995V/600V/480V)
ED12	Motor Control Centers (<600V)
ED13	Low Voltage Power & Distribution (<600V)
ED14	General Lighting, Receptacle & Utilization Equipment
	All Locations
ED15	Grounding & Lightning Protection
ED16	Emergency Lighting
ED17	Perimeter Lighting
All subsystems	Raceways & Cable

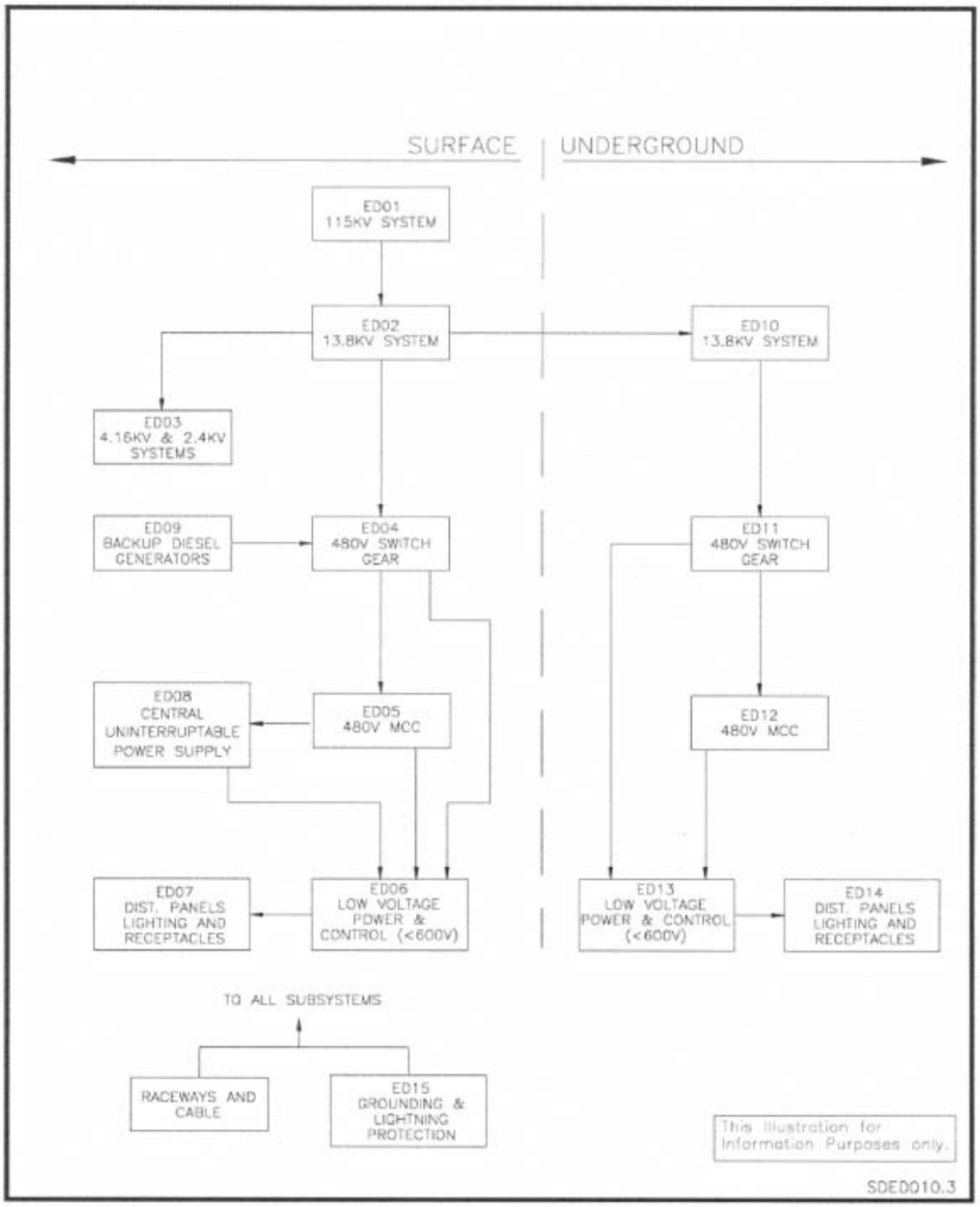

Figure ED-1 – SDD-ED00 Subsystem Configuration

1.0 ED00 – WIPP ELECTRICAL DISTRIBUTION SYSTEM

1.1 ED00 – Introduction

The electrical system is designed to supply power at the following nominal bus voltages:

- 13.8 kVAC, nominal, 3-phase, 3-wire, 60 Hz - Power supply for the main plant substation, underground switching stations, surface and underground unit substations, and portable power centers, with transformer primaries rated at 13.8 kVAC nominal.

- 4.16 kVAC, nominal, 3-phase, 3-wire, 60 Hz - Power supply for the main exhaust fan drive motors.

- 2.4 kVAC, nominal, 3-phase, 3-wire, 60 Hz - Power supply for the drive motor for the M-G set which provides the backup supply for the SH Shaft Drive Motor. Also power supply for alternate Low Voltage power to Salt Hoist House MCC.

- 995 VAC, nominal, 3-phase, 3-wire, 60 Hz - Power supply to Underground Continuous Miner (Eimco) via Portable Power Center (PPC).

- 600 VAC, nominal, 3-phase, 3-wire, 60 Hz - Power supply to Underground Continuous Miner or to Road Header (Dosco) via Portable Power Center (PPC).

- 480 VAC, nominal, 3-phase, 3-wire, 60 Hz - Power supply to Underground Auxiliary Equipment (Exhaust Fans, Core Drills, HERE Machine, etc.) Via Portable Power Center (PPC).

- 480/277 VAC, nominal, 3-phase, 3- and 4-wire, 60 Hz - Power supply for motor control centers, distribution panelboards, the Air Intake Shaft drive motor, solid state DC converter systems for the SH and Waste Hoists, Underground filtration fans, lighting and power distribution transformers with primaries rated at 480 VAC nominal.

- 208Y/120 VAC, nominal, 3-phase, 3- and 4-wire, 60 Hz - Power supply for control systems, instrumentation, lighting, communication, and small (fractional horsepower) motor-driven equipment.

- 120/240 VAC, nominal, 1-phase, 3-wire, 60 Hz - power supply for control system, instrumentation, lighting, communication, etc.

- 208Y/120 VAC, nominal, 3-phase, 4-wire, 60 Hz, Central Uninterruptible Power Supply (UPS) for power essential loads. Loads must be continuously energized under all plant operating modes.

Electrical distribution equipment is protected through the use of various protective devices which control the trip functions of an associated circuit breaker. Breakers may be tripped as the result of an overload condition, fault condition, or variation of system parameters such as voltage or frequency which deviates outside set point conditions for the protective device. Set points are determined by use of engineering methods and documented in controlled drawings and reports.

In-ground raceways are designed and installed to select surface facilities to facilitate infrastructure development and repair of existing in-ground conductors. An in-ground conduit duct bank system distributes electrical power in select areas of the WIPP site. Both control and power distribution is routed through the duct bank system from select area substations to their connected loads. The duct bank system is routed using in-ground pull boxes to limit the number of offsets or bends in each run of conduit.

A Plant Metering System (PMS) designed to utilize digital metering and communications technologies is installed to disseminate power, energy, and power quality information to licensed users throughout the site. The meter system consists of the meters, communications equipment, and system software. For meter reference, see drawing 25-J-096-W series.

1.2 ECC00 – Design Requirements

The following requirements must be maintained for any design modification or maintenance performed on this system.

The functional classifications are defined in the Documented Safety Analysis (DSA) and the General Plant Design Description (GPDD).

Design of electrical equipment shall conform to normal commercial/industrial products and manufacturers accepted product specifications utilizing whenever possible components with a twenty five year design life, subject to appropriate maintenance. Electrical distribution equipment shall be standard industrial grade with applicable interrupting, latching, short circuit, impulse, operating voltage and protective device ratings in accordance with the application design parameters. Plant equipment shall be designed to withstand the maximum short circuit currents available with the source impedance values at maximum and minimum credible values.

All pieces of equipment of a particular type (i.e., switchgear, breakers, Motor Control Centers, etc.) shall be of uniform capacity and rating, to the extent practical, and shall similarly be of uniform physical design and appearance.

The Electrical Distribution System shall be designed to provide reliability assurance by use of interconnecting feeders and backup sources of power

supply to minimize the possibility of loss of power both on the surface and underground during normal operating and maintenance conditions.

Whenever practical, the major subsystems of the Electric System shall be designed to allow appropriate periodic inspection, testing and scheduled maintenance, for important areas and features such as backup diesel generator units, switchgear, etc.

Whenever practical, the selection and interconnection of equipment for the Electrical System shall be designed to allow an adequate maintenance and testing program which does not require any significant reduction in plant operating efficiency for its implementation.

All relays, instruments and controllers which may require periodic maintenance or attention are to be mounted on panels with secured covers or behind doors whenever practical.

Equipment shall be sized to account for maximum calculated load conditions plus an aggregate minimum margin for future growth of 15% of the total load on that equipment. A 15% load growth factor is assumed in system design. The operating mode resulting in the worst case for continuous current ratings, and voltage drop is utilized in the design.

The equipment shall have sufficient strength and interrupting capacities to withstand the highest short circuit, withstand, latching, and overload conditions that can be encountered with consideration given to the load growth margin. Supplemental current limiting devices may be used if necessary.

All transformers located within buildings are to be dry type with forced air ventilation where required. Transformers located within 30 ft of building openings shall utilize low flammable silicone based or similar type oil. All other transformers located in outdoor substations may utilize non-polychlorinated biphenyls (PCBs) oil. All liquid filled transformers are to be provided with oil retaining gravels or enclosures in accordance with the NEC Article 450.27.

The electrical system shall provide voltage at the equipment terminals within the operating voltage range of the equipment during minimum and maximum system load conditions in accordance with parameters listed in Appendix E. The minimum voltage level at the motor and bus during starting conditions is to be within the allowable limits of Appendix E. This voltage level is to insure the following:

- Voltage is adequate to provide torque to accelerate starting motor.
- Voltage is adequate to prevent excessive deceleration of running motors.
- Voltage is adequate to prevent drop out of electromagnetically held devices (e.g., contactors).

Fire Protection

Fire protection for System ED00 equipment is to be provided in conjunction with fire protection for the equipment with which it is located or by portable fire extinguishers.

Consult FP00 for areas requiring fire walls to be considered in electrical design.

Power System Protection and Control

System ED00 is designed to minimize short circuit currents to allow the use of manufacturer's minimum standard short circuit withstand rated equipment. The use of current limiting reactors and other current limiting devices is employed on certain area substations and motor control centers to ensure compliance with the manufacturer's applicable short circuit withstand equipment rating.

Protective devices shall be in accordance with industry standards to provide selective and coordinated protection for the power distribution system through use of protective relays and direct acting trip devices. These protective devices shall be provided throughout the plant distribution system to perform the following:

- Detect the presence of abnormal system conditions
- Isolate faulty equipment
- Minimize damage to equipment and protect personnel
- Maintain service to the unaffected part of the system with minimum disturbance

To accomplish the above functions, the protective relaying shall be designed to provide selectivity, sensitivity, and reliability.

Selectivity shall be achieved by dividing the distribution system into protective zones and selecting protective relays and devices which are capable of recognizing that the fault is present within a given zone of protection. In order to localize the consequence of disturbances set points are selective in operation so that the one nearest the fault on its power source side will have the first chance to operate. Should any device fail to operate the next in series upstream will become active, and so on up to circuit breakers in the Utility Substation electrical yard. The protective relays and devices then operate to isolate the faulty equipment or the affected zone.

Typically 13.8 kV ED02 protective devices use torroidal current transformers mounted on breaker phase lugs to sense instantaneous and delayed over current trips and a zero sequence current transformer on the output lines from the

breaker (minus any equipment ground conductors) to provide ground fault protection signals. Ground faults may also be the sensed summation of the three phase sensors for residual fault determination or by the use of over voltage relays on the neutral at the transformer. A wye-delta ground transformer is connected to the neutral in such a way that when zero sequence (ground fault) current flows, a potential difference is developed between the circuit neutral and ground. An over voltage relay then detects this voltage and will activate the protection circuits. The protective relays in general either activate a lockout relay or by some other means must be manually reset after activation.

Sensitivity of protection shall be assured by analyzing the system as appropriate for various operating and faulted conditions and applying relay settings which enable the relays to operate correctly under these faulty conditions.

1.3 ED00 – Standards and Codes

Structural and Support loading requirements for all Electrical System equipment, including the backup diesel generators shall be in accordance with the Uniform Building Code as modified by Manufacturers equipment requirements. No special seismic or wind loading requirements apply to electrical distribution equipment.

The design and construction codes and standards applicable to electrical distribution equipment shall be in conformance with relevant ANSI, the National Electric Code, NFPA 70, the applicable requirements of DOE Orders 420.1B, *Facility Safety*; and 430.1B, *Real Property Asset Management*; and other industry standards listed in each subsystem of this SDD. Codes and Standards for specific items of equipment shall be listed in applicable WIPP design or purchase specifications.

The design and installation of wires, cables and raceways shall be subject to design guides which include, but shall not be limited to, NEMA VE-1, NFPA-70, AISI Steel Electrical Raceways Design Manual, and 29 CFR 1910 (OSHA).

The electrical distribution system shall satisfy the requirements of the Mine Safety and Health Administration (MSHA), 30 CFR Part 57, and selected sections of 30 CFR Part 75.

UL Building Materials Directory and UL 1479.

Appropriate Codes and Standards listed in Appendix F, Supplemental Codes and Standards.

In the event of a conflict between the above codes and standards and other requirements imposed by lower tier project documents, this SDD shall govern.

1.4 ED00 – System Operation and Precautions

Information on the setpoints of Electrical Distribution system Protective Relays are documented as follows:

- For 2.4 kV to 13.8 kV circuit breakers, see drawing series 25-J-019-W.
- For 480 V substation circuit breakers, see drawing series 25-J-021-W.
- The two backup diesel generators instrument/device setpoints are listed in drawing series 25-J-071-W and 25-J-072-W.
- The central UPS instantaneous/device setpoints are listed in drawing series 45-J-095-W.
- For the Motor Control Center setpoints see the equipment list.

Mechanical safety interlocks provided with switchgear power circuit breakers are as follows:

- A positive mechanical interlock permits moving a breaker only when the primary contacts are open.
- Mechanical and electrical interlocks prevent closing the primary contacts while the breaker is being moved.
- Safety shutters open or close over the stationary primary connections in response to the movement of the circuit breaker levering-in mechanism.
- A spring discharge interlock is provided to discharge the closing spring when a breaker is inserted or withdrawn from the cell.
- A breaker interference stop hinders insertion of a unit of incorrect type or rating into the cell. Breakers with equal or higher voltage and current ratings can be inserted; breakers with lower ratings are hindered.
- A breaker roll out stop block is provided to prevent removal of the breaker from the cell until a manual latch on the breaker is depressed.

Fire protection is provided by the location of portable fire extinguishers or through the use of fire protection equipment inherent to the facility.

The voltage levels at buses are to be optimized for the full load and minimum load conditions that are expected throughout the anticipated range of voltage variations of the power source by appropriate adjustment of the voltage tap settings of the intervening transformers.

The electrical supply connections to any equipment are identified on controlled drawings and as follows:

- Where the supplying device is within the 13.8 kV Switchgear Station, the Plant Substation, a local substation or an MCC the appropriate single line diagram identifies the feeder circuit and its connection to upper tier supply boards.

- Where the supplying device is a lighting or distribution panel, a minipower center or local panel board, a switch or a distribution transformer the location should be identified from the equipment list. The low power distribution diagram(s) for that area identify the supplying device.

- In all cases the equipment list contains references to drawings or schedules in which the particular item of equipment and its power supply connections are described.

Medium voltage (1 kV-69 kV) switchgear should be inaccessible to nonelectrical personnel located in areas (such as the Hoist Houses) with controlled access.

The operation and monitoring of the electrical distribution system is performed in accordance with WIPP site operating procedures.

Information on the operating configuration to the Electrical Distribution System is provided to the Central Monitoring Room (CMR) via interconnections to the CMS Local Processing Units (LPUs). Control of select switchgear functions are controlled by these same interconnections. No other instruments are required for the day to day operation.

Other equipment monitoring is performed on individual switchgear via the use of Operational Log Sheets.

2.0 ED01 – 115 kV SYSTEM ELECTRICAL UTILITY

2.1 ED01 – Subsystem Introduction

The Utility substation encompasses an area approximately 160' by 320' surrounded by a 8' fence located adjacent to the East side of the WIPP site. It contains both the 115 kV electrical Utility equipment, subsystem ED01 equipment, and elements of the 13.8 kV WIPP switchgear related to subsystem ED02.

A 24' by 24' control house located south of the north station transformer stand contains operating control and metering panels for system ED01 equipment. These panels relate to the following functions:

- Control and monitoring of the Station Transformer

- Operation of SF6 ring bus breakers, 13.8 kV WIPP feeder breakers, capacitor bank pre-insertion switches, and various disconnect switches

- Utility metering of WIPP power consumption
- Electrical Utility Overload and ground fault protection circuitry

The Utility Substation is located on a ground grid that extends approximately 3' beyond its outside fence.

During normal operation the three-phase electrical power is transmitted to the WIPP Utility Substation via two 115 kV, 397.5 kCM, Aluminum Cable Steel Reinforced (ACSR) transmission cables owned and operated by the Utility. The WIPP Utility Substation is in a 5-breaker ring-bus configuration, which allows either or both transmission sources to be selected to energize the substation.

The incoming power lines connect through two dead end towers to a 2-1/2 in., NPS aluminum, five-SF6 breaker, and ring-bus. The ring-bus connects to the primaries of two 12/16/20 MVA 115-13.8 kV station transformers. The secondary of each station transformer connects to 2-in. IPS, tubular aluminum bus which is run to one of two 15 kV Vacuum Circuit Breakers (VCB). One VCB is located on the north and one is located on the south side of the substation. The load side of the VCBs are connected to two Gang Operated Air Break (GOAB) disconnect switches through 2-in. UPS aluminum tubular bus. Three lightning arresters, one per phase are located on the GOAB switch risers.

Three-phase power is transformed from the 115 kV level to the 13.8 kV nominal distribution voltage via two 12 MVA fan cooled, resistive grounded, delta-wye transformers. Each transformer is connected on its secondary side to a 13.8 kV feeder via a VCB and a GOAB switch. The 13.8 kV power feeders together with control and instrument cables are routed to the WIPP Plant Substation via two below grade duct banks.

Voltage regulation is accomplished utilizing internal transformer voltage regulators and two switchable Utility owned capacitor banks. Use of the capacitor banks in conjunction with the voltage regulators is sufficient to maintain voltage variation within specified limits with 20MVA power delivery to the WIPP.

The neutral of the secondary 13.8 kV wye winding of the station transformer is resistive grounded. The resistor is electrically connected by aluminum tubing to the Utility system ground connector leaving the secondary windings of the transformer.

The interfaces between the Utility, subsystem EDO1 and subsystem EDO2 are at the 13.8 kV cable connection at the GOAB switches, the connection of the neutral ground resistors to each main transformer neutral, and the control cable connections in the electrical Utility control house which are routed to the WIPP Plant Substation.
Revenue class current transformers connected in series with each main incoming feed and 14.4 kV to 120 V potential transformers supply the input to two revenue

meters located in the Utility Substation control house. This revenue meter is coupled to two digital meters located in the Plant Substation. The supplied signals are pulse type and are used to match energy and demand usage with that measured with the Plant Substation meters. The monitored energy parameters are kilowatt-hour and kiloVAR-hour usage. A demand synchronizing pulse is supplied to match the utility beginning and end of the sliding demand window with the Plant Substation meters.

The output of two nonrevenue class digital meters located in the Utility Substation control house supply voltage signals for the north and south bus to the CMR. These signals are routed in control conduit to the Plant Substation Local Processing Unit.

2.2 ED01 – Subsystem design Requirements

Design responsibility of the ED01 subsystem resides with the Utility.

2.3 ED01 – Subsystem Codes and Standards

Responsibility for application of suitable codes and standards for the ED01 subsystem resides with the Utility.

2.4 ED01 – Subsystem Operation and Precautions

Subsystem ED01 equipment is the property of the electrical utility Co., who is responsible for its operation and maintenance.

A one line primary power distribution diagram is contained in drawing series 25-J-065-W.

The two electrical Utility breakers can be opened (tripped) from the CMR for emergency disconnect or from the electrical Utility dispatcher. Status information for these breakers is available at the CMR and the electrical utility dispatch, and can be visually confirmed by WIPP personnel locally (even though access is denied to these breakers). These two breakers can only be closed remotely from the electrical utility dispatch, or by the electrical Utility personnel locally. In order to close these breakers, the WIPP Facility Operations will contact the electrical utility dispatcher and request that they be closed.

Two GOAB switches are accessible by authorized WIPP personnel for lockout and tagout through separate gated yards located on the northwest and southwest ends of the substation. The remainder of the WIPP Utility Substation will not be accessible except to the commercial electrical utility personnel.

Operation of the two GOAB switches located in the WIPP/Utility yard must be done only with its corresponding breaker open, either breaker No. 3340 or No. 3355. Visual confirmation of the status of the breaker must be confirmed by observation of the breaker semaphore.

A minimum distance of 25-foot minimum physical separation between the Utility and WIPP facility ground system must be maintained.

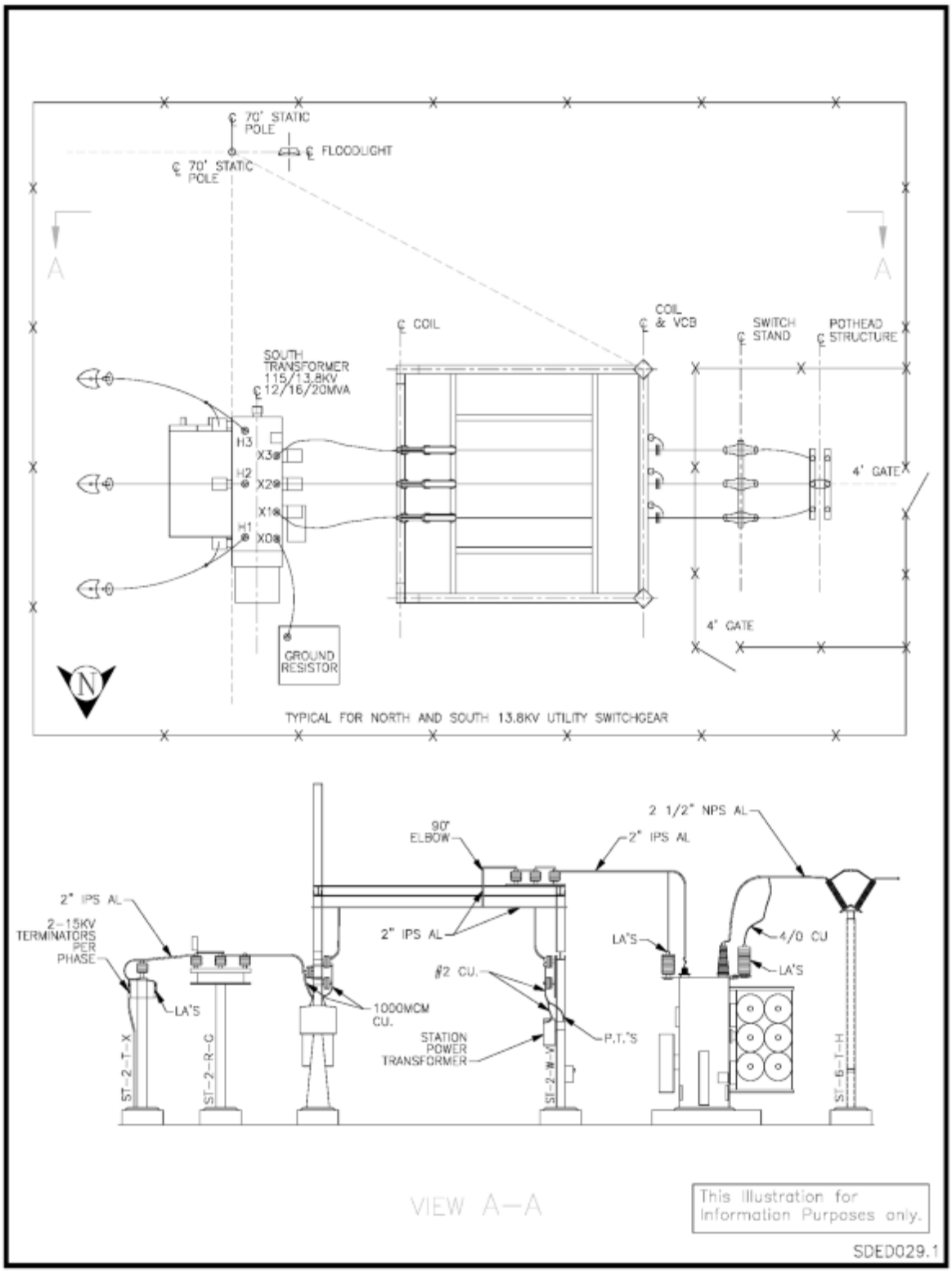

Figure ED01-1 – Utility Substation Equipment Layout

3.0 ED02 – 13.8 kV SWITCHGEAR & EQUIPMENT

3.1 ED02 – Subsystem Introduction

This subsystem comprises the equipment which receives 13.8 kV power from the Utility Switchyard (ED01) and supplies it to lower voltage distribution subsystems (ED03 and ED04). Three 13.8 kV feeders in separate shafts will supply the underground electrical subsystem (ED10) for system redundancy and reliability.

The three principal elements of subsystem ED02 consist of the 13.8 kV power feeders run from the Utility Compounds, the Plant Substation/13.8 kV switchgear, and the 13.8 kV equipment located in the Area Substations. Where this subsystem supplies lower voltage distribution boards or area substations, the transformers and their related control and protection circuitry are included in ED02. The interface will be at the Secondary terminals of the Transformers.

Separate power feeders supply the WIPP Plant Substation from the two SPS 13.8 kV feeder breakers located in the Utility Substation. Power is delivered via 15 kV rated, shielded cables run from the electrical Utility GOAB through a below grade duct bank to the Plant Substation The 13.8 kV cable shielding is grounded at the GOAB switch location at the Utility Substation but is not grounded at the Plant Substation. This location for the shield grounding was selected as the lightning arresters located at the Utility Substation offer greater shield protection. The cable shield is connected on one side only to ensure that the ground separation requirements between the Utility and WIPP ground grids is maintained.

Power enters the substation from an enclosed 15 kV rated bus which connects to the incoming shielded cables on the north outside wall to the Plant Substation. Each feeder is connected to the 15 kV rated bus in separate enclosure compartments to allow isolated access to each feeder. The enclosed bus is brought through the substation north wall overhead to the line side of two vacuum breaker-switches. One vacuum breaker-switch connects to the north bus (25SA) while the other vacuum breaker-switch connects to the south bus (25SB).

The neutral for each transformer is connected to the WIPP owned resistor tied to the electrical Utility power transformer neutrals. The neutral utilizes an unshielded 5 kV rated insulated cable that is run from the resistor connection to each corresponding ground bus in the Plant Substation.

Control cables are connected from the Utility Substation to the Plant Substation through one duct in the below grade duct bank. All control and status connections are first brought into Unit-13 within the Plant Substation and from there to the various control circuits. Control and status connections are routed to an adjacent LPU Wiring cabinet which consolidates all interconnections with the CMR.

The Plant Substation/13.8 kV switchgear is the main distribution bus for providing electrical power to the local area substations on the surface and underground. It contains a 1200 amp, 13.8 kV 500 MVA rated bus (25S) which is subdivided into two subsections, 25SA and 25SB interconnected by a tie-breaker. This tie-breaker may be used to isolate or connect each bus as required.

Nine Plant Substation feeder breakers distribute 13.8 kV power from the Plant Substation to the surface area substations and Underground switching stations. Surface substations have the 13.8 kV first routed to their Load Interrupter Switches (LIS) and then to the substation transformer primary lugs. Fault protection is supplied for each feeder. Protection for each of the substation primary transformer windings is provided either through its respective feeder relaying or through the use of LIS fuses.

Underground 13.8 kV power is fed to the underground switching stations through three separate shafts from the Plant Substation. Each feeder is fault and lightning protected, and utilizes a ground continuity relay.

Alternative 13.8 kV supply feeders, one from each bus of the Plant Sub, are provided to all the surface substations with the exception of Sub 5 and the Salt Hoist Sub. In the event of failure of the feeder breaker from one Bus to the substation a transfer can be made to the feeder line from the second Bus.

The 13.8 kV Harmonic Filter equipment is located in the SH Shaft Hoist House switchyard. It is connected to the 13.8 kV lines supplying ac/dc power converters 38P-PC04/1 & 2 via LIS 38P-SW15/4. Its function is to provide a low impedance path to ground which removes the harmonic currents generated by the rectification process in the converters from the 13.8 kV lines.

The basic configuration used in the filter design is that of a High-Pass filter. The equipment consists of a central 10-ft steel lattice tower with three 10-ft pedestals grouped around it. Three condensers, a surge arrester and a potential transformer are mounted on top of the tower. Each one of the three pedestals carries an air core filter reactor mounted above a resistor assembly.

The filter surge arrester connects the common connection of the low potential terminals of the filter reactors to ground. This surge arrester is mounted on the tower along with a potential transformer which supplies a loss of phase relay located in the hoist control panel.

3.2 ED02 – Subsystem Design Requirements

The 13.8 kV ED02 radial fed distribution transformers shall have minimum specifications as given in Table ED02-1 and as follows:

- All connections to each outdoor transformer shall be brought to a single box with a gasketed cover plate.

- Dial Type thermometers with maximum indicators and high temperature alarms (also fan switching contacts where appropriate) shall be fitted to all liquid-type transformers, and some dry-type transformers.

- Digital Type Winding Temperature Indicator and Controller, with three sensors Type "E" Thermocouples, with three Set Points Low (Fan Activation), High (Local-Alarm), and High-High (Local-Trip), with remote analog signal capability (Output: 4-20 mA) shall be provided to all dry-type transformers.

- Liquid level gauges, max winding temp gauges and coolant pressure gauges are to be fitted in all liquid filled transformers.

- Pressure/vacuum relief assemblies which maintain enclosure integrity in conditions as may occur following severe faults shall be installed in liquid transformers.

- No-load tap changers shall be fitted, with a minimum of two taps above and two below the normal operating tap.

- Indoor transformers shall be dry type unless vaulted per NEC requirements.

Control power in the ED02 system switchgear shall be from 115 VAC nominal or lower.

All medium voltage breakers shall be rated for the available short circuit current for interruption and latch capability.

3.3 ED02 – Subsystem Codes and Standards

ED02 codes and standards are as per applicable listed standards in Appendix F, Supplemental Codes and Standards.

3.4 ED02 – Subsystem Operation and Precautions

A one line primary power Distribution Diagram is contained in drawing series 25-J-020-W. These controlled drawings contain additional information on operations, 480V distribution on both surface and underground, protection, and fault analysis.

Select breakers in the Plant Sub are incorporated into the backup diesel breaker interlock system. Aspects of this system are incorporated into ED02, ED04, and ED09 equipment.

Vendor Publications which describe the various models of ED02 equipment along with their operating and maintenance requirements are enclosed in the manuals for the substations maintained in the Engineering File Room.

The tie breaker together with the two main supply breakers are interlocked with protective relaying to ensure that the two incoming power sources are in sync prior to connecting them together. A sync check enable switch is provided to control this operation.

Normal Plant alignment is with the tie-breaker open and each half the Plant Substation buses supplied power from their respective feeder. However, the electrical distribution system has the capability to operate with the tie-breaker closed to supply power from either one or both sources.

120VAC control power to the Plant Substation 25P-SWG15/1, is provided via two pad-mounted transformers, outdoor liquid-type (Oil), 25 kVA, 13,800 - 240/120V, one for each Plant Sub Bus. An additional 240 - 120V control power supply is available from Area Sub 3 only when either backup diesel generator is excited. Automatic transfer switches located within the plant substation transfer to available control power from Plant Sub Bus A, or Plant Sub Bus B, or Area Sub 3, in that order of availability.

Capacitor trip units in the Plant Sub allow breakers to be tripped in the event of loss of control power. The connection of these units is arranged such that loss of control power de-energizes a relay with normally closed contacts in the trip circuit of each breaker.

Load Interrupter Switches (LIS)

Load Interrupter Types are as outlined in Table ED02-2, operating characteristics are as given below:

- Movement of the Switch operating Handle charges a compression spring which is released when the spring lever goes over a toggle. This snaps the switch open or closed at a predetermined speed.

- An interlock prevents closing of the switch when the front enclosure door is open.

- Where switches form part of a supply transfer configuration an interlock prevents either switch from being closed if the other switch is already closed.

- Positive mechanical Indicator which indicates that the switch is open or closed.

- A viewing window which allows visual confirmation of contact status.

- In the case of Area Substations 3, 4, 5, 7, 8, Support Building Substation, SH Hoist Substation, and U/G Switching Station #2, power fuses are installed in each line to provide selective overcurrent protection.

A revenue pulse is delivered to the WIPP Plant Substation from Utility revenue meters and is used by two digital power meters located in the Plant Substation incoming units to monitor power parameters delivered to the Plant Substation. Revenue class current and potential transformers are located on each incoming line at the WIPP Plant substation. The output of these sensors are used to feed the power parameters to the digital meters.

The following indicators and recorders are a sample of the readouts provided by the electronic meters. These and other readouts may be displayed on the local Modular Graphics Terminal or may be transmitted via communication protocol to a station server:

- Three-phase Voltage
- Three-phase amps
- Power factor
- Instantaneous Power in kW
- Watt-hour meter recorder

These as well as the additional power meter functions which are available over the Local Area Network may be used for trending, troubleshooting, or power quality monitoring utilizing the meter system software.

Digital Power Meters installed on the surface and the underground equipment are part of the WIPP Site Plant Metering System (PMS). For details and references, see drawing No. 25-J-096-W.

TABLE ED02-1 - 13.8 kV Surface Distribution Transformer Ratings

Location	Equip No.	Mft.	kVA @55°C OA/FA	kVA @65°C OA/FA	Sec Volts	Coolant	Wdg	Z %	Wdg BIL kV HV	Wdg BIL kV LV
Sub 1	25P-TR15/1	NOTE 1	1500/1725	1680/1932	480/277	Oil	△/Y	7.8	95	30
Sub 2	25P-TR15/2	NOTE 1	1500/1725	1680/1932	480/277	Oil	△/Y	7.8	95	30
Sub 3	25P-TR15/3A	NOTE 1	1000/1150	1120/1288	480/277	Silicon	△/Y	8.0	95	30
	25P-TR15/3B	NOTE 1	1000/1150	1120/1288	480/277	Oil	△/Y	8.1	95	30
Sub 4	25P-TR15/4	NOTE 1	1000/1150	1120/1288	480/277	Silicon	△/Y	8.O	95	30
Sub 5	25P-TR15/5	NOTE 1	1000/1150	1120/1288	480/277	Oil	△/Y	7.91	95	30
Sub 6	25P-TR15/6	NOTE 1	1500/1680	1725/1932	480/277	Oil	△/Y	7.82	95	30
Sub 7	25P-TR15/7	NOTE 1	2500	2500/3125	4160/2400	Rtemp	△/Y	6.13	95	75
Sub 8	25P-TR-15/8	NOTE 1	1000/1333	AA-DRY	480/277	Air	△/Y	7.43	60	10
Waste Hoist Substation	31P-TR15/1	NOTE 1	1000 (K-9)	AA-DRY	475/274	Air	△/Y	8.1	95	15
Supp Bldg Substation	45P-TR15/1	NOTE 1	1000/1333	AA-DRY	480/277	Air	△/Y	8.06	60	10
S.H. Hoist Substation	38P-TR15/1	NOTE 1	3000	3360/4200	2400	Oil	△/△	6.1	95	45
	38P-TR15/2	NOTE 1	1350/1512	1552/1738	475	Oil	△/△	8.70	95	60
	38P-TR15/3	NOTE 1	1350/1512	1552/1738	475/274	Oil	△/Y	8.87	95	60

NOTE 1. For Transformer manufacturer and specific details, refer to the site equipment register.

Load Interrupter Switches (LISs) provide a 13.8 kV disconnecting means for all Surface Area Substations (SUBs), for all U/G Switching Stations (SSs), and for all U/G Portable Power Centers (PPCs). LISs can be identified in the One Line Diagram drawing set 25-J-020-W, or in each surface/underground switchgear drawing. For Load Interruptor Switch (LIS) manufacturer and specific details, refer to the site equipment register.

4.0 ED03 – 4,160 V & 2,400 V SWITCHGEAR

4.1 ED03 – Subsystem Introduction

This subsystem comprises the equipment which receives 2.4 kV and 4.16 kV, three-phase, 60 Hz power from System ED02 and supplies it to motor loads.

2.4 kV Distribution Subsystem

This subsystem comprises the switchgear and related protective instrumentation required to control the 2.4 kV power supply to the Standby motor-generator set, and an alternate control power source to the SH Hoist via a 300 kVA transformer to the SH Hoist House.

The major components in this group consist of one (1) 3000 kVA 13.8 kV-2.4 kV delta-delta transformer; one (1) 2.4 kV switchgear/sectionalizing unit; and one (1) 300 kVA 2.4 kV-480/277V dekta-wye transformer. These units are located outdoors at the SH Hoist Substation.

The Power center contains two Vacuum Circuit Breakers. These breakers are rated for operation at 14.4 kV and for 400 or 600 amps continuous R.M.S. current. The breakers are fitted with capacitor trip devices and with visual disconnect indication.

As the supply transformer 38P-TR15/1 has delta/delta windings, a delta/wye grounding transformer with zigzag secondary is used to provide a grounded neutral. The potential across a grounding resistor operates a ground fault trip unit for the feeder breakers. Instantaneous and time delayed over current trips are supplied from current transformers located in the breaker output cables.

4160 distribution Subsystem

The 4.16 kV switchgear is located in area Substation 7. This switchgear is supplied via a 2500 kVA 13.8 kV-4160V delta-wye transformer. It consists of electrically operated stored energy type circuit breakers. Control power shall come from a 115V AC supply located in the switchgear.

Control of the three 4.16 kV motors is by full voltage single speed, non reversible starters.

4.2 ED03 – Subsystem Design Requirements

4160 V Distribution Subsystem

The motor starters shall be provided with the following protective devices:

- Thermal Relay (49)
- Phase Sequence Relay (47)
- Motor Protective Relay (MPR) Common Trip

The MPR shall receive inputs from line current transformers, ground current transformers, phase differential transformers and winding resistance temperature detectors (RTD)s and provide the following Starter Trip functions:

- Instantaneous Over current with time delay
- Current Overload trip
- RTD Winding temp
- Locked Rotor current
- Locked Rotor with RTD delay
- Ground Fault current
- Ground Fault Current with time delay
- Phase Sequence

Backup Over current protection for each motor is to be provided by CLS Fuses with time/current characteristics for motor service.

4.3 ED03 – Subsystem Codes and Standards

ED03 codes and standards are as per applicable listed standards in Appendix F, supplemental Codes and Standards.

4.4 ED03 – Subsystem Operation and Precautions

4160 V Switchgear

A schematic diagram of the operation of the Ampgard Starters in conjunction with System VU01 instrumentation and control equipment is contained in drawing 41-J-007-W series.

A detailed description of the 4.16 kV switchgear is provided in Vendor Manual ordered on S.O. 3395-01 P.O. 762 dated 1988.

Detailed information on the MPR and other starter components is contained in the Vendor Manual for Substation 7 ordered on S.O. 3395-01 P.O. 762 dated 1988.

The 4160 switchgear main breaker, CB-1 can be closed only locally. It can be tripped locally or from the CMR where open and closed indication is also available.

The starters can be activated only from the local control panel 413-CP-307-01B in the Exhaust Shaft Filter Building.

Opening of the incoming 4.16 kV breaker shall be detected locally. A common alarm shall be transmitted to the Central Monitor and Control Room.

A voltmeter with three phase selector switch shall be provided at each 4.16 kV switchgear bus to monitor bus voltage.

The breaker is normally opened and closed by the electrical operation of trip coils supplied from a service transformer. A capacitor trip device mounted in each breaker provides stored energy which can be used to operate the trip coil after a loss of control power supply. For maintenance purposes the closing spring can be charged manually using a manual charging crank, also the breaker can be closed and opened by operating manual trip and close paddles on the front cover of the breaker unit. Control power will continue to be supplied in the disconnected position by a plug and umbilical cord. This plug can be disconnected as needed for test or maintenance purposes.

A potential transformer required to provide control power is mounted in a roll out tray located in the cell above breaker CB-1. Primary and secondary disconnecting devices disconnect the transformer from the switchgear when in the withdrawn position. A grounding device contacts the fuses in the withdrawn position. This effectively discharges the transformer, so that the fuses can be safely changed.

Controls mounted on the panels of breakers include a local/remote selector switch and a trip/close selector switch.

5.0 ED04 – 480 V SWITCHGEAR

5.1 ED04 – Subsystem Introduction

Surface (ED04) substations containing this switchgear, provide the basic low voltage power supplies to plant equipment and facilities. They receive 480 VAC normal three-phase, 3 or 4 wire, 60 Hz supply from subsystem ED02 power transformers and supply power to local loads, motor control centers (MCC) and utilization equipment for the ED05 and ED06 subsystems. Typically, larger loads (over ~ 50 kW) are fed directly from feeder breakers in the 480 V substations.

The ED02 Transformer secondary protection is supplied through the use of the 480 V main power circuit breakers that also supply protection for the substation bus. The surface substations continue the electrical distribution via power feeder breakers located in the substation switchgear. Equipment may be either directly

connected to the substation feeder breakers or the power may be supplied to additional low voltage distribution equipment.

5.2 ED04 – Subsystem Design Requirements

Connection from the ED02 step down transformer to the 480 V, outdoor switchgear main breakers shall be by a non-segregated, three-phase, non-ventilated vermin proof metal enclosed bus or transition section, switchgear metal enclosed vermin proof cable bus, or a combination of both.

Under-voltage trips shall be fitted to all Sub 3 breakers except CB-1, 7, 9, 11, and 18.

Siemens-Allis Substations utilize their low voltage Type R Metal enclosed switchgear. The cubicles are comprised of full depth side sheets segregating breaker components from the bus section, from each other and from compartments containing auxiliary secondary equipment.

Where the substations are located outdoors these lineups are enclosed in weather resistant steel housings. An illuminated service aisle is provided at the front of the switchgear allowing inspection and maintenance without exposure to the elements. An access door is provided at each end of the aisle wall with panic bar release inside the aisle. The rear of each cubicle is equipped with a door for access to the primary cable access area and secondary terminal blocks.

All 480 V power breakers use the same spring operated closing mechanism with variations in spring size according to frame size. Breakers are designed for either manual operation or electrical operation.

Electrical operation shall be provided where control functions are required at the CMR. In the case of manually operated units, the closing springs are charged by the use of a charging handle. In the case of electrical units, the closing spring is charged by an electric motor.

5.3 ED04 – Subsystem Codes and Standards

ED04 codes and standards are as per applicable listed standards in Appendix F, Supplemental Codes and Standards.

5.4 ED04 – Subsystem Operation and Precautions

The interconnection of ED04 substations with the Plant Substation is shown in drawing 25-J-020-W series

The schemes and requirements for the Breaker Interlock System are found in drawing series 25-J-TBD-W.

The Sub 3 single line and control schemes are configured as shown in drawing 25-J-015-W series.

General Electric 480 V AKR low voltage power circuit breakers are in use in Substation 6. Substation 6 configuration is covered in drawing 25-J-064-W series. The 480 V circuit Breaker models are listed in the substation layout diagrams included in this Section.

Information on Siemens-Allis 480V Breakers is documented as follows:

- Siemens-Allis Equipment Manual SG3068 provides installation, operation, maintenance and parts information on Type RL Breakers.

- Siemens-Allis Equipment Manual SG3118-01 provides installation, operation and maintenance information on the Static Trip III over current trip system.

The following documents describe Siemens-Allis Switchgear:

- SG-3088 Low Voltage Metal-Enclosed Switchgear Type R
- SG-3368 Switchboard Instruments

The following documents describe General Electric (Substation 6 Equipment):

- Industrial Electric Manufacturing (IEM) Substation 6 Catalog data book

- IEM Drawing 87-DPO-016941 superseded by previous drawing, but contains parts list

Information on General Electric 480 V Breakers is documented as follows:

- General Electric Manual GEA 10265A describes Type AKR Low-Voltage Power Circuit Breakers. It also includes a description of the Micro-Versa Trip Device.

- The status of each ED04 substation main breaker with the exception of Substation 6 and Substation 8 is transmitted to the CMR through LPU connections.

- 120 V, 500 W heaters with non adjustable thermostats are fitted to breaker cubicles. These heaters are supplied from the switchgear control power transformers.

All Substation 3 breakers are electrically operated and may be controlled locally or remotely as follows:

- Sub 3 breakers CB-2, 3 and 4, which supply the exhaust Filter Building Fans 41-BM-860A, B & C, are controlled locally or remotely from the CMR. They can be started and stopped locally in the exhaust filter building at Panel 413-CP-056-01, or from CMR logic signals during a shift to filtration, or from the CMR during normal operation.

- Sub 3 breakers CB-5 and 6 which supply the exhaust filter building services and the Safety and Emergency building respectively can be controlled locally or remotely from the CMR.

- Sub 3 breakers CB-1, CB-12, CB-13 and CB-18 can only be controlled locally.

Sub 3 Bus Tie Breaker Operation

Substation 3 buses 25S3A and 25S3B are connected by its tie breaker CB-9. The tie breaker is normally in the open position. During normal utility power supply conditions the tie breaker can be closed if its interlocking operational limitations have been met. The operational limitations are controlled via CMS software and by hardwired interlocks should the CMS be shut down.

The tie breaker may also be closed during CMS software driven configuration of the substation. The software control program works in conjunction with the Breaker Interlock System (BIS) to ensure that the operation will not be performed when any one of the two backup diesels is connected to the substation. Currently, the software configures the substation from split bus operation to single ended operation.

Sub 3 Tie Feeder Breaker Operation

Tie lines exist between Sub 3 and substations supplying the Waste Handling Facility (Sub 1 and the Support Bldg. Sub). These ties ensure that, even in the event of loss of a transformer, main breaker or both load interrupter switches in any one of these substations, power may be transferred to or from it by its tie feeder connection to Sub 3.

Sub 3 Diesel Generator Feeder Breaker Operation

Operation of breakers CB-7 and CB-11, which connect the diesel generators to Sub 3, is interlocked to their local and remote control by the BIS. A selector switch located in Sub 3 allows one of two interlock modes to be selected. The BIS may be operated from its CMS software, which allows greater flexibility in electrical alignments, or from its hardwired mode.

The BIS software interlock is programmed to disallow breakers to be closed if closing them connects the diesel generators with Utility power. Once a diesel generator has been connected to the electrical distribution system, the software

BIS allows cognizant Operational personnel 15 system lineups based on system experience.

If the BIS hardwired interlock is selected it prevents either of Sub 3 generator breakers, CB-7 or CB-11, to be closed if the tie breaker and either one of the main breakers are closed. If the tie breaker is open, the BIS hardwired interlock prevents CB-7 from closing if the main breaker for the bus 25S3A (breaker CB-8) is closed and prevents CB-11 from closing if the main breaker for 25S3B (breaker CB-10) is closed.

Sub 3 Control Power Supply

Control power is supplied to Sub 3 under normal conditions from two 15 kVA 480-240/120V CPTs supplied from the secondaries of transformers 25P-TR15/3A & B. In the event of loss of utility power, control power for critical functions is available from two 3 kVA 480-240/120 V CPTs supplied from the output terminals of Diesel Generators 1 and 2.

Automatic Transfer of the Sub 3 control load between these CPTs is carried out automatically by Transfer Switch 25-ATR3 located in Section 4 of Sub 3.

Under normal conditions control power is supplied to the switchgear heaters from Bus B and to distribution box 25P-DP03/33, which supplies breaker control power, from Bus A. Loss of either Bus will automatically transfer the load supplied by that bus to the other. In the event of the loss of utility power supply either Diesel Generator 1 or 2 is started up. Currently, only one diesel generator is operated at a time. The diesel that is started will assume through its CPT the control circuit load from distribution Box 25P-DP03/33.

In the event of the failure of the diesel generator supplying control power, the control power load is automatically transferred to the CPT supplied from the other diesel. Excitation of either one of the running Diesel Generators automatically connects a control power supply to transfer control power to the Plant Sub. Control Power is required at the Plant Sub for reconfiguration of its 13.8 kV circuit breakers. Reconfiguration of these breakers is necessary to realign the facility to utilize the backup power.

Table ED04-1 lists the principal characteristics of the surface area substations.

TABLE ED04-1 - 480V Surface Substation Characteristics

Substation Equipment Designator Number		Facility Location Number	BUS No.	BUS contn rating amps	BUS s.c. rating kamps	SWGR Supply
1	25P-SWG04/1	254.1	25S1	3,000	42	NOTE 1
2	25P-SWG04/2	254.2	25S2	3,200	42	NOTE 1
3	25P-SWG04/3	254.3	25S3A 25S3B	2,000 2,000	42 42	NOTE 1 NOTE 1
4	25P-SWG04/4	254.4	25S4	1,600	42	NOTE 1
5	25P-SWG04/5	254.5	25S5	1,600	42	NOTE 1
6	25P-SWG04/6	254.6	25S6	3,000	42	NOTE 1
Support Bldg.	45P-SWG04/1	451	45S1	1,600	30	NOTE 1
8	25P-SWG04/8	254.8	25S8	1,600	30	NOTE 1

NOTE 1. For switchgear manufacturer and specific details, refer to the site equipment register.

6.0 ED05 – 480 V MOTOR CONTROL CENTERS

6.1 ED05 – Subsystem Introduction

Surface (ED05) Motor Control Centers Motor Control Centers (<600 V) comprising this subsystem receives 480 V nominal power from the substations in subsystem ED04. Motor Control Centers generally serve motor loads from 0.33HP to 100HP, and static loads from 1 kW to 100 kW. Intermediate loads (between ~ 10 and 50 kW) located in major buildings are supplied from 480 V Motor Control Centers (MCCs). Larger motors may be supplied when control features are required which are not readily available in 480V substations. Subsystem ED05 supplies subsystem ED06 distribution panels.

Low voltage electrical distribution includes the equipment required to distribute the 480 V electrical power obtained from the substations or portable power centers throughout the surface and underground. The 480 V three-phase power may be directly utilized or further transformed and distributed as either 120/208 V three-phase, or 120/240 V single-phase power. The low voltage distribution interfaces at the point of connection to the final utilization equipment.

The low voltage electrical distribution centers are located and generally selected to ensure that the 480 V loads supplied will not develop voltage drops in excess of 3% without special design considerations such as installing oversized conductors.

All main and feeder breakers are molded case units with thermal magnetic overload trip devices with adjustable set points. Motors are protected by motor overload and ground fault protectors located in the MCCs.

6.2 ED05 – Subsystem Design Requirements

Wiring between the control units and their connected loads is in accordance with NEMA Class 1 Type B requirements. Terminal blocks at the front of each draw out frame connect the external cables to the control unit circuits.

Installation of the external cables shall be installed to allow sufficient slack for the draw-out frame stabs to be disconnected without requiring disconnection of power or control cables.

Each MCC bus shall be provided with 480-120 V potential transformers for control or indication metering and relays.

6.3 ED05 – Subsystem Codes and Standards

ED05 codes and standards are as per applicable listed standards in appendix F, Supplemental Codes and Standards.

6.4 ED05 – Subsystem Operation and Precautions

Power Factor corrective capacitors connected to individual MCCs through molded case circuit breakers provide reactive kVAR.

There are thirteen MCCs located in the principal plant surface buildings which act as distribution centers for loads too small to be supplied directly from the area substations.

TABLE ED05-1 - Surface Motor Control Center Characteristics

Location	Equipment No.	Drawing Ref.	Bus KA	Feed
Waste Hoist Room	31P-MCC04/1	31-J-511-W	22	SB, CB-4
Salt Handling Hoist House	38P-MCC04/2	38-J-021-W	22	Sub5, CB-4
Waste Handling Building Vestibule Ground Floor	41P-MCC04/1	41-J-511-W	22	Sub1, CB-3
Operating Gallery 2nd floor	41P-MCC04/2	41-J-527-W	22	Sub1, CB-4
Mechanical Equipment Rm.	41P-MCC04/3	41-J-512-W	22	Sub1, CB-5
Overpack Area	41P-MCC04/5	41-J-513-W	22	Sub2, CB-5
Mechanical Equipment Rm.	41P-MCC04/6	41-J-514-W	22	SB, CB-3
Exhaust Filter Bldg. 413	41P-MCC04/7	41-J-510-W	22	Sub3, CB-5
Warehouse/Shops Bldg. 453	45P-MCC04/1	45-J-043-W	22	Sub4, CB-2
Water Pump house Bldg. 456	45P-MCC04/2	45-J-515-W	22	Sub4, CB-3
Support Building 451 Elec. Equip. Rm-2nd floor	45P-MCC04/3	45-J-511-W	22	Sub1, CB-2
Elec. Equip. Rm-Grnd floor	45P-MCC04/4	45-J-510-W	22	SB, CB-2
Guard Security Bldg. 458	45P-MCC04/5	45-J-512-W	22	Sub4, CB-5
Facility 254.5	38P-MCC04/5	25-J-063-W	42	Sub5, CB-1

NOTE. For Motor Control Center (MCC) manufacturer and specific details, refer to the site equipment register.

Most MCC Busses are supplied through a manually operated disconnect switch to which are connected an array of control devices. Typically these include molded case breakers, motor circuit protection units and contactor starters along with their associated control, overload and ground fault protection components. Nonautomatic breakers may be used as switches and have trip unit designations of "n/a."

7.0 ED06 – LOW VOLTAGE POWER & DISTRIBUTION (<600 V)

7.1 ED06 – Subsystem Introduction

These subsystems cover all distribution boards, panelboards, switchboards and switchracks installed for control of light and power circuits, less than 600 V, on the surface (ED06). Instrumentation and control circuitry, and equipment directly associated with low voltage power distribution and control are included within these subsystems. Subsystems ED04 and ED05 supply power to ED06.

Subsystem ED06 supplies smaller loads. If located in major surface buildings, loads are supplied from distribution and lighting panels and may be connected to the 480V MCCs. These panels are 277/480V, 3-phase, 4-wire or 120/208 V, either single or 3-phase, supplied via dry type distribution transformers

In some cases local panelboards are used to connect groups of distribution panels. Also, "mini power center" units are used in which a dry transformer is contained within the distribution panel enclosure.

Power Distribution to Trailers and Yard Facilities

Switchracks are distributed throughout the Yard. Switchracks supply power to trailers and miscellaneous outdoor equipment. Switchracks are made up of metal enclosed isolation switches, distribution transformers, wireways and distribution panels mounted on frames at selected locations in the Yard.

Panelboards

All panelboard units are front connected. Each assembly consists of a combined service disconnect and distribution section along with one or two additional distribution sections. Silver-finished copper bus bars interconnect all sections. Top, bottom and side wiring gutters in all sections permit connection of the distribution control units through removable front cover plates.

All distribution and main breakers are molded case units with instantaneous and overload trips with set points. Set points are defined in the single line diagrams for each distribution panel. The main breaker in each panelboard is a molded case unit rated at 400 amps. Ground fault protection is provided by use of ground fault relays which operate shunt trips in the specified distribution breakers. The ground fault relays are mounted on a common panel with a visible pilot light on its cover which monitors the absence of ground faults in all relays.

7.2 ED06 – Subsystem Design Requirements

Lighting and Distribution Panels

Bus bars shall be made of copper with bolted connections. Bus bar connections areas are silver or tin plated.

The main bus in each lighting and distribution panel, along with the main breaker, is to be rated for 22,000 symmetrical amps interrupting or shall otherwise be adequately rated for the symmetrical short circuit amps available.

Molded case circuit breakers are of interchangeable thermal-magnetic design and conform to NEMA standard AB 1. All such units are to be bolt in type, quick-make, quick-break, trip free, and resettable after trip.

Multipole breakers shall be of the single unit type or have a device which connects the operational mechanisms into a single unit.

Main breakers are to be installed vertically with the handle up in the "On" position. Horizontally installed breakers shall have the handle to the right in the "On" position.

Branch circuit breakers used for switching lighting circuits shall be switch duty rated. The circuit breaker shall be listed, or labeled as "swd."

All wire connectors, except screw terminals shall be anti-turn solderless type. Interiors are to be designed so that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connection.

A minimum of 20 percent spare breaker and space capacity is recommended for initial installation of lighting and distribution panels.

Distribution Transformer Design Characteristics

These transformers are to be 600 V class, dry-type, two-winding, self-cooled units designed, manufactured and tested to the relevant IEEE, ANSI and NEMA standards listed in Appendix D of this SDD.

They are to be installed with their nominal rating based on an ambient temp of 40° C.

On units rated 30 kVA and below, the core/coil assembly may be completely encapsulated in a proportioned mixture of resin and aggregate. Encapsulation shall provide a moisture-proof, shock resistant seal. The heavy gauge steel enclosure may be to non-ventilated NEMA 3R requirements.

On units rated above 30 kVA, the core/coil assembly may be impregnated with non-hygroscopic, thermo-setting varnish. The assembly may be installed on vibration-absorbing pads and securely bolted to the base to minimize sound transmission. The heavy gauge steel enclosure may be ventilated to meet Nema 2 requirements.

All transformer enclosure temperatures are not to exceed 90° C.

All transformers are to be equipped with a termination compartment suitable for conduit entry and convenient wiring.

7.3 ED06 – Subsystem Codes and Standards

Lighting and Distribution panels are designed and built in accordance with the requirements of the National Electric Code (NEC) and NEMA standards PB.1 and PB1.1.

7.4 ED06 – Subsystem Operation and Precautions

There are four panelboards in Subsystem ED06 which are located and described as follows:

Number	Building	Location	Drawing No.
45P-DP04/1	Support Building	1st Fl Elec Rm	45-J-044-W
45P-DP04/2	Support Building	2nd Fl Elec Rm	45-J-044-W
41P-DP04/3	Waste Hndlg Bldg	Mech Equipment Rm	41-J-512-W
41P-DP04/4	TRUPACT Maint Fac	1st Fl N Wall	41-J-516-W

A tag with the panelboard equipment identification number is to be located on the front of each unit.

The voltage levels in 120/208 VAC and 277/480 VAC power and lighting distribution panels can be adjusted by rewiring to alternate tap connections in the transformer connection boxes.

Critical services in the EOC can be supplied through UPS 45P-UPS03/5. Normally this UPS is bypassed. In the event of activation of the EOC the UPS is immediately put into operation.

8.0 ED07 – GENERAL LIGHTING, RECEPTACLE & UTILIZATION EQUIPMENT

8.1 ED07 – Subsystem Introduction

This subsystem provides power for general lighting, receptacle and utilization equipment on the surface (ED07). Equipment required to perform these functions includes lighting control equipment, lighting fixtures and receptacles.

120/208 V, one-phase and three-phase receptacles, sized to the work being accomplished, shall be provided as required.

480 V, three-phase receptacles, sized to the work being accomplished, shall be provided in welding areas and elsewhere as required.

120 V duplex receptacles shall be provided in office areas, lobbies, restrooms and in areas where portable equipment may be used.

Lighting Requirements

The lighting subsystem is subdivided according to two functional classifications. Normal, and Standby lighting. Any of the particular lighting equipment inclusive of lighting in ED16 and ED17 subsystems may be subject to more than one set of these functional requirements.

Normal lighting provides illumination to perform tasks and safe movement from the normal utility power sources.

Standby lighting provides illumination to perform tasks during loss of offsite Utility power. Example areas where standby lighting is employed include the CMR, Emergency Operations Center, Waste Handling Building and also those areas in which medical and decontamination services operate, and areas needed for maintenance of security.

8.2 ED07 – Subsystem Design Requirements

Convenience receptacles shall be designed for a load of approximately 3 amps each for general office areas and approximately 8 amps each for laboratory and shop areas

Luminaries Selection and Design

The plant lighting systems shall provide illumination of plant facilities to meet the following design objectives:

In large, high ceiling areas (i.e., height greater than 10 feet) where there are no mercury restrictions, high intensity discharge (HID) or Inductively Coupled Electrodeless (ICE) fluorescent luminaries may be used.

In areas where HID or ICE fluorescent luminaries cannot be used, linear fluorescent or incandescent luminaries shall be used; however, the use of fluorescent luminaries shall conform to the same provisions for enclosure and maintenance that are required for HID luminaries. Choice of incandescent or fluorescent shall be based on efficiency, economic evaluation of capital cost, maintenance cost, and reliability.

Luminaries for in-plant installation shall not have any polyvinyl chloride parts. Any materials used shall not have a flame spread rating less than or equal to 25 (refer to ASTM E 84).

Luminaries for indoor plant illumination shall be designed and/or installed to minimize glare. Luminaries shall be mounted as high as practical.

All indoor type luminaries shall be semi-direct, if possible, with a 10% upward component to provide illumination of piping, cable trays, ducts, and values which may be located above the luminaries and require identification and/or inspection. All indoor type luminaries, except those enclosed and gasketed, shall be the ventilated type to minimize collection of dust on lamp and reflector, where practical.

For general requirements, fixtures shall be of standard, high-efficiency, commercial grade. Emphasis shall be placed on energy-efficient fixtures, selected on the basis of minimum life-cycle costs and satisfaction of visual task requirements.

For lighting fixtures with ballasts, the ballasts shall be UL listed, thermally protected, and shall conform to CBM-ETL (Certified Ballast Manufacturers Electrical Testing Laboratory) requirements.

The construction of luminaries shall be suited to their environment (e.g., maximum ambient temperature, humidity, corrosive atmosphere, radiation dose) and designed to minimize the effects of these conditions on performance, reliability, and life. In areas classified as hazardous in NEC.500 (paint storage rooms, paint booth, etc.) lighting fixtures with a class I, group "D" rating will be used.

Luminaire lamps which are regularly subject to abnormal vibrations shall have vibration-proof sockets and vibration service lamps.

Normal Lighting

Area and task lighting levels should originate from IES recommendations. Supplemented or reduced light levels are acceptable for specific task needs. Where higher illumination levels are required, consideration shall be given to providing local or task-supplemental lighting to minimize general overhead lighting requirements.

The plant illumination levels shall be considered the average illumination level at the floor elevation of the area or cell. In order to achieve uniform illumination, the spacing-to-mounting-height ratio shall be as close as possible to that recommended for the type of luminaries used. In local areas where the lighting level may not be uniform or a higher average lighting level is required, supplemental luminaries shall be provided.

The permanently installed normal lighting system levels of illumination shall not necessarily account for illumination required for maintenance operations. In normally inaccessible, radioactive cells temporary lighting shall be utilized when cells are accessed. In all other areas of the plant power distribution system shall provide receptacles at strategic locations to supply temporary maintenance lighting, if required.

In offices and administrative areas of the plant (including the CMR), the normal lighting system shall be designed to be conducive to tasks performed in those areas. Attention to glare shall be of greater importance in these areas than in the process areas of the plant. The luminance ratio in office and administrative areas shall be minimized within practical limits.

The design of the lighting system in offices and administrative areas shall minimize veiling reflectance on task surfaces by strategic placement of luminaries, proper selection of diffusing media, and/or use of supplementary lighting.

The normal interior lighting system; shall be designed for a high degree of availability. In inaccessible cells, where remote viewing devices are used, spare luminaries, normally off, shall be provided to allow for lamp blowouts throughout the design life of the plant. Accessible luminaries shall be located to facilitate ease of maintenance and relamping operations where practical.

In cases where it is expected that lighting will be frequently switched on and off, conveniently located switches shall be provided, otherwise lighting shall be switched by manual operation of circuit breakers at the lighting panel or by an automated control system. Outdoor lighting shall be controlled by photocells.

Lighting Systems Electrical Design Criteria

At the surface service voltages for lighting fixtures shall be 120 V or 277/480 V.

High Intensity Discharge Lamps

Sodium vapor lighting may be installed indoors in hot cells, shops and some offices. It may be used outdoors for perimeter, building access and roadway lighting.

High-pressure sodium vapor type lamps are to be procured on the basis of an anticipated average rated life of 24,000 hours with an assumed start every 10 hours and a ±10 percent voltage fluctuation. Lenses may be the glass reflector type where the glass is tempered, laminated or double strength clear glass

Globes may be made of high-impact, heat resistant, prismatic ribbed glass.

All exposed hardware on lamps mounted outdoors is to be 300 Series Stainless Steel or higher for corrosion resistance. In the case of outdoor luminaries the entire assemblies should be capable of withstanding the salt spray test specified in ASTM B 117. Lamp holders are to be heavy duty units specified to be dust and moisture proof. The housing features described for the HID lamps are also applicable to ICE luminaries.

All HID ballasts are to be high power factor (>90%) and incorporate non-PCB capacitors. They are capable of starting the lamps at the lowest ambient temperature wherever located.

Fluorescent Light Fixtures

Ballasts are of the rapid-start, high power factor, energy conserving type. All ballasts are to be capable of starting their lamps at the least favorable ambient temperature applicable to their location. Full electronic ballasts with ratings for high power factor, low total harmonic distortion, ballast factor greater than 1.0 shall be provided for new and retro-fit projects.

8.3 ED07 – Subsystem Codes and Standards

Lighting installations shall be designed using the following design guidelines

Illuminating Engineering Society, "IES Lighting Handbook"

Illuminating Engineering Society, RP-7 "American National Standard Practice for Industrial Lighting" (ANSI A11.1)

Illuminating Engineering Society, RP-7 "American National Standard Practice for Office Lighting" (ANSI A132.1)

UL 57 (Lighting Fixtures) and UL 1029

CBM-ETL (Certified Ballast Manufacturers Electrical Testing Laboratory) requirements.

ASTM E 84 Flame Spread Ratings

ASTM B 117 Salt Spray Test

Plastics used as light-diffusers shall conform to the requirements of the Standard Building Code, Section 2606.1.

Ballasts are provided in accordance with the requirements of UL 935 class P

All Fluorescent lenses or light diffusing panels may be 100 percent virgin methyl-methacrylate in accordance with ASTM D788. They are to be nonburing, self-extinguishing, or slow burning when tested in accordance with ASTM D 635.

The preceding documents reflect general design practices which may not be adequate in specific applications. Cognizance shall be taken of architect/engineer experience and practices in developing the lighting systems criteria and design. Where the specific criteria of this SDD deviate from these documents, the SDD shall take precedence.

8.4 ED07 – Subsystem Operation and Precautions

During normal operations the standby lighting will be fed from the offsite utility power through designated supply circuits. Following loss of the utility power, the backup diesels generators will be started up and the designated standby lighting circuits will be transferred by the operator to this source of power. Standby lighting, and the diesel supply arrangements for them, are as follows:

Location	Equipment	Sub/Dp
Waste Handling Building	41P-MCC04/6	SB, CB3
Perimeter Lights (Partial)	41P-MCC04/6	SB, CB3
CMR Lighting	45P-DP03/17	45P-DP03/15
	45P-MCC04/3	Sub 1, CB2
EOC Lighting	45P-UPS03/5	Sub3/Sub 1
	45P-DP03/3	Sub 3/Sub 1

9.0 ED08 – CENTRAL UNINTERRUPTIBLE POWER SUPPLY (UPS)

9.1 ED08 – Subsystem Introduction

The Central UPS receives its normal 480 VAC, three-phase supply from the Support Building Substation via a Switchboard and an Automatic Transfer Switch. The Central UPS also can receive alternate 480 VAC, three-phase supply from Area Substation #1 via a Motor Control Center and via same Automatic Transfer Switch mentioned above. The Central UPS is rated to deliver 100 kVA/80 kW, 208Y/120 VAC, three-phase, 60 cycle, 278 Amps maximum supply to essential loads.

Upon failure of normal Utility power, the Central UPS System will automatically transfer to battery power. The battery banks are designed to supply the full rated capacity of the UPS unit load for a period of not less than 30 minutes. The 30-minute requirement is based on the maximum anticipated start-up time for the backup diesel generators. Start-up of at least one diesel will allow power to be restored to Substation 3, the Support Building Substation, and Area Substation #1 from which the battery charger and inverter can be fed.

The UPS consists of a main input breaker, an input filter, a rectifier/battery charger, two battery banks, inverter, output isolation transformer, and distribution circuit breakers. During Normal operation utility power is input to the rectifier/battery charger to maintain the two battery banks, and power the inverter feeding the output isolation transformer and distribution breakers connected to loads requiring a UPS supply. The output of the inverter via an isolation transformer is directed to the various ED08 essential distribution panels via UPS distribution breakers, and via two Manual Transfer Switches.

9.2 ED08 – Subsystem Design Requirements

The power supply circuits to the inverters shall include devices which provide protection against internal faults. Similarly current limiting circuits shall be incorporated in output circuits to protect against overloads. An Alternate 480 V source shall be provided to supply the UPS Loads. Maintenance Bypass Switching shall be provided to manually switch the load from the inverters to the alternate AC source without interruption of service. This will enable maintenance work to be performed on the inverter, chargers, battery and static transfer switch.

Static Transfer Switches shall provide automatic transfer of the loads to alternate AC power with no interruption of power. Maximum transfer time shall be 4 milliseconds.

Distribution Panels shall be three-phase 4 wire with a main breaker or main lugs. The number of branch circuits and interrupting capacity shall meet system requirements.

The Inverters shall be sized for a capacity which allows power to be supplied to the loads continuously plus 25% spare capacity.

The Battery Charger shall have the capacity to supply 100% full load power to the inverter and recharge the batteries.

The Batteries shall have the capacity to deliver full inverter output for 30 minutes. Thirty minutes is based on the anticipated start-up time for the diesel generators.

Each inverter shall be furnished with integral instrumentation such as:

- AC output volts, amps, frequency, and over temperature alarms
- Indicators and controls for the static transfer switch, which monitors position, synchronization and alternate source status

The rectifier/battery charger - rectifies ac input to dc for maintaining battery charge and consists of a main ac input circuit breaker which provides mechanical isolation and electrical protection for the input to the UPS. The regulation is carried out by controlling the conduction angles of the power module's internal silicon-controlled rectifiers, allowing the rectifier/battery charger to supply a stable dc voltage (within ± 1%).

The dc voltage is to be filtered by a capacitor bank; and a dc shunt which monitors the battery charger current. The microprocessor regulates the dc current at the desired level. Battery current is normally limited to 10% of the Ampere-hour (Ah) rating of the battery string.

The input auto-transformer shall match input source voltage to that required internally by the UPS.

An output transformer shall provide the required output voltage for attached loads.

9.3 ED08 – Subsystem Codes and Standards

Requirements for System ED08 shall comply with NFPA 70 and IEEE 446.

9.4 ED08 – Subsystem Operation and Precautions

Drawing 45-J-095-W series illustrates the principal features of the Central UPS (45P-UPS03/2). This drawing covers the essential loads and system boundaries with the ED05 and HV03 subsystems.

The Central UPS System is located in the Support Building power equipment room along with its associated equipment which encompasses the UPS, manual and automatic transfer switches, power conditioner, disconnect switches, and distribution panels. Control of UPS Equipment is performed locally in the Support Building electrical room.

The alternate 480 VAC, three-phase power source to the Central UPS is provided through an automatic transfer switch supplied from Substation #1 through ED05 MCC equipment.

Upon complete loss of site power the Central UPS located in the Support Building will supply power to essential and computer loads. Three-phase, 480 V alternating current (VAC) voltage, is fed to the input section of the UPS where it is converted to direct current voltage (DC). The converted DC voltage is applied to charging the UPS battery bank and is applied to the output inverter to supply the 480 VAC, three phase output of the UPS.

The UPS may be bypassed through the power conditioner by selecting the alternate of two manual transfer switches which are normally connected to the output of the UPS. The power conditioner receives its power from Substation #1 through the same ED05 MCC equipment supplying the UPS. The UPS has an internal by-pass breaker which may be selected to circumvent the UPS rectifier and inverter. This supplies utility power directly to the output of the UPS.

The Central UPS status shall be displayed and annunciated in the CMR. Parameters to be monitored include UPS on line, UPS on battery, and a summary alarm.

A system status and control panel (SS&CP) provides controls to select system operation, and indicators that allow system performance to be monitored. A liquid-crystal display (LCD) is used to display system operating parameter; provide step-by-step operating instructions to the system operator; and provide a diagnostic capability with instructions to assist in troubleshooting in EPS monitor software.

The UPS programmable controls (excluding circuit breakers and nonautomatic switches) are located on the SS&CP. Specifics of the control features are described in the EPS-2000 O&M manual.

Modular construction of the Central UPS facilitates maintenance of the system.

The UPS shall have the following checks carried out on at least a monthly basis:

- All indication lights and alarms operative
- Acceptable battery charge and discharge rates
- Correct operation of the static transfer switch
- Periodic checks on batteries, fuses, and the cooling air system, including filters, should be carried out according to manufactures instructions.

The UPS System will supply the following equipment located in the Waste Handling and Support Buildings:

- Central Monitoring
- PA and Intercom
- LPUs
- Radiological Monitoring
- Analytic Chemistry Laboratory Instruments
- Central Computer Network System

The Central UPS System provides power to essential and computer loads as shown. Uninterruptible power supply requirements in other locations are met by individual local units whose design requirements are included in those of the systems they serve.

Essential Load	Bldg.	Room	Computer Load	Bldg.	Room
45-P-DP03/15	451	116	45P-DP03-71A	451	229
41P-DP03/10	411	121	45P-DP03-71B	451	229
41P-DP03-11	411	211			
45P-DP03-17	451	229			

10.0 ED09 – BACKUP DIESEL GENERATORS

10.1 ED09 – Subsystem Introduction

Scope of this subsystem includes the generator units, controls, fuel tank, feeders, switchgear and load bank system.

Backup power is supplied via one of two 277/480V, three-phase, 60 Hz on-site diesel generators. A select load list is supplied power up to 1100 kW of continuous power via connection of one of the diesels. These generators are located in two separate outdoor modular enclosures along with necessary controls, fuel tanks, feeders and cooling systems. A block diagram of a diesel generator enclosure layout is shown in figure ED09-1.

Only one diesel at a time is allowed to run with the remaining diesel as backup, should the initial diesel fail to start or maintain load. The selected diesel supplies power first to Area Sub 3 and then to select loads either directly or by back feeding through the substation transformers to the 13.8 kV distribution system.

Either a computer based or hardwired interlock systems may be selected to ensure that the Utility power will not be inadvertently connected to the diesel power when the diesel is being used. The hardwired interlock system is automatically selected should the computer based interlock system fail.

Each enclosure contains all auxiliaries required to start, load and operate a diesel generator set. These comprise:

- A 16 cylinder diesel with an electric governor and loading device coupled to a 480 V three-phase generator with brushless exciter.

- A switchgear cubicle which contains generator control circuits, a main circuit breaker, switches and metering transformers and indicators.

- A battery, with a connected charging system, for providing power to the controls and diesel starter motors.

- Diesel engine instrumentation contained in a gauge panel and a control panel which includes auto-start system, protective devices, indicators and sequencing controls.

- The engine cooling system includes a fan cooled water radiator, oil cooler and inlet air after cooler heat exchangers, four unit temperature regulator, instrumentation, piping, and a fan.

- A fuel system which consists of a day tank located under the enclosure floor, a turbocharger mounted on the diesel, interconnecting piping and operating valves injectors, return fuel lines, and gauges. A 500-gallon bowser containing reserve diesel fuel is parked at a short distance from the enclosures.

- Clean combustion air from filters is supplied through dual in line turbocharger systems located on top of the engine. The air is thereby compressed, passed through an after cooler, and into an inlet chambers in each cylinder head.

- Exhaust gases leaving through the exhaust valves are passed into two exhaust manifolds. From there they are directed into the two turbines on the shafts which drive the compressors discussed in the previous paragraph prior to being exhausted.

Load Bank System

A resistive load bank is provided which consists of 480 V switchgear and a load bank. The system is used to support regular scheduled testing of backup diesel generators at any time, without disturbing normal site electrical lineups.

The 480 V switchgear load bank equipment is used as a junction point between backup diesel generators, area substation #3 and the load bank. The switchgear is mounted in a free standing steel enclosure, which in turn is mounted in a walk-in shelter. The switchgear enclosure is divided in seven sections which together with kirk-key interlocked disconnect switches, 480V bus, and auxiliary control devices connects each generator to the Sub 3 breakers and to the load bank.

10.2 ED09 – Subsystem Design Requirements

The incoming 480 V breakers connecting the diesel generators to their distribution boards shall be tripped on over current, ground fault, and phase reversal.

Total fuel storage capacity at the WIPP Site shall be sufficient for the operation of the generator at full load for 1 day. Additional supplies shall be available within a few hours by tanker truck.

The system shall be rated so that, when account is taken of the 80% load factor recorded for the select loads, each diesel generator can, by itself, supply the total load.

The battery and a charger shall be located along with the engine control panel.

The lubrication system for the diesel engine shall have an engine driven circulation pump.

A fast response, static type exciter and voltage regulator shall be provided for the generator unit.

A suitable filter and silencer shall be provided for the engine air intake and a muffler shall be provided for each engine exhaust.

The diesel generators shall have an engine control panel mounted on the engine and a generator control panel located adjacent to it. These panels shall allow local control and monitoring of the system with supervisory information

transmitted remotely. A system test switch shall allow local testing to be carried out when the engine mode selector switch is in the auto remote start position.

The following devices shall be included as a minimum on the engine control panel:

- Start-stop and test switches
- Pressure gauges and temperature indicators, as required
- Tachometer, engine overspeed, low lube oil pressure and other mechanical protection indicators, emergency stop

The generator control panel will include the following devices as a minimum:

- Main generator breaker with thermal overload protection
- Control switches and indication lights
- Ammeter and voltmeter with selector switches
- Wattmeter and varmeter
- Engine speed and load control devices
- Voltage control instrumentation
- Engine load testing instrumentation

The following alarms shall be provided both remotely (the CMR) and on the local generator control panel:

- Generator started alarm
- Generator trouble alarm
- Generator test alarm

Generator Breakers (CB-G1 and CB-G2) shall be protected by over current, ground fault, and phase reversal. Additionally, each circuit breaker is to be opened by a common trip from its supplying diesel engine. The common trip is activated by the following engine conditions:

- Overspeed
- Low Oil Pressure
- High Water Temperature
- Emergency Stop

An electric protective system shall be provided which activates alarms and where necessary shuts down the diesel if any of the following failures occurs:

• Overspeed	Shuts off inlet air and fuel
• Low oil pressure	Shuts off inlet air and fuel at a low oil pressure which is a function of speed

- High Water temp — Shuts off fuel
- Crank overspeed — Disengages starter motor pinion if crank over speeds
- Engine Reversal — If tachometer speed sensor shows reversal - shuts off fuel

The load bank shall be of the resistive type, permanently mounted, fee standing, vertical exhaust, forced air cooled, rated for 1200 kW, 480 VAC, three-phase, 60 HZ, 50 kW resolution with local and remote control panels, and digital metering capabilities.

10.3 ED09 – Subsystem Codes and Standards

The overall requirements for subsystem ED09 shall comply with NFPA 70 and NFPA 110.

Exhaust noise levels shall be in accordance with the Federal Noise Regulations of OSHA 29 CFR Part 1910, "Occupational Safety Health Standard, Subpart O."

10.4 ED09- Subsystem Operation and Precautions

Drawings 25-J-071-W and 25-J-072-W series cover the system interfaces, set points, spare parts, and configuration of the generator units.

The diesel breaker interlocks are covered in the Breaker Interlock System (BIS) drawings 25-J-099-W series.

Start-up and shutdown of this subsystem may be performed either locally or at the CMR. The local operating controls are contained in two units: the Engine Control Panel mounted on the generator, and the free standing Generator Control Cubicle. The Engine control panel contains an automatic diesel start-up and protection system. It has a three position engine mode selector switch labeled as follows: Manual Local Start, Off/Reset and Auto/Remote start. For operation from the CMR the switch is set in the Auto/Remote Start position.

Each diesel generator is to be started and electrically loaded to nominally 50% of rated capacity once each month.

Loading and Load shedding will be performed manually by plant operators at the substations where control equipment is located. The diesel generators shall have the capability to be brought on line within 30 minutes. Backup power loads can be connected to the diesel generators either through the Plant Sub or through the ties and LISs which interconnect the Area Subs.

Table ED09-1 provides a sequential list of all the loads that may need to be connected to the backup diesel generators following loss of utility power. The sequence described is tentative and would be varied to accommodate the status of the facility at the time of the incident.

The Generator Control Cubicle contains all electrical controls and protective devices required for the start up and operation of the generator, and for its connection to Bus 3A or 3B. A key locked auto Start Mode Selector Switch integrates the electrical controls with the diesel start-up circuitry. This switch is kept in auto for both local and CMR start-up.

Before start-up the voltage regulator switch inside this cubicle should be at off position and the governor speed control (also inside the cubicle) should be at idle. After start-up the governor speed control should be switched to rated speed and the voltage regulator switched on by local operations. During normal operation the only actions performed from the Generator Control Cubicle are voltage and frequency adjustment. Engine speed, and thereby frequency, can be set to the required value by adjustment of the governor set point. This is performed by the use of the frequency control on the Generator Control Panel. A voltage control on the same panel allows exciter output to be adjusted to provide required terminal volts.

Automatic Voltage Regulator Controls inside the switchgear cabinet include a gain control and a voltage droop control. An adjustment control is provided on the front panel of the cubicle which allows ±5% variation in alternator volts between no-load and full load. A droop potentiometer is supplied which enables the droop of speed with load to be adjusted. A speed trim potentiometer located on the front panel allows speed to be adjusted through ±4% (or ±2.4 Hz).

The lower compartments in the Switchgear cubicles contain the main breakers CB-G1 and CB-G2. These 480 V breakers are air-break metal-enclosed draw-out units and are designed for both manual and electrical operation. In the case of normal electrical operation the spring is charged automatically when control power is connected to the breaker. Where manual operation is required the closing spring is tensioned by the use of a cranking handle on the front of the unit.

The breaker can be closed and tripped open by the operation of a control switch on the front panel of the switchgear cubicle. The status of the breaker is displayed on the generator control panel with pilot lights.

The protection functions are performed by transmitting trip function requirements from the engine control panel to the governor controller. Here they are applied as signals which cause the actuator to take the necessary protective action.

Each generator supplies a single phase, 3 kVA, 480-120/240 V control power transformer. These units are connected to Sub 3 control power system by Transition Switch ATR3 which is located in Sub 3.

The 480 V Load Bank switchgear interlocks include a kirk-key interlock between the two disconnect switches for the load bank system, to allow only one switch to be closed at one time.

Generator Breaker Interlock System (BIS)

A breaker interlock switch located in Substation 3 enables and disables a software/hardware based breaker interlock system (BIS). The BIS is designed to fail-safe to a hard-wired interlock. Interlock requirements are designed to keep the incoming Utility power from being connected to the on-site backup diesel generator power.

The software interlock system evaluates the status of Plant Sub breakers CB-4, CB-7, CB-9, CB-12, and CB-13, Sub 3 breakers CB-7, CB-8, CB-9, CB-10, and CB-11, and backup diesel generator breakers CB-G1 and CB-G2 to determine if an "enable" or "disable" close signal is to be sent to the appropriate breaker. If the system determines that separation exists between the utility and backup diesel power, it will "enable" the close capability of the appropriate backup diesel generator breaker and its corresponding Sub 3 breaker (CB-7 or CB-11) which then may be closed to connect the generator power to the Sub 3 bus.

Once a backup diesel generator is connected to Sub 3, the BIS software ensures that regardless of electrical distribution realignment, a breaker configuration will be maintained which keeps the utility and generator power separated. The BIS maintains this separation by disabling the close capability on the necessary breakers. With a diesel connected to Substation 3, any and all of the interlock breakers listed above can be closed except for any that are maintaining the Utility and backup diesel power separation. By opening breakers in the interlock scheme not maintaining the separation, it is possible to close a previously close-disabled breaker if the opened breaker will maintain the power separation.

If the software interlock system is disabled then the hardwired interlocked breakers are Plant substation breaker CB-12 and CB-13, and Substation 3 breakers CB-7, CB-8, CB-9, CB-10, and CB-11. If either plant substation breaker CB-12 or CB-13 is closed then the hardwired interlocked substation breakers are close-disabled as follows:

- If Sub 3 breaker CB-8 is closed and breaker CB-7 is mechanically closed, it will trip open.

- If Sub 3 breaker CB-10 is closed and CB-11 is mechanically closed, it will trip open.

- If Sub 3 breaker CB-7 or CB-9 are closed, then breaker CB-8 will be close disabled.

- If Sub 3 CB-11 or CB-9 are closed, then CB-10 will be close disabled.

With the hardwired interlock enabled plat Sub breakers CB-12 and CB-13 will both be close disabled.

- If Sub 3 breakers CB-10 and CB-11 are closed.
- If Sub 3 breakers CB-8 and CB-7 are closed.
- If Sub 3 breakers CB-8, CB-9, and CB-11 are closed.
- If Sub 3 breakers CB-7, CB-9, and CB-10 are closed.

TABLE ED09-1 - Diesel Generator Loads Under Backup Power Conditions

SEQUENCE	DESCRIPTION	RATED kW	SUPPLY CONNECTION		
			SUB	CB	Local Dist
1	U/G Filter/n Exh Fan (235HP)				
	41-BM-860A, B or C	188	Sub 3	CB-2,	3 or 4
	Control Power for motors			CB-5	41P-MCC04/7
2	Uninterruptible Power System	72	Sup Bldg		
	Central Monitoring System			CB-2	45P-MCC04/4
	WHB Continuous Air Monitors			CB-2	45P-MCC04/4
3	Communications Systems	16			
	WIPP Site Telephone Hut		Sup Bldg	CB-2	45P-MCC04/4
	GTE Telephone Hut		Sub-5	CB-2	Sw/rck24P-SWR04/1
4	CMR HVAC	20	Sup Bldg		
	Motors 45-BM-130 and 136 or			CB-2	45P-MCC04/4
	45-BM-131			CB-2	45P-MCC04/4
	45-BM-137		Sub 1	CB-2	45-P-MCC04/3
5	WHB Cranes	80	Sub 1	CB-3	41P-MCC04/1
				CB-4	41P-MCC04/2
6	WHB Exhaust Fans	100	Sup Bldg		
	Motor 41-BM-805 or 806 and			CB-3	41P-MCC04/6
	Motor 41-BM-816 or 817			CB-3	41P-MCC04/6
	Cntrl Power for motors			Sub 2	CB-8 41P-DP04/3
7	WHB Lighting	45	Sup Bldg	CB-3	41P-MCC04/6
8	Fire Prot in WHB & Sup Bldg	30			
	411-FP-01132 (WHB)		Sup Bldg	CB-3	41P-MCC04/6
	451-FP-01132 (SB)		Sup Bldg	CB-2	45P-MCC04/4
	451-FP-08941 (SB-CMR)		Sub 1	CB-2	45P-MCC04/3
9	Main Air Compressor (200HP)	160			
	Motor 41-GM-021A or B		Sub 2	CB-5	41P-MCC04/3
	Drier 41-K-001		Sub 1	CB-5	41P-MCC04/5
	CW System 41-G-041		Sub 1	CB-5	41P-MCC04/5
10	Guard and Security Building	35	Sub 4	CB-5	45P-MCC04/5
11	Air Int Shaft Hoist (400HP)**	330	Sub 6		
	Hoist Motor			CB-3	DiscSw 33P-HM04/1
	Cntrl & Services for motor			CB-5	Sw/rck33P-SWR04/1
12	U/G Essential Loads	100	Configuration according to WP 04-ED1631		
13	WHB Vacuum Pumps	50	Sup Bldg	CB-3	41P-MCC04/6
*	Fire Pump (200HP) 45-G-601	160	Sub 4	CB-6	Controler 45-GS-601
*	EOC in Sfty & Emgcy Serv Bldg	10	Sub 1	CB-9	45P-DP04/27

* Would be connected whenever required

** Includes S.H. & Waste Hoist Dynamic Lowering Loads

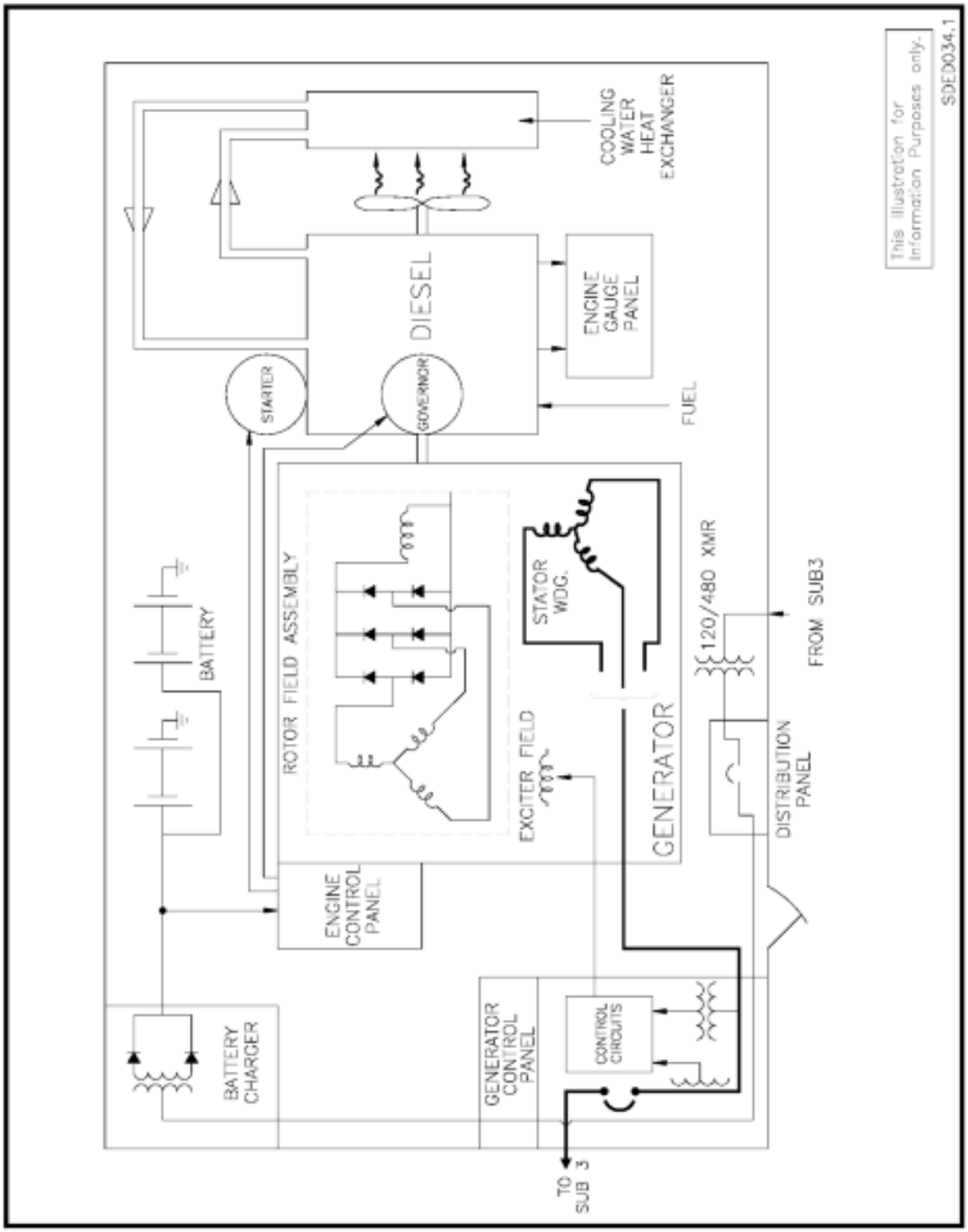

Figure ED09 -1 - Backup Diesel Generator Enclosure Layout

11.0 ED10 – 13.8 kV U/G SWITCHGEAR EQUIPMENT

11.1 ED1 - Subsystem Introduction

This subsystem interconnects with the main surface 13.8 kV system ED02 and provides a 13.8 kV power source for use in the underground mine.

Power is transmitted underground via two feeders mine power cables (3-Conductors, 15 kV, 90°C, Type MP-GC). Cables are located in two shafts: the Salt Handling (SH) Shaft, the Waste Handling (WH) Shaft. Three interconnected 13.8 kV underground switching stations allow power to be maintained for all underground equipment in the event of the loss of one or two underground supply cables.

This subsystem contains two principal equipment features. These are the 13.8 kV switching stations and the 13.8 kV distribution equipment installed in the underground substations and portable power centers. The system also includes all underground dry type transformers with a primary input of 13.8 kV.

From the switching stations 13.8 kV is distributed to various areas of the underground for utilization. The underground 13.8 kV electrical distribution is accomplished using several Cables (3-Conductors, 15 kV, 90°C, Type SHD-GC) configured to supply power to portable power centers or permanent mounted substations.

Two underground fixed substations (SUBs) and seven mobile portable power centers (PPCs), receive 13.8 kV supply from four switching stations. For power configuration see Drawing # 25-J-020-W5.

Subsystem ED10 equipment associated with each underground substation or portable power center generally consists of step down transformers connected to the switching station circuit breakers either directly or via load interrupter switch. The interface with ED11 is at the secondary terminals of these transformers. Where this subsystem supplies lower voltage distribution boards the transformers and their related control and protection circuitry are included in ED10.

11.2 ED10 – Subsystem Design Requirements

All electrical equipment installed in the mine shall be designed and installed to operate efficiently in the dusty and possibly corrosive atmosphere of the mine.

Substations and switching stations shall be contained in free standing deadfront units with all instruments, relays, etc., mounted on the front panels and covered by dust tight lockable doors. All underground 13.8 kV switchgear shall have provision for local control, trip and status indication functions. Interlocks on the back panels shall prevent the units from being energized when the back panels are not in place.

The breakers shall be either manually or electrically operated from a 115V AC supply which will also activate a stored energy capacitor to trip. Each Circuit breaker has its own control power, operating, protection and metering circuits.

Capacitor Trip Units shall provide current for trip circuit operation even in the event of the failure of control power. A lit pilot light on the device shall verify that the capacitor is fully charged

All breakers are to be equipped with over current, ground fault and ground check system/ground wire monitor protection relays. Optionally, breakers may have under-voltage protection.

All dry-type transformers configured with delta/wye primary to Secondary windings shall have the neutrals of the secondary wye grounded through resistors rated to meet MSHA requirements. The Neutral Grounding Resistor (NGR) for the secondary wye windings are either mounted within the transformer enclosures or in separate ventilated enclosures adjacent to the transformers and shall limit the ground fault current to 25 amps. The neutrals of the wye secondary windings of transformers are connected to the substation buses through the resistors.

Units shall be dry type with natural convection air cooling. Transformers are to be mounted in free-standing enclosures with ventilation louvers.

Digital Type Winding Temperature Indicator and Controller, with three sensors Type "E" Thermocouples, with three Set Points Low (Fan Activation), High (Local-Alarm), and High-High (Local-Trip), with remote analog signal capability (Output: 4-20 mA) shall be provided to all dry-type transformers.

Transformer no-load tap changers are to be fitted with a minimum of two taps above and two below the normal operating tap.

Table ED10-1 lists underground distribution transformer characteristics.

11.3 ED10 – Subsystem Codes and Standards

Underground 13.8 kV breakers shall be vacuum interrupter mine type equipment and shall satisfy the requirements of 30 CFR 57, and selected sections of 30 CFR 75.

11.4 ED10 – Subsystem Operation and Precautions

Drawing 25-J-019-W4 and W5 includes a listing of the protective relay functions provided on the circuit breakers in the switching stations their set points and associated types and styles.

The location and interconnection of ED10 equipment can be followed on drawing series 53-J-009-W.

The principal elements of subsystem ED10, and the normal and alternate supply arrangements for a typical configuration of these loads are shown in drawing 25-J-020-W series.

Part of the interface scheme between Systems ED02 and ED10 is shown on drawings 25-J-020-W1, 25-J-066-W1, and individuals drawings showing single line diagram of the switching stations.

WIPP Underground Electrical Equipment No. and Drawing No. Cross-Reference Tables are shown in drawing 25-J-020-W1.

Each one of the three U/G switching stations which act as terminals for the shaft feeders can be completely de-energized to allow maintenance or repair. When a switching station is isolated U/G load transfer arrangements exist which allow electrical services to be maintained to essential and experimental loads.

Switching stations 1, 2 and 4 located in and adjacent to drift S-90 provide termination points for the feeder mine power cables entering through the Salt Handling Shaft, the Exhaust Shaft and the Waste Shaft respectively. Switching Station 5 is located in S2520 and provides termination points for the feeder mine power cables entering the waste disposal areas.

Underground substations and switching stations are positioned in recessed alcoves in the drifts with access available to all sides of the lineups. Barriers across the entry to these alcoves act as control points beyond which access by non-electrical personnel is prohibited.

Switching Station 2 is split into two Buses with an interconnecting tie circuit breaker. A three-way mechanical interlock in the U/G Switching Station 2 allows the bus to be divided into two sections by opening the tie breaker. Each of the two bus sections can be supplied electrical power from different sources. The two incoming disconnect switches and the one tie breaker are interlocked so that only two of the three devices can be closed at any one time. This prevents the paralleling of the two power sources. The interconnecting tie breaker has no metering and no functioning protective relays. An under-voltage relay is fitted but is currently disconnected.

ED10 Load Interrupter Switches (LIS) are air insulated, three pole, gang-operated with quick make and break operation. The nonremovable front handles have provision for locking the handle in either the open or closed position by means of padlocks. A switch position indicator attached to the operating shaft can be viewed through a window in the door or side panel. Arrows indicate switch open or closed position. S & C Manual 769-16 and Federal Pacific Auto Jet Manual describes the installation operation and maintenance of these switches.

13.8 kV Switching Station Circuit Breakers

All Switching Station 13.8 kV Circuit Breakers are 600 amp Vacuum Circuit Breakers. Each Vacuum breaker cubicle is divided into two compartments. The lower compartment contains the breaker and has a glass inspection window. The upper compartment contains control switches, control circuitry and metering for that unit.

Primary disconnection in these breakers takes place at contacts inside three vacuum interrupter bottles. A linkage connected to the main shaft causes blades in series with the vacuum interrupter bottle to operate immediately after operation of the primary contacts. This feature provides a visual disconnect which can be used as verification of the operation of the contacts enclosed in the vacuum bottles.

Closure of these breakers is carried out by the use of energy stored in charged springs. Residual energy in the springs is sufficient to open the breaker when a mechanical trip button is pushed. Actuator trip energy is supplied by External Capacitor Trip Units connected to breaker trip circuit.

Ground Check System/Ground Wire Monitor/95-Relay monitors the ground conductor continuity between each breaker and the step down transformer which it supplies. This device utilizes a pilot line brought back from the termination of the ground line to be monitored. An EMF is applied across this circuit. An increase in resistance of over 3 ohms in the pilot/ground circuit provides a trip signal. A built in test feature allows a 3 ohm resistance to be introduced and the performance of the detection circuit verified.

Open (green) and closed (red) pilot lights on each panel indicate the operating status of that breaker.

The following controls are mounted on each breaker panel:

- Control Power switch
- Heater switch
- Trip pushbutton

Two remote control boxes operate select breakers in Switching Station 1 and 2. Remote operating controls for Switching Station 2 breakers CB-1, CB-2 and CB-5 are located on a wall panel adjacent to Switching Station 1. Remote operating controls for both Switching Station 1 breaker CB-1, and Switching Station 2 breakers CB-1, CB-2 and CB-5 are located on a wall panel in the Hoist Loading area in the Waste Handling Building. This facilitates restoration of power following a total loss of power or other off normal condition

The remote controlled circuit breakers have motorized spring charging and are operated electrically. Remote trip initiation is accomplished by activation of relay

(Remote Trip Scheme) and it's normally open contact connected to the breaker trip circuit.

Switching Station Instrumentation and Control Features

The controls and instrumentation in Switching Stations 1, 2, 4, and 5 are similar. However upgrades in the controls and instruments have been incorporated in Switching Station 5. Information describing the installation, operation and maintenance of the relays, controls and instruments discussed in this subsection is provided within the O & M Manuals for the individual switching stations.

TABLE ED10-1 - 13.8 kV Underground Distribution Transformer Characteristics

Load Served	Equipment No.	Manufacturer	kVA	Sec Volts	Neutral Grounding Resistor Ohms	Z %	Wdg BIL kV	
							HV	LV
U/G Sub 1	53P-TR15/1	NOTE 1	1000	480/277	19.25	5-5.75	60	10
U/G Sub 3	53P-TR15/3	NOTE 1	500	480/277	19.25	5	95	10
U/G Sub 4	53P-TR15/4	NOTE 1	1000	480/277	19.25	5-5.75	60	10
U/G Sub 5	53P-TR15/5	NOTE 1	500	480/277	19.25	4.62	95	10
74P-PC04/2	74P-TR15/8	NOTE 1	500	480/277	19.25	–-	95	10
74P-PC06/2	74P-TR15/4		1000	600/480	24/18	5-5.75	95	10
74P-PC10/2	74P-TR15/5	NOTE 1	1500	995/480	44/19.25	5-5.75	95	10
74P-PC10/3	74P-TR15/6	NOTE 1	1500	995/480	44/19.25	5-5.75	95	10
74P-PC10/4	74P-TR15/7	NOTE 1	2000	995/600/480	44/22	5-5.75	95	10
74P-PC10/5	74P-TR15/9	NOTE 1	2000	995-600-480	44/22	4.43	95	10
74P-PC10/6	74P-TR15/10	NOTE 1	2000	995/600-480	44/22	4.62	95	10

NOTE 1. For Transformer manufacturer and specific details, refer to the site equipment register.

12.0 ED11 – 480 V U/G SWITCHGEAR

12.1 ED11 – Subsystem Introduction

Underground (ED11) substations containing this switchgear, provide the basic low voltage power supplies to underground equipment and facilities. They receive 13.8 kVAC nominal three-phase, 3-wire, 60 Hz-supply from subsystem ED10 and supply power to local loads, MCC and static or portable equipment.

There are two fixed area substations and seven portable power centers (PPCs) which convert (or have the capability of converting) the 13.8 kV supply from the ED10 Underground Switching Stations to a 480 V supply for local use. A 600 V/995 V supply is also available to power mining machines via selected portable power centers.

There are two different types of underground substations. They can be categorized as follows:

- Underground Subs 1 and 4 contain Molded Case Breakers (CB), Ground Fault Relays (GFR), Ground Wire Monitors (GWM)/Ground Check System (GCS)/95-Relays. Units are designed similar to switchboards. Substation 1 was manufactured by Line Power Manufacturing Co., and Substation 4 was manufactured by Industrial Electrical Manufacturing Co. (IEM).

- Portable Power Centers (PPCs) are units of unique design intended for use in a mining environment.

12.2 ED11 – Subsystem Design Requirements

Appropriate switchgear features provided to meet this requirement include:

- The switchgear shall be a dead front assembly, free standing enclosure made of heavy gauge reinforced steel. They are to be dust tight and rated for non-ventilated underground use in accordance with NEMA type 12 requirements.

- Breakers supplying three-phase equipment shall be thermal magnetic type.

- Ground wire monitor (GWM/GCS/95) relay. Each feeder supplying power to portable equipment shall be protected with a GWM.

- Ground Fault Relay (GFR). Each feeder shall be protected with a GFR.

- Provision is to be included for the use of a grounding conductor along with the power cable for all output connections to these substations. This grounding conductor is to be connected to the grounded side of the transformer neutral grounding resistor (NGR).

- Devices are to be provided which allow circuit breaker disconnection to be confirmed visually.

- All circuit breakers in the Underground Substations shall be manually or electrically operated as required.

12.3 ED11 – Subsystem Codes and Standards

Design of these substations and portable power centers, conforms with MSHA regulations for Underground Service as described in 30 CFR Parts 56 and 57 Subpart K.

12.4 ED11 – Subsystem Operation and Precautions

Two fixed ED11 Substations (SUBs) are designated as follows:

- U/G Substation 1 53P-SBD04/5
- U/G Substation 4 53P-SBD04/4

Two mobile ED11 Portable power Centers (PPCs) are being used as fixed ED11 substations and are designated as follows:

- U/G Substation 3 53P-SWG04/3
- U/G Substation 5 53P-SWG04/5

Seven mobile ED11 PPCs are used as power centers through out the mine, and are designated as follows:

- U/G Portable Power Center PPC 74P-PC04/2
- U/G Portable Power Center PPC 74P-PC06/2
- U/G Portable Power Center PPC 74P-PC10/2
- U/G Portable Power Center PPC 74P-PC10/3
- U/G Portable Power Center PPC 74P-PC10/4
- U/G Portable Power Center PPC 74P-PC10/5
- U/G Portable Power Center PPC 74P-PC10/6

The interconnection of eight of these stations with the 13.8 kV system is shown in drawing 25-J-20-W5.

Part of the interface scheme between Systems ED10 and ED11 is shown on drawings 25-J-020-W1, and individual drawings showing Single Line Diagram for Substations and Portable Power Centers.

WIPP Underground Electrical Equipment No. and Drawing No. Cross-Reference Tables are shown in drawing 25-J-020-W1.

Information on the construction, operation and maintenance of the ED11 substations and portable power centers are contained in the vendor supplied O & M Manuals.

The substation metering panels have voltmeter and ammeters with line selector switches, or digital power meters. A 480 V, three-phase distribution panel within the substation provides for the connection of local single phase loads.

The substation switchgear is divided into three compartments: A front compartment in which the controls and instruments are mounted; an intermediate compartment which contains the bus bars, control power and current transformers; a rear compartment which provides for cable termination.

A panel separates the substation intermediate and rear compartments. Access to the rear compartment is through a removable back panel. Three-phase potential and current transformers connected between the main breaker and the bus provide voltage and load current measurement. All cabling is designed for top entry.

All substation circuit breakers are of molded case construction and are fitted with shunt trips. The main and feeder breakers are fitted with ground fault and instantaneous and delayed over current trips.

The feeder breakers utilize a zero sequence current transformer to sense ground faults. Each feeder breaker has associated with it individual solid state ground wire monitoring devices. These will cause the breaker to open in the event of a ground fault and whenever the ground wire or pilot wire circuit is broken.

Selected ground check trips in U/G Substations 1, 3, and 4 have been disabled to prevent tripping a breaker when energized after loss of power.

Portable Power Centers

PPCs consists of three basic sections an incoming 13.8 kV section, a step down transformer section, and a low voltage section. All three sections are located in a single low profile assembly mounted on skids/wheels for portable operation.

The incoming Section contains:

A standard 13.8 kV Input, which consists of one three pole fused manually operated Load Interrupter Switch (LIS), and one input high voltage coupler/nip (Gear Mounted Plug - PMG).

A standard 13.8 kV feed-thru feature, which consist of one three pole fused manually operated Load Interrupter Switch (LIS), and one high voltage feed-thru coupler/nip (Gear Mounted Socket - SFG). This feature is standard on all the PPC's, except 53P-SWG04/3.

This section allows for adequate internal cable bending radius and seals the cable entries against the salt dust environment. The incoming/outgoing feeder cables includes one pilot conductor and ground conductors. The LIS is part of system ED10 and has a viewing window on the side of the compartment to allow the operator to check switch contact status.

The pilot conductor from incoming 13.8 kV feeder connects in series, to one or two Emergency Stop Pushbuttons, all Interlock Switches (top & side covers), to one Transformer Temperature Relay (49) trip contact, and to one Feed-Thru High Voltage Coupler/Nip cap jumper. These devices must all be secure to provide a continuous pilot circuit which would then enable the incoming 13.8 kV breaker to be closed. Interlocks on the Load Interrupter Switch (LIS) prevent the 600V/995V miner feeder breakers and/or the 480V main breaker from being closed if the LIS is not closed.

The transformer section is partitioned from the incoming line section and the 480 V Distribution Center with fireproof partitions. The transformer is part of Subsystem ED10. The ground terminal of the Neutral Grounding Resistor (NGR) and the transformer primary ground are connected to the power center frame. Current transformers in two phases and a directly connected voltmeter provide load current and voltage measurements at the main transformer secondary winding terminals.

The low voltage section supplies three-phase 995 V and/or 600 V, and 480 V nominal power depending on the secondary transformer ratings. Table ED10-1 details the secondary voltage levels of the PPC transformers.

The Low Voltage sections have the following features:

- One or two 995 V and/or 600 V panel which contains a molded case breaker, a ground monitor and ground fault assembly and a receptacle for an outgoing cable containing 3 line conductors, 1 pilot wire, and 2 ground conductors.

- A 480 V main breaker panel which contains a molded case breaker with Undervoltage Release (UVR), which supplies 480V to all feeder breakers circuits.

- 480 V feeder distribution panels, each of which contains molded case breakers with Shunt Trip (ST), a ground monitor and ground fault assembly and a receptacle for an outgoing cable containing 3 line conductors, 1 pilot wire and 2 ground conductors.

- A metering panel which monitors line current and voltage at the main 480 V breaker by means of meters and line selector switches.

- A utility panel which contains a 480 V, 15 amp main beaker, a 5 kVA, 480 V-120/240 V transformer and 120 V and 240 V local power and lighting receptacles.

- A monitoring panel containing a transformer temperature relay (49).

The single voltage Low Voltage sections have the following features:

- Metering panels which monitor Secondary Voltage and line Current, also Transformer Temperature.

- A utility panel which contains a 5 kVA 480/240/120 V transformer, a main molded case breaker and four receptacles (2, 120 V and 2, 240 V) supplied through individual molded case breakers with overload protection.

13.0 ED12 – U/G MOTOR CONTROL CENTERS

13.1 ED12 – Subsystem Introduction

Underground Motor Control Centers (<600V) comprising this subsystem receives 480 V nominal power from the substations in subsystem ED11. Motor Control Centers generally server motor loads from 0.33HP to 100HP and static loads from 1 kW to 100 kW.

No 480 V motor control centers are located in the underground facility. They were removed when the Experimental area was closed off.

13.2 ED12 – Subsystem Design Requirements

In general, MCC design should meet those requirements of subsystem ED05 with the added requirements of:

- Ground fault protection is to be provided for all molded case breakers by an acceptable Ground Fault System. One such acceptable system may comprise two components: a GR instantaneous trip relay with reset switch and a window current transformer through which all power cables to the load pass. When a ground fault in excess of the relay pickup current occurs, the relay trips and opens the holding circuit of the MCP contactor. This opens the contactor and isolates the ground fault from the line.

- A suitable NEMA rated enclosure for dust salt environment shall be selected. Enclosures may be made of high-impact strength fiberglass reinforced polyester material with high resistance to corrosion and heat. The switch enclosure access doors are to be mechanically interlocked with the switches to allow opening only when the switches are in the OFF position.

13.3 ED12 – Subsystem Codes and Standards

In general MCC Codes and Standards are the same as for sub system ED05 with the additional requirement of meeting MSHA regulations for Underground Service as described in 30 CFR 57, and selected sections of 30 CFR 75.

13.4 ED12 – Subsystem Operation and Precautions

This section is not applicable as no ED12 equipment is installed.

14.0 ED13 – LOW VOLTAGE POWER & DISTRIBUTION (<600 V)

14.1 ED13 – Subsystem Introduction

These subsystems cover all distribution boards, panelboards, switchboards and switchracks installed for control of light and power circuits, less than 600 V, in the underground (ED13). Instrumentation and control circuitry, and equipment directly associated with low voltage power distribution and control are included within these subsystems. The following subsystems supply power to ED13:

- ED11 U/G 480 V Substation
- ED11 U/G 480 V Portable Power Center
- ED12 U/G Motor Control Centers

Subsystem ED13 supplies underground loads at voltages of 480 V or less.

The underground facility can be divided into the following two main areas which are served by the underground 480 V substations:

- The shaft pillar area adjacent to the four shafts is supplied from U/G substations 1 and 4 (53P-SBD04/5 and 53P-SBD04/4 respectively).

- The nuclear waste storage area at the south end of the mine is supplied from Sub 5 (53P-SWG04/5) or Sub 3 (53P-SWG04/3).

Loads in these areas are supplied either directly from feeder breakers in the substations or from distribution or lighting panels connected to the substations.

<u>Shaft Pillar Area</u>

The distribution boards which supply the ventilation, lighting and bulkhead door operating mechanisms in the shaft pillar area are supplied through manually operated transfer switches which allow operation to be restored in the event of a failure in either U/G Sub 1 or U/G Sub 4.

Nuclear Waste Storage Area

The nuclear waste storage area at the south end of the mine is supplied from U/G Sub 5 or U/G Sub 3. These substations supply two sets of distribution boards and a number of receptacles.

14.2 ED13 – Subsystem Design Requirements

Minipower center transformers in the underground shall be single phase.

The minipower centers, distribution panels and transformers are to be procured to the same specifications as those used for equivalent equipment installed in the surface facility. As a result the specific design requirements for ED06 equipment can be applied to similar subsystem ED13 equipment.

Disconnect Switches are to be NEMA type HD heavy duty, enclosed blade units with a quick make and break mechanism. Fusible switches have fuse clips with steel reinforcing springs. Switches are to be rated for the connected load per NEC guidelines.

Enclosures may be made of high-impact strength fiberglass reinforced polyester material with high resistance to corrosion and heat. A suitable NEMA rated enclosure for dust salt environment shall be selected (minimum requirement is a NEMA Type 12). The switch enclosure access doors are to be mechanically interlocked with the switches to allow opening only when the switches are in the OFF position.

Three-phase receptacles are 3 wire 4 pole (three-phases + ground). Receptacle housings may be made of copper free aluminum with insulators of polyester material. Receptacles shall have spring doors. When the receptacles are mounted below safety switches the receptacle spring door is to be mechanically interlocked with the switch operating mechanism. The safety switch cannot be closed until the plug is fully inserted and the plug cannot be withdrawn unless the switch is open.

14.3 ED13 – Subsystem Codes and Standards

The LV Power Distribution system in the underground area shall be in compliance with MSHA Regulations contained in 30 CFR 57, and selected sections of 30 CFR 75.

14.4 ED13 – Subsystem Operation and Precautions

Supply configurations for the ED13 equipment are shown on drawing 25-J-020-W5.

The location of all waste storage area electrical distribution equipment including receptacles and cable routing is shown in drawing 53-J-009-W3 and W4.

The location of all shaft pillar area electrical distribution equipment including receptacles and cable routing in the Shaft Pillar Area is shown in drawings 53-J-009-W2 and 53-J-009-W3.

15.0 ED14 – U/G GENERAL LIGHTING, RECEPTACLE & UTILIZATION EQUIPMENT

15.1 ED14 – Subsystem Introduction

These subsystems provide power for general lighting, receptacle and utilization equipment in the underground. Equipment required to perform these functions includes lighting control equipment, lighting fixtures and receptacles.

This Section describes the two separate features of the lighting system provided for the Underground. These are general lighting and the S-400 drift lighting. The lighting and distribution panels through which the lighting system is supplied are closely integrated with system ED13.

15.2 ED14 – Subsystem Design Requirements

In work or test areas arrays of luminaries are provided as shown in the individual lighting Plans. Units are installed in line with centers 15 to 25 ft apart depending on the application.

All lights mounted in underground drifts, crosscuts and shaft access Areas are rated for 480 V single phase.

Fluorescent Lights in underground instrument and office sheds are rated at 120 V and are connected across line to neutral of the minipower centers located within these integrated units. This is not considered to contravene MSHA as the shed lighting circuits form part of self-contained modules whose overall supply is handled according to the code.

Control of lighting power supply is carried out on a zone basis by means of circuit breakers located in the local distribution panels. Selected zones have lighting contactors installed for additional control.

Flashing beacon lights of amber color will operate in the Waste Transportation Route to identify that a waste shipment is in progress to the panel disposal area.

<u>S-400 Drift Lighting</u>

This drift connects the Waste Shaft with the Exhaust Shaft. The luminaries are spaced at 24 ft intervals where the drift is 12 ft wide. Where the drift is 24 ft wide, two lines of luminaries are run, 12 ft apart with fittings spaced together at 24 ft intervals.

These units are rated for 480 V single phase.

The descriptions provided for the surface lighting describe ED14 lighting equipment subject to the additions and changes listed below.

High Intensity Discharge (HID) Lamps

All underground HID lamps are of the sodium vapor type. Luminaries are ceiling mounted with lamps rated at 480 V, 150 or 250 watts.

Fluorescent Luminaries

Fluorescent lamps used underground are 96 in. T12 rapid start units rated at 480 V, 95 watts. Lamps are mounted in surface fixtures singly or in pairs. Lamps are installed in gasketed enclosures which are dust and moisture resistant. The enclosures are composed of fiberglass upper bodies and acrylic diffusers held together by stainless steel clips.

Metal Halide Luminaries

Metal Halide lamps used underground are universal mount, 175 watt, phosphor coated. Ballasts rated for 480 V, high efficiency, high power factor and fused input. Luminaries are surface mounted and one lamp per unit. Lamps are installed in gasketed enclosures which are dust and moisture resistant. The enclosures are composed of painted aluminum upper bodies and acrylic diffusers held together by stainless steel fasteners. Illumination pattern is square type. Quick disconnecting feature is provided for ease of maintenance.

15.3 ED14 – Subsystem Codes and Standards

Underground general lighting, receptacle & utilization equipment shall be in compliance with MSHA Regulations contained in 30 CFR 57, and selected sections of 30 CFR 75.

15.4 ED14 – Subsystem Operation and Precautions

Installation details of HID luminaries underground are shown in drawing 53-J-533-01E.

Installation Details of Metal Halides and Fluorescent Luminaries underground are shown in drawing 53-J-104 W.

S-400 Drift lighting is lit by an array of High pressure sodium lamps as shown in drawing 53-J-533-01E. Supply comes from 53P-LP04/7 located adjacent to the Waste Shaft. Alternate supplies to this LP can be taken from Sub 1 or Sub 4 by way of Transfer Switch 53P-SW04/114.

General lighting in the underground facility is provided by fluorescent luminaries. The type and arrangement of this equipment is described in the following lighting plans:

Area Designation	Drawing No.
S-700 drift and Fuel Storage Are	53-J-092-W
Mech. and Electrical shop	53-J-117-W
Drifts connecting Shaft and Storage Areas	53-J-581*W
N250, E300 Shop Area	53-J-104-W1
Waste Transport Route	53-J-134-W

It is seen from these plans that lighting fixtures are located at each intersection of a main drift and a cross cut. There are no light fixtures in the storage exhaust drift, E-300.

The different types of lamps used can be identified in the Lighting plans for Underground areas. These lamps fall into two categories: high intensity discharge lamps and fluorescent lamps.

16.0 ED15 – GROUNDING & LIGHTNING PROTECTION

16.1 ED15 – Subsystem Introduction

This subsystem (ED15) provides necessary grounding materials and interconnections between the equipment, structures and earth ground to attain an overall resistance-to-earth value sufficiently low so that the voltage rise to remote earth, that could occur at any point in the grounding system under maximum line to ground fault conditions, will be limited to a safe value.

The WIPP grounding system uses a resistive grounded electrical system. It consists of grounding resistors, a direct buried surface site ground grid, bare copper underground facility ground, facility ground rings, facility ground conductors, grounding conductors, ground buses, equipment grounding conductors, bonding, and grounding electrodes.

The grounding system is subdivided into four distinct parts. The Utility ground system, the Plant ground system, the Facility ground system, and nonelectrical structure grounding. The Utility ground system is owned and operated by the utility and is physically separated from the WIPP plant ground system.

Lightning protection utilizes the Plant ground system and consists of lightning arresters located at select substations and a lightning dissipation system. The lightning dissipation system uses pole mounted arrays, which encircle the WIPP fenced area, and umbrella arrays, which are mounted on top of select facilities and hoist gantries.

16.2 ED15 – Subsystem Design Requirements

To limit lightning and fault voltage rise to the underground, the Utility and Plant ground system must be maintained with a 25-ft minimum separation. This limitation includes the use of a 5 kV rated insulated neutral run to the transformer ground resistor for each incoming power feeder. Use of ground resistors limits the available ground fault current and therefore the voltage step potential during the fault or lightning strike.

Equipment protection is achieved by installing lightning arresters which are required for each underground feeder prior to entry into their respective shafts.

In order to meet lightning and ground fault current limiting requirements, the underground 13.8 kV and 480 V electrical distribution systems are three wire systems and utilize neutral resistors. The underground 480 V system does not utilize 277 V loads.

The grounding electrode conductors of the plant ground grid shall consist of a 4/0 AWG stranded annealed copper wire grounding cable encircling the site; within this there will be located a rectangular array of similarly dimensioned cross connecting ground cables. The plant ground grid covers the entire site with its perimeter approximately 3-ft beyond the boundary fence.

The grounding electrodes shall be copper-clad steel, 3/4 in. diameter ground rods, at least 10 ft long shall be driven into the ground at the corners of the grid and at intermediate points if necessary, to obtain a resistance from the equivalent grounding electrode system to earth of not more than 5 ohms as measured by the "fall of potential" method.

Connections to ground rods are made with removable clamps to permit periodic inspection, testing, and maintenance.

Ground grids consist of 4/0 AWG stranded copper conductor buried at a depth of not less than 18 in. Buried joints are painted with a coal tar base paint to prevent corrosion. Exposed connections are made of high conductivity cast copper. Selected ground rods shall be installed in vitreous clay or concrete pipe for periodic inspection, tests and maintenance.

Each building and substation, or other surface permanent structure containing electrical equipment, shall be encircled by a grounding electrode conductor, all of similar dimensions to the plant grid ground cable. These individual grounding subsystems are termed "Facility ground grids."

Each Facility ground grid shall be connected to the plant ground grid with a minimum of two connections preferably at diagonally opposite corners of the building or structure.

The following items shall be connected to the plant ground grid, either directly or through the facility ground grid:

- Alternate outside columns of steel-framed buildings
- All metal noncurrent-carrying parts of motors and major electrical equipment
- All metal pipes, metal tanks, etc.
- The neutrals of the diesel generators
- The secondary neutrals of power transformers at less than 600 V
- Ground buses of switchgear, switchracks, motor control centers, distribution boards and instrumentation frames

Grounding grid taps to building steel and grounding connections are protected at grade interfaces and concrete penetrations with PVC conduit.

As required by MSHA the size of the neutral grounding resistors in a low voltage (600 V) underground load center shall be such as to limit ground fault current to 25 amps. Feeders from these transformers shall each have a system grounding circuit, originating at the grounded side of the grounding resistor, and shall extend along with the power conductor and serve as a grounding electrode conductor for the frames of all the electrical equipment fed power from that transformer.

Single phase low voltage underground transformers with secondaries rated at 120 V shall have one leg of the 120 V winding solidly grounded.

Equipment Grounding

Equipment grounding conductors are sized in accordance with the NEC but are nowhere less than #8 AWG.

Equipment requiring grounding shall include all devices that are normally electrically energized, such as generators, transformers, switchgear, motor control centers, control cabinets, instrument panels, power and lighting panels, motors, lighting fixtures, receptacles, lighting standards and similar devices. In addition all electrically conductive structures or equipment enclosing or in close proximity to current carrying parts that may become inadvertently energized shall also be connected to the grounding system. These items include fences, cable trays, conduits, tanks, building steel, ladders, stairs, railing, high voltage disconnect switch handles and towers of all types. In general, all electrically energized equipment enclosures shall be supplied with a means of connection of adequately sized grounding conductors to ground the frame of the equipment

and any enclosed ground buses in accordance with Article 250 of the National Electric Code.

At least two connections to ground shall be made on enclosures for generators, power transformers greater than 45 kVA, high, medium, and low voltage switchgear breakers, and motor control centers. At least two connections to ground shall be made on disconnecting switch supports. The two connections shall constitute two different current paths to grounded building steel and/or the ground grid. The secondary neutrals of all low voltage power distribution, lighting and control transformers are solidly grounded as shown in all System ED00 drawings.

Connections to ground buses and connections of equipment grounding conductors to switch boxes, panel boards, cabinets and similar items are made with either bolted mechanical lugs or compression connectors. Lighting Fixture enclosures are grounded by means of single continuous ground conductors run in the same raceways as the circuit conductors and attached to the metal enclosures of the lighting fixtures and their related local switch boxes. Raceways carrying 480 V or higher voltage power feeder conductors are grounded by means of bare or insulated grounding conductors connected to the Facility Grounding Systems. Conduits shall not be used as ground paths.

Motor frames, panel boards and enclosures housing electrical devices such as switches, motor starters, control devices and similar items are grounded to the Facility Ground Grid with equipment grounding conductors. Equipment is never grounded by connection to building steel structure or to conduit.

In the case of motors the equipment ground conductor is terminated with a proper connector under one of the hold-down bolts of the motor frame. The system grounding conductor of the feeder cable is terminated at the ground terminal in the motor terminal box.

The frames of motors rated less than 460 VAC shall be grounded in the following manner:

- Direct connection to the Facility ground grid; or

- Connection to the Facility ground by a conductor connected to the ground bus at the supply panel and enclosed in the same conduit as the phase or power lines

The frames of motors rated at 460 VAC or above shall be grounded in the following manner:

- Direct connection to the Facility ground grid; and
- Connection by a conductor connected to the ground bus at the supply panel and enclosed in the same conduit as the phase or power lines

Cable trays shall be metallic and shall be grounded and electrically continuous. Cable trays carrying cables to electrically energized equipment shall be electrically connected to the equipment ground bus. Cable trays are not considered acceptable fault return paths.

All conductors used for the grounding system shall be copper. Joints or splices of grounding conductors or connections to grounded parts shall be done by either exothermic welding, engineer-approved compression connectors, or bolted connectors, where suited for the application. Joints between the ground grid and building steel shall be exothermically welded.

Instrument and communication equipment enclosures shall be effectively grounded to the facility ground to ensure the safety of personnel, the protection of equipment, and the proper functioning of protective devices.

Where required by the installing Cognizant Engineer, signal ground circuits in instrument and communications equipment shall be insulated from the enclosures and shall be connected by insulated cable to a main instrument ground bus which is then connected to the facility ground grid at one point only through a removable link.

Portable equipment shall be grounded by means of ground conductor in the power cable of flexible cord terminated in a grounding type plug.

Where railroad tracks leave the plant site, insulated track joints shall be installed to isolate the plant trackage from the main line and prevent interference with railroad signal and communication systems. The entire length of track within the plant site boundary shall be grounded.

Trailing cables for portable underground equipment shall contain one or more ground conductors having a cross sectional area of not less than one-half that of the power conductor. A pilot or pilotless ground continuity check circuit shall be provided for each trailing cable 480V and above to open the associated feeder breaker when either the ground or the ground check circuit is open or inoperative.

The protection ground circuits shall be derived from surface ground which shall be physically separated and insulated from the utility grounding system in order to avoid the transfer of potential to portable equipment due to a fault or surge of the utility system.

Surface Facility Grounding

The ground resistor in the secondary neutrals of transformers supplying intermediate voltage (2400 V and/or 4.16 kV) motor loads shall be selected in conjunction with the ground fault protection system so as to limit fault current to 25 amps.

13.8 kV System Grounding

The 13.8 kV system is grounded through resistors located at four points: the neutral of the secondary windings of each of the two 115 kV/13.8 kV main transformers and two grounding transformers connected at the interrupter switches which feed buses 3A and 3B in Sub 3.

To meet MSHA requirements the grounding resistors were designed to operate in conjunction with the ground fault protection system so as to limit the voltage drop in the grounding circuit external to the resistor to not more than 100 V. A maximum ground fault current of 70 amps was assumed occurring at U/G Substation 2. This fault was accommodated by 50 amp resistors in the Main Sub and two 10 amp fault currents in the primaries of the two wye-delta grounding transformers. Taken in conjunction with the impedance of the system the resulting voltage drop is less than 50 V which is acceptable and allows scope for expansion.

4.16 kV System Grounding

The 4.16 kV system is grounded through a neutral to ground resistor at transformer 25P-TR15/7 in Sub 7. The load supplied by this transformer comprises the induction motors which drive the three main exhaust fans 41BM-700A, B & C.

The rating of the ground resistor is based on the requirement to provide protection for ground faults over as much as possible of the fan motor stator winding. Ground faults at motor terminals will be 20 times as great as those 95% into the windings. For instance if the operation of a standard ground fault relay with 15 amp pickup is assumed 95% into the winding then a 300 amp ground fault current would occur in the event of a fault at the motor terminals. In order to provide good selectivity in ground fault protection as well, a 400 amp for 10 second resistor was selected with a 40 amp continuous rating. An additional level of motor ground fault protection is included in the amp-guard starters for these motors.

2.4 kV System Grounding

As this system is supplied through transformer 38P-TR15/1 which has delta/delta windings, a zig-zag grounding transformer is connected to the transformer

secondary. The loads on the 2.4 kV system are the 2,200 HP synchronous drive motor for the SH standby M-G set, and the alternate feed to 38P-MCC04/2.

The zig-zag grounding transformer supplies a 25 amp grounding resistor. Both transformer and resistor are located in the Ensign power center. The same factors influence selection of resistor rating as those discussed in the previous section for the 4.6 kV system. As a result of the step down voltage ratio of the zig-zag transformer the 25 amp current rating is equivalent to the 400 amp rating of the resistor in the 4.16 kV transformer neutral.

Additional ground fault protection is provided by the General Electric Limit-amp synchronous motor starter which incorporates ground protection.

480 V System Grounding

The surface 480 V distribution system is based on the use of three phase, 4 wire feeders supplied from area substations. Ground fault protection is provided on the main breakers and the majority of the feeder breakers in these substations.

Underground Facility Grounding

Four #4/0 AWG stranded copper ground cables installed in the Air Intake, Salt Handling, Waste and Exhaust Shafts connect the surface plant ground grid to the underground facility. The ground grid in the mine shall be connected to the surface grid via these grounding electrode conductors in the shafts. The grounding conductor shall be hung on messenger cables and shall be distributed throughout the mine. Spur ground cable connections from the main #4/0 ground cables utilize #2 bare copper wire.

All stationary equipment, electrical and non-electrical, that is made of metal or housed in metal enclosures located in the shafts or underground facility is connected to this cabling system.

A fail safe ground continuity check circuit device shall be employed for each 13.8 kV underground mine feeder to open the associated feeder breaker when the feeder ground loop is open or inoperative.

Underground 13.8 kV System Grounding

The secondary neutrals of transformers with a 13.8 kV primary which supply underground areas shall be grounded through resistors that will limit the voltage drops in the ground circuits external to the resistors to not more than 100 V under ground fault conditions.

The underground 13.8 kV system is supplied from the surface and is grounded at the surface.

Ground check protective relays are connected to all 13.8 kV feeder cables in the shafts and underground facility. These relays are located on Plant Sub breakers CB-2 and CB-5 and on Vacuum Interrupter Switch 25P-VIS15/11 which supplies the underground. They monitor continuity of the ground wire by means of a pilot wire which accompanies the cable to its terminating point. Failure of the ground circuit will cause the relay to trip its feeder breaker. These relays also provide an under voltage trip function which trips the feeder breaker when the line voltage falls to less than 60% of its nominal value. These features meet specific MSHA requirements.

Underground System Grounding

All underground dry type transformers with a primary input of 13.8 kV, have the neutrals of their secondary windings resistor grounded. These resistors (NGR) are rated for 15 amp continuous current.

All outgoing low voltage feeder supplied from U/G Substations and Portable Power Centers shall have ground fault relays (GFR) and shall be set to trip at 5 Amps instantaneous.

Underground Below 240 V System Grounding

The neutral taps of the secondary windings of transformers rated at 120/240 V are solidly grounded.

Lightning Protection System

The lightning protection system is based on the use of dissipation arrays located in various configurations over the WIPP facility. These arrays are grounded and provide a very large number of discharge points through which ions would leak to charged clouds overhead. By so doing the system reduces the electrostatic potential induced between the charged clouds and the facility to a level that does not permit the generation of a lightning strike to the facility. The system is passive and is actuated by the charges present in the overhead clouds.

The system is made up of three basic elements: the dissipaters or ionizers, the ground current collectors and the wiring systems which interconnect them.

The dissipating arrays to be installed on the C&SH shaft head frames, the Air Intake shaft and the Waste Handling Building shall not extend more than 23 ft above these structures, and the diameter of the arrays shall not be larger than 15 ft. Arrays shall be connected to ground terminals by downleads of material compatible with that used for the arrays.

Hemisphere arrays consist of umbrella shaped steel assemblies located on poles adjacent to the structures to be protected, or in the case of towers on top of the structures. The umbrella arms are wound with stainless steel wires which carry large numbers of short perpendicular dissipation wires through which charged

ions leak up to neutralize any charged clouds overhead. The grounding cable from the tower connects to the Plant Ground Grid. There are five hemisphere arrays: two at the Exhaust Filter Building, one each at the Salt Handling and Air Intake Shaft Hoists and one at the water tower.

A conic array is positioned over the Waste Handling Shaft. This Assembly consists of a central pole mounted on top and in the center of the tower. All the dissipation wires connect together at the top of the pole. From there they are brought down to evenly spaced grounded anchors round the rim of the tower. As in the previous case, perpendicular cross wires located at frequent intervals along the dissipation wires provide escape paths for charged ions. The dissipation wires are grounded to the Facility Ground which is connected to the plant ground.

Roof arrays are located along the outer rim of the Waste Handling Building roof and between supports on the site perimeter lamp poles. In conjunction with the other arrays within the site the perimeter roof arrays operate to leak off charge and so reduce the potential of the entire site with respect to lightning activity from active charged clouds.

Distribution type lightning arresters shall be used to protect the utility substation, the main plant substation, underground switch stations, the portable underground power centers, and the meteorological data site.

16.3 ED15 – Subsystem Standard and Codes

As applicable grounding system design is carried out in conformance with the NFPA 70 (Ref) and IEEE 142.

Substation and switching grounding system shall comply with IEEE 80 and grounding connections with IEEE 837.

The neutrals of all transformers feeding the ED04 system are solidly grounded to meet requirements of Article 250 of the NEC.

The mining related facilities on the surface and the mine shafts shall comply with 30 CFR Parts 56/57.12025 to 12028. The ED15 supplementary sections expand on the application of these codes as they relate to the WIPP facility.

Grounding of underground electrical equipment shall be in conformance with relevant MSHA requirements as defined in 30 CFR Part 57.12025 through 57.12027 and 30 CFR 75.

Joints in the Plant ground grid are made by an exothermic welding process as defined in Chapter 57 of the AWS Handbook.

Connections between ground cables are made by split-bolt or U-bolt connectors as described in the NEC or in UL 467.

The #4/0 AWG ground conductors are made of medium-hard-drawn copper in accordance with ASTM B 2 and B 8.

The ground rods are in accordance with ASTM B 228.

Grounding of all electrical components is carried out in conformance with Article 250 of the NEC

Conduits shall be grounded in accordance with Article 250, Section IV of the National Electrical Code.

Lightning protection utilizes a combination of a conventional system as described in NFPA 78 and a dissipation arrays system.

NFPA Standard #780 "Standard for the Installation of Lightning Protection Systems."

16.4 ED15 – Subsystem Operation and Precautions

There are two major but separate ground grids on the WIPP site, the Utility and Plant ground grids. These are shown on drawing 25-J-027-W1 and drawing 24-C-037-W.

The methods of connecting equipment ground conductors to electrical components and the Facility Grid shown in drawing 25-J-027-W (series).

Methods of installation of grounding rods are shown in drawing 25-J-027-W (series). This drawing also shows the use of connectors for carrying out exothermic welds and the use of busbars for interconnecting ground cables aboveground.

Grounding detail for the steel columns of buildings, steel tanks, pressure vessels, handrails and other structural parts are shown in drawings 25-J-027-W (series).

The arrangement of the lightning dissipaters and ground current collection is based on the use of the WIPP Plant Ground Grid as shown in drawing 25-J-027-W1.

The wiring system connecting the dissipaters with the plant ground grid utilizes the facility ground grids shown in drawing 25-J-027-W2.

The layout of the original ground cable system underground is shown in drawings 53-J-520-01E and 53-J-521-01E.

Lightning system protection components are shown in drawing 25-J-030-W, sheets 1 to 7.

The resistors at the main Utility transformers are mounted on an adjacent tower to each of the transformers as shown in drawing 25-J-065-W series.

17.0 ED16 – EMERGENCY LIGHTING

17.1 ED16 – Subsystem Introduction

This subsystem covers all emergency lighting at the WIPP site. Subsystems ED06 and ED07 supply power to ED16.

Emergency lighting provides illumination and marks facility exits to aid egress from the facility during emergency conditions.

17.2 ED16 – Subsystem Design Requirements

Each Building Emergency Egress light shall contain as a minimum a charger unit, test switches, LED charge rate pilot lights, and activation logic which will illuminate the lamp in the event of loss of normal lighting power.

Building Egress light lamps are each to be rated for the minimum lumen output to be equivalent to that of a 25 watt sealed beam lamp. Circuitry shall be rated for operation from the 277 V or 120 V lighting circuits to which they are connected.

Illuminated Exit Signs shall be rated to the 120 V or 277 V lighting circuits in the areas which they serve. Under normal conditions lamps in these units are lit by the connected supplies which also charge their batteries. In the event of failure of the supply the integral battery is to provide the power needed to maintain illumination of the sign. Test switches and LED charge rate pilot lights are also to be fitted. Exit signs identifying points of egress shall be completely self contained (battery, charger, and components within exit sign housing).

The NEC requires that battery power be sufficient to energize the lighting with the battery voltage remaining at over 87.5% of normal for not less than 90 minutes.

17.3 ED16 – Subsystem Codes and Standards

All the above Emergency Lighting Equipment was designed to meet the related requirements of Section 700.12 of the NEC.

"Life Safety Code," NFPA 101, Sections 5-9 and 5-10, for illumination and identification of means of egress.

17.4 ED16 – Subsystem Operation and Precautions

Emergency lighting systems are required to be installed in the following facilities per the requirements of NFPA 101:

- 411 – Waste Handling Building
- 412 – TRUPACT Maintenance Building
- 451 – Support Building
- 452 – Safety and Emergency Services Building
- 455 – Maintenance Shop Building
- 489 – Training Building

18.0 ED17 – SECURITY AND PERIMETER LIGHTING

18.1 ED17 – Subsystem Introduction

The Security Lighting system comprises pole mounted high intensity lamps intended to illuminate the plant perimeter fence, the main thru ways and adjacent parking areas as required by SDD PP00. Perimeter lighting is a subset of the Security Lighting system.

18.2 ED17 – Subsystem Design Requirements

The Security/Perimeter lighting system shall be designed in accordance with the requirements of SDD PP00.

Illumination levels within the 20 ft Security Zone on either side of the perimeter fence must provide for the assessment of unauthorized activities and/or persons at the pedestrian and vehicular entrances and allow examination and inspections.

18.3 ED17 – Subsystem Codes and Standards

Codes and standards shall be those as applicable from ED07 General Lighting.

18.4 ED17 – Subsystem Operation and Precautions

Connection of select Perimeter Security lighting sources to Sub 3 following loss of Utility Power will enable them to be supplied from diesel power.

Power supply to the Security Lighting comes from the following sources:

Location	Dist Board	MCC.	Sub
Water Pumphouse	45P-LP04/31	45P MCC04/2	4
Warehouse	45P-LP04/1	45P-MCC04/1	4
Exhaust Filter Building	41P-LP04/11	41P MCC04/7	3
Waste Handling Building	4P-LP04/5	41P MCC04/6	SB
Substation 5	CB-10	N/A	5

19.0 ED – RACEWAYS & CABLE – ALL SUBSYSTEMS

These requirements cover the cable and raceways required to interconnect all electrical equipment and devices within the scope of the Electrical System.

This scope encompasses both the electrical systems previously described in this section of this SDD, and also the interfacing system which require these features to be supplied for their electrical/instrumentation equipment. The interface between the cabling function and electrical components is at the terminals of the interconnected equipment.

19.1 ED – Design Requirements

Design Requirements for wiring methods, cable capacity ratings and group derating factors for cables in trays shall be in accordance with the National Electric Code (NEC).

The insulation or jacket materials used for wires and cables shall not support combustion. Polyvinyl chloride (PVC) insulation or jacketing shall not be used and the use of plastic material shall be minimized to the extent practical.

Cables shall be specified having 90°C thermosetting insulation material (EPR, XLPE, EPDM), hypalon (chlorosulfonated polyethylene) neoprene, or chlorinated polyethylene (CPE) jacketing. Conductors contained within equipment, except for qualified switchgear bus conductors, shall be of high-conductivity copper insulated with flame retardant thermoset type. Thermoplastic insulation may be used if installed in metallic conduits.

Outdoor cabling between structures shall generally be installed below ground by the use of an underground duct bank with concrete encasement where necessary or direct burial. The use of overhead bus ducts, conduits and cable trays is permissible for short runs where underground location is impractical.

Indoor cabling shall be installed by the use of underground cellular raceways, conduit, wire ways, and trays.

The cables shall be separated by voltage classification into four subgroups and run in separate raceways at the surface.

Underground cables shall be separated either by the use of an "open wire" arrangement or by running them suspended from separate messenger cables. Classification of the four subgroups is as follows.

Instrumentation Cable

Refer to Electrical Specification E-Q-281 (Specification For Instrumentation Cables).

Public Address and Intercom Cable

Refer to Electrical Specification E-Q-281 (Specification For Instrumentation Cables).

Fire Alarm Cable

Refer to Electrical Specification E-Q-281 (Specification For Instrumentation Cables).

Fiber Optical Cables

Refer to Electrical Specification E-Q-281 (Specification For Instrumentation Cables).

Power Cable

13.8 kV power cable between the WIPP Utility Substation and the Plant Substation is carried in a concrete duct bank.

All cables are labeled with stick on plastic tags carrying the cable number at their terminations.

Where pull boxes are required for power cables these are made of pre-cast concrete sections with cable entry through PVC stubs which extend out approximately 5 ft. Pullboxes have bottom drainage openings and removable screw down steel cover plates.

Control and Communication Cables

All control and communication electrical cables are routed in PVC conduit in the Yard cable trenches. These cables are separated into the following categories:

- Central Monitoring System Data Highway
- Telephone, P/A system and Intercom
- Control and instrumentation
- Security and Access Control system

Cables for the above categories are run in separate PVC conduits which terminate in separate boxes and where necessary are accessed through separate pull boxes. The conduit is either 2 in. or larger in diameter. The conduit is embedded in sand and is covered by a "red lean" concrete strip similar to that used for power cables.

When practical 25% spare ducts are provided in each cable trench containing conduits.

A separate system of fiber-optics cables covers the site. This system connects the VAX central computer to users throughout the site. The cable is installed in conduit and loops between J boxes in all the buildings served.

Cabling in WIPP Surface Buildings.

Electric cables, cable terminations, termination boxes, conduits, cable trays, panels, switches and other materials and fittings are in conformance with UL requirements.

Cabling in the WIPP Underground Facility

The 13.8 kV Mine Power Cables enters the Underground Facility through three shafts: the SH Shaft, the Waste Handling Shaft and the Exhaust Shaft. These shafts also contain other cables related to hoist operation, telephone and data link services, geomechanical instruments and Sandia experimental instrumentation. These circuits are identified in the drawings and schedules of the systems which they serve.

Cable support arrangements in the shafts are as shown in controlled drawings 53-J-014-W series. Curved steel channels approximately 5 ft long are attached in the horizontal plane to the shaft sides by steel pads bolted to the walls. These channels are located at 60 ft intervals down the shafts. At each channel level individual cables (or groups of smaller diameter cables) are fitted with split-laced mesh cable grips which are suspended from angle irons or other supports welded to the channels. These are spaced appropriately along the channels so as to provide necessary separation.

Where termination boxes or junction boxes are required in the shafts these are mounted as shown in controlled drawings 53-J-014-W series. In the case of the upper concrete lined half of the shaft they are located on the surface of the shaft behind protective pipe frames. In the case of the lower unlined part of the shaft they are located in recesses in the salt with protective frames mounted over the openings.

Underground Cabling

Cables in underground drifts are either suspended from the back or laid in supports along the ribs. Controlled drawings 53-J-014-W series shows typical fixtures used to support cabling as described below.

In the case of suspended cabling a messenger cable is laid between hanging devices bolted into the salt by expansion anchors at 20 ft max intervals. The ends of the messenger cable are tensioned by means of turnbuckles connected to anchors. The cable is then suspended from the messenger cable at the anchors by vinyl coated steel hangers. Ground wires are located along with messenger cables. The minimum lateral separation between the cables is 12 in. for 13.8 kV single conductors, 18 in. for two or three conductor <600 V power cable and 6 in. for signal cable (telephone, fire alarm and instrument). Signal cables are always separated from >600V power cable by at least 24 in.

In the case of cables located along the ribs use is made of J hooks bolted to the salt by expansion anchors. The cable is laid within the hooks. Vertical separation is identical with the lateral separation described in the previous paragraph for the suspended cable.

Where cable passes through bulkheads use is made of sealed penetrations. Where a cable suspended from a messenger passes through a bulkhead a ground connection is made from a terminal on the bulkhead to the messenger. In the case of a power cable this can be done by connecting a ground on the metal case of the penetration to the messenger. This effectively grounds the bulkhead. The messenger and ground wire pass thorough the bulkhead by way of an non-insulated bushing.

Medium Voltage 5 kV and 15 kV Power Cable

Refer to Electrical Specification E-P-398 (Specification For Medium Voltage Power Cable).

600 V Cable

Refer to Electrical Specification E-P-245 (Specification For 600 V Power Cable).

19.2 ED Codes and Standards

Conductor codes are in accordance with NEMA WC 30.

Insulation meets the requirements of ICEA S-68-516.

Instrumentation cable is UL listed as type TC in accordance with the NEC, Article 336. It is used in both dry and wet locations.

The conductors and ground wire are copper, Class B stranded in accordance with ASTM B8. The conductors are tinned, soft, or annealed copper as practical in accordance with ASTM B 33.

Cable jacket of heavy duty thermoset compound meets the requirements of ICEA S-68-516.

600 V cable is insulated in accordance with NEMA WC 8-88:

Cabling in the Underground Facility meets applicable requirements of the National Electric Code and of 30 CFR, Part 57 of the Mine Safety and Health Administration Federal Mining Code for Metal & Non-Metallic Underground Mines.

EMT complies with Federal Spec WW-C-563 and ANSI Standard C80.3.

19.3 ED – Operation and Precautions

Cabling within the WIPP Yard is either directly buried or carried in conduit in underground trenches. The original layout of the cable routes in the Yard is shown in drawings 25-J-530, 25-J-531, 25-J-533, 25-J-534, AND 25-J-536.

Detail of the cable and conduit content of individual trenches is shown in Drawings numbered 24-C-032-W, 25-C-036-W1 through W5, 24-C-037-W, 24-C-038-W, 24-C-039-W, 24-C-040-W, and 24-C-041-W.

Specific Features for outfitting the underground cable installation are described in Drawing 53-J-014-W.

The Instrumentation tray and cable routing underground is shown in drawings 53-J-009-W series.

Power cable previously install in the Yards and site may be directly buried in trenches separated by about 3 ft from adjacent trenches containing other cabling. The power cables are packed in sand and covered with a 4 inch strip of "red lean" concrete which both protects and acts as an indicator during surface excavation. The top of the concrete strip is located about 1 ft below the bottom of the 2 ft layer of crushed rock which covers the site.

The two backup diesel generators are connected by a concrete lined cable trench located at their eastern side. The trench is approximately 2 ft 6 in. wide, 3 ft 6 in. deep and 28 ft long. It is covered by removable steel cover plates. The trench contains three superimposed wire trays. The top tray contains DG 1 power cables. The bottom tray contains DG 2 power cables. The middle tray contains control cables for both DGs. Cables enter the concrete trench from each DG, through vertical steel enclosed raceways on the sides of the diesel enclosures.

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDICES

STATEMENT of INTENT

The appendixes to this SDD are provided for information purposes only and do not form part of the controlled document.

Some of the data contained in these Appendixes may also appear elsewhere in controlled documents. Should a conflict exist between information in an Appendix and that contained in a controlled document, the controlled document will always have precedence.

The following is a list of SDD ED00 Appendixes:

APPENDIX	TITLE
A	Definitions and Acronyms
B	Maintenance Schedules
C	System Interfaces
D	Operating limits
E	Parameter List
F	Operations Guidelines
G	Supplementary Codes and Standards

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDIX A – DEFINITIONS AND ACRONYMS

DEFINITIONS

The nomenclature adopted for the WIPP electrical facilities, discussed in this SDD, is described by the following definitions.

APPENDIX A – DEFINITIONS

WIPP Utility Substation	A fenced-in compound which contains two incoming 115 kV supply feeders and related power system infrastructure. The Utility Substation power system has been designed as a Ring Bus Configuration. The North incoming supply feeder from Cunningham/Maddox Plant via Potash Junction Interface, and the South incoming supply feeder from Maddox/Cunningham Plant via Witten Switching Station. It contains ED01 & ED02 equipment.
Plant Substation	An outdoor 13.8 kV Switchgear, which contains medium-voltage equipment like twelve vacuum circuit breakers and two distribution buses connected via a tie breaker. It's the main gear that interconnects all site loads with the WIPP Utility Substation (see above). It contains ED02 equipment.
Area Substation	Outdoor substations which transform 13.8 kV power from the plant substation to 480 V or 4.16 kV (Sub 7) and distribute it for use in the surface facility. They contain both ED02 and ED04 equipment (Sub 7 contains ED02 and ED03 equipment).
SH Hoist Substation	An outdoor substation which provides a normal power output of 475 V via power converters and manual transfer switch to power the Salt Handling Hoist drive motor (2300 HP). An Alternate power output of 475 V via MG set and manual transfer switch is available as a backup system to power the SH Hoist drive motor. A harmonic filter is in stalled on the 13.8 kV side. It contains ED02 and ED03 equipment.
Support Building Substation	An indoor substation, similar in function to the area substations (see above), which supplies loads in the Support and Waste Handling Buildings. It contains ED02 and ED04 equipment.

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDIX A – DEFINITIONS

Waste Hoist Substation	An indoor substation which only provides 475 V power to the Waste Hoist drive motor (600 HP) via Power Converters. It contains only ED02 equipment.
Switchracks	Open air switchracks supply <600 V loads in trailers and smaller buildings and structures from area substations or motor control centers. They contain ED06 equipment.
U/G Switching Stations	Three Underground (U/G) Switching Stations which receive 13.8 kV power from the surface and distribute it to the underground Substations and Portable Power Centers (PPC). All switching stations contain ED10 equipment.
U/G Substation	480 V distribution switchgear supplied from the switching stations (see above) which provide a function underground similar to that provided on the surface by the area substations (see above). They contain ED10 and ED11 equipment.
U/G Portable Power Centers	Portable Power Centers (PPC) are mobile units with low voltage outputs of 995 V/600 V/480 V. Medium voltage 13.8 kV supplied from switching stations (see above). Units provide power to 995 V Continuous Miner (EIMCO), TO 600 V Continuous Miner, To 600 V Road Header (DOSCO), to 480 V equipment (Exhaust Fans, Core Drills, HERE. machine, etc). They contain ED10 and ED11 equipment.

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDIX A – ACRONYMS

ACRONYM	DEFINITION
A	Amps, unit of electrical current
AC	Alternating electrical current
ACSR	Aluminum cable steel reinforced
AISC	American Institute of Steel Construction
ANS	American Nuclear Society
ANSI	American National Standards Institute
ARM	Area Radiation Monitor
ASNT	American Society for Nondestructive Testing
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Material
AWG	American Wire Gauge
AWS	American Welding Society
AU00	Underground Facility and Equipment System Designator
BIL	Basic Impulse Level (Insulation Level Dielectric Test Voltage)
BIS	Breaker Interlock System
BPSS	Backup Power Supply System
CAM	(Area) Continuous Air Monitor
CA00	Compressed Air System Designator
CB	Circuit Breaker
CF00	Plant Buildings, Facilities, and Misc. Equipment System Designator
CFR	Code of Federal Regulations
CM00	Plant Monitoring and Communication System Designator
CMR	Central Monitoring Room
CMS	Central Monitoring System
DEMA	Diesel Engine Manufacturers Association
db	Decibels, unit of logarithmic gain often related to sound
DC	Direct Electrical Current
DOE	U.S. Department of Energy
ED00	Electrical Distribution System Designator
EFB	Exhaust Filter Building
EM00	Environmental Monitoring System Designator
EMT	Electro-Metallic Tubing
EPA	Environmental Protection Agency
FP00	Fire Protection System Designator
FSAR	Final Safety Analysis Report

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDIX A – ACRONYMS

ACRONYM	DEFINITION
GC00	General Civil and Structural System Designator
HEPA	High Efficiency Particulate Air Filter
HI	Hydraulic Institute
HID	High Intensity Discharge (lamp)
HP	Horsepower
HV00	Heating and Ventilating System Designator
Hz	Hertz, unit of frequency
IES	Illumination Engineering Society
IEEE	Institute of Electrical and Electronic Engineers
IMC	Intermediate Metal Conduit
ISA	Instrument Society of America
IPCEA	Insulated Power Cable Engineers Association
kV	kilo volt, unit of electrical voltage
kW	kilowatt, unit of electrical power
kWH	kilo watt hours, unit of electrical energy
kVA	kilo volt amps, unit of electrical power
kVAR	kilo volt amps reactive, unit of reactive power
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LIS	Load Interrupter Switch
LPU	Local Processing Unit
mA	milliamps, unit of electrical current
mb	millibar, unit of pressure
MCC	Motor Control Center
MG	Motor-generator
MOC	Mechanism Operated Cell (switches)
MPR	Motor Protection Relay
MSHA	Mine Safety and Health Administration
mV	millivolts
NC	Normally Closed (Contacts)
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NO	Normally Open (Contacts)
OA/FA	self cooled/forced air cooled transformer ratings

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDIX A – ACRONYMS

ACRONYM	DEFINITION
O&M	Operations & Maintenance
OSHA	Occupational Safety and Health Administration
PA	Personnel Address equipment
PCB	Polychlorinated biphenyls
PF	Power Factor
PMS	Plant Metering System
PPC	Portable Power Center
ppbv	parts per billion per volume
psi	pounds per square inch
PVC	Polyvinyl chloride
QA	Quality Assurance
R	Ohms, unit of electrical resistance
RM00	Radiation Monitoring System Designator
RMS	Root Mean Squared, electrical voltage form factor
RPM	Revolutions Per Minute
RTD	Resistance Temperature Detector
SDD	System Design Description
SNL	Sandia National Laboratories
SPS	South Western Public Service Company
SSPC	Steel Structures Paining Council
UG or U/G	Underground
UL	Underwriters Laboratory
UPS	Uninterruptible Power Supple
uin	micro-inches
uF	micro-Farad, unit of electrical capacity
uH	micro-Henry, unit of electrical inductance
UH00	Underground Hoisting System Designator
V	volts
VA	Volt-Amps, unit of electrical power
VU00	Underground Ventilation System Designator

APPENDIX A – DEFINITIONS AND ACRONYMS

APPENDIX A – ACRONYMS

ACRONYM	DEFINITION
W	watts, unit of electrical power
WD00	Water Distribution System Designator
WHB	Waste Handling Building
WH00	Waste Handling Equipment System Designator
WIPP	Waste Isolation Pilot Plant
Z	Electrical Impedance in percent

APPENDIX B – MAINTENANCE SCHEDULES

APPENDIX B – MAINTENANCE SCHEDULES

Introduction

In accordance with DOE requirements, the maintenance program " --shall contain provisions sufficient to preserve, predict, or restore the availability, operability, and reliability of plant structures, systems, and components important to safe and reliable operation of the --- facility." This is the guiding requirement and basis for the following material.

Due to the dependence of the site on the Electrical Distribution (ED) System, maintenance should be scheduled at a time of site inactivity, if at all possible.

This section provides guidance for the preparation of procedures needed to implement the Maintenance Program. These procedures will be subject to an authorized approval and change control process.

Maintenance Approach

The maintenance program will ensure that the property is maintained in a manner which promotes operational safety, work health, environmental protection and compliance, property preservation, and cost-effectiveness while meeting the programmatic mission. In carrying out this program a graded approach shall be taken by line management in the development and implementation of the maintenance program. By a graded approach, it is intended that the depth of detail required and the magnitude of resources expended for a particular maintenance function be commensurate with the functions importance to safe and reliable operation, environmental compliance, safeguards and security, programmatic mission, facility preservation, and/or other facility specific requirements.

The graded approach to maintenance can be implemented by establishing an essential equipment list with two or more categories. These categories would grade components according to their importance in the operation of the facility. The most essential and costliest items receiving the most maintenance attention followed by less attention for less essential items.

Preference on the maintenance of the Electrical System will be in the following order:

1) Clean, adjust, rework, or repair equipment in place.

2) Remove and replace with available spare; rework, or repair original; requalify original, and maintain as spare.

3) Remove, rework, or repair, requalify, and return to service.

APPENDIX B – MAINTENANCE SCHEDULES

Corrective Maintenance

Corrective maintenance on all sub-systems in the Electrical Distribution system will follow the above stated preference of repair in-place; replace, or remove and repair maintenance. Maintenance on this system shall be performed with the component and/or system de-energized.

When practical, an alternate power sources for essential loads should be provided before de-energizing a major switchboard or OPENING a major circuit breaker. De-energizing a specific panel or switchboard will probably result in the loss of a site function. All de-energizing of component or systems must be site wide coordinated.

Preventive Maintenance

The preventive maintenance program discussed in this section generally follows that recommended by NFPA-70B, Electrical Equipment Maintenance, 1990 edition. The atmosphere or environment in which this electrical equipment operates effect its operating capabilities and the degree of maintenance required. Temperature, moisture, and dirt are the main factors which contribute to electrical equipment deterioration. The recommended preventive maintenance frequency discussed in this section should be followed for at least four maintenance cycles, unless undue failures dictate a shorter cycle or until trending of the specific equipment as outlined in the MOIM indicates that a change in periodicity is warranted.

In addition to trending, specific manufacture's recommendations on the types of maintenance and the periodicity of preventive maintenance must be considered. Neither the equipment vendor nor national standards factor in the graded approach used in this system. Preventive maintenance will be performed more frequent on critical items and less frequent on the same item used in a less critical application. As equipment history is accumulated, preventive maintenance items and frequency should be altered, the result in the maximum benefit to the overall goal.

Table B-1 is a summary of the frequency of maintenance recommended in the following discussions for the different types of major equipment employed in this system.

The Electrical Distribution equipment utilized in the (ED00) Electrical Distribution System will be discussed generically in this section. Sub-systems which contain unique equipment will be discussed as follows:

1) ED08 – Central Uninterruptible Power Supply
2) ED09 – Backup Diesel Generators
3) ED10 and ED11 – Underground Switchgear

APPENDIX B – MAINTENANCE SCHEDULES

Liquid-Filled Transformers

Manufacturers of the different types of oil filled transformers are identified in Table ED02-1. Transformer preventive maintenance usually requires disruption of service, therefore, preventive, and corrective maintenance should be combined into one outage. On an annual basis the following should be performed as recommended by the manufacturer.

1) Laboratory analysis of the insulation-cooling media (oil).

2) Visual inspection for oil leaks, cleanliness, and functions of moving parts (fans, doors, etc.)

3) Blanket gas laboratory analysis.

4) Observe transformer gauges for acceptable values and record along with environmental parameters.

5) Torque major connection bolts to manufacturers recommended values.

6) Megger test and/or high-potential insulation test as recommended by the manufacturer.

Some manufacturers will require more extensive preventive maintenance on a three-to-six year basis. Some examples are as follows:

1) Extensive insulating oil analysis and/or oil replacement
2) Inside tank inspection
3) Tank pressure relief testing
4) Tank painting

APPENDIX B – MAINTENANCE SCHEDULES

TABLE B-1 GENERAL GUIDELINE FOR MAINTENANCE FREQUENCY

Preventive Maintenance Equipment	Recommended Inspection Period	Recommended In-service Period*
Liquid-Filled Transformers	1 yr	1M
Dry transformers: 13.8 kV	3 yr	1M
Dry Transformers: 480 V	3 yr	1M
Power Circuit Breakers	1 yr	None
Circuit Breakers: Molded	1 yr	None
Switchgear Assembilies	1 yr	6M
Load Interrupter Switch	3 yr	None
Harmonic Filter	3 yr	3M
Motor Control Center	3 yr	3M
Contactors	1 yr	None
Protective Relays	2 yr	None
Other Electrical Boards	3 yr	6M
Batteries (varies with application)	1M	1W
Diesel Engine	3M	1 shift
Diesel Generator	6M	1 day
UPS	3M	1W
U/G Switchgear	1 yr	3M

* Weekly or monthly in-service inspection may be omitted when they coincide with performance of the defined preventive maintenance.

Maintenance Requirements

Maintenance requirements for the equipment and components of the building electrical power system should be in accordance with manufacturers recommendations and standard industrial practice.

In-Service Inspection

Non electric exit signs shall be processed as solid rad waste at the end of their useful life and shall be replaced with new signs.

Dry Transformers - 13.8 kV

Preventive maintenance for dry type transformers can usually be performed on a three to six year schedule. Manufacturer's recommendation should be followed. Some of the typical maintenance requirements are as follows:

1) Extensive inside of enclosure inspection for cleanliness, tightness, and free cooling paths.

2) Cooling fan operation

3) Megger tests and/or high-potential tests as recommended by the manufacturer.

Dry Transformers - 480V

Dry low voltage transformers usually require little preventive maintenance. Besides the visual examination, clean with compressed gas and vacuum. Megger and/or high potential test as recommended by manufacturer.

Circuit Breakers - Metal Enclosure

Between one and three years, metal clad switchgear circuit breakers should be removed from their cubicle. The following maintenance should be performed as applicable and as recommended by the manufacturer.

1) Detailed inspection for dirt, corona, tracking splattered areas on insulation, (heat discoloration, etc).

2) Clean with compressed gas, vacuum cleaner, and lint-free rags and solvent.

3) Dress, clean, and align main, arcing, and intermediate (if so equipped) contacts.

4) Check main contacts and drawout contacts for proper pressure and main contact open distance.

5) Check air puffer device, if so equipped.

6) Check opening and closing springs for proper force.

7) Perform megger and high potential tests.

8) For vacuum breakers, the integrity of the vacuum bottle should be checked per manufacturers' instructions.

9) Main contact resistance should be measured.

10) Lubricate only the moving parts recommended by manufacturer.

11) All auxiliary devices should be verified by functional testing.

APPENDIX B – MAINTENANCE SCHEDULES

Circuit Breakers - Molded Case

The performance of molded case circuit breakers is based on production testing and calibration at the manufacturers' plant. These tests are based on UL standards. Molded case breakers are sealed so that operation of the mechanism can not be adjusted. They can be expected to perform properly with preventive maintenance limited to detection of internal heat, loose terminals, dirt removal. If a molded case breaker is used in a critical circuit, the breaker should be manually operated once a year as practical.

Switchgear Assemblies

These assemblies, outdoors and indoors, house circuit breakers, transformers and other devices. While circuit breakers and transformers should be maintained as outline previously, other equipment in the switchgear assemblies should also be maintained on a regular basis. After de-energizing the assemblies, the following preventive maintenance should be performed somewhere between one and three years depending on ambient conditions.

1) Bus bars cleaned and torqued.

2) Calibrate protection relays.

3) Verify proper operation of heaters, louvers, interlocks, etc.

4) Verify all station grounds.

5) CTs and PTs are handled as dry transformers.

6) Megger and high potential test cables, busses, and wiring as recommended by current industry standards. Varies based on equipment essentiality.

7) Spot painting should be considered.

Load Interrupter Switches

These medium voltage switches should follow the same preventive maintenance schedule as circuit breakers with maintenance requirements adjusted to the needs of the simpler mechanisms.

13.8 kV Harmonic Filters

The harmonic filter used with the Salt Handling Hoist equipment is comprised of all static parts and requires little preventive maintenance. The filter is made up of condensers (capacitors), reactors (inductors), and resistors.

APPENDIX B – MAINTENANCE SCHEDULES

Preventive maintenance will be limited to cleaning and performance of any specific test required by the manufacturer. This maintenance is required on a three to six year cycle and should be coordinated with other 13.8 kV shutdown schedules.

Motor Control Center (MCC)

MCC can be maintained similar to switchgear assemblies. Most MCCs are indoors and at a lower voltage and can have a less frequent maintenance schedule based on the environment.

Contactors

Since contactors are the working portion of a MCC, normal wear can be expected. The only preventive maintenance is to perform an inspection with the unit de-energized. Specific attention is paid to moving parts. Deficiencies observed should usually result in corrective maintenance replacement. This inspection should be performed yearly along with any specific manufacturers' recommendations.

Protective Relays

Subject to manufacturers requirements, protection relays can be tested either with circuit breaker in operation (CLOSED), or withdrawn from the operating position. Manufacturer's test sets or approved equivalent shall be used for protective relay testing. Protective relays include overcurrent, undervoltage, phase sequence, ground check, ground fault and other type devices are separately accessible for testing. Overcurrent protective device settings which cover long time, short time, and instantaneous operation should be verified at least every two years. If the protective device setting programs do not include circuit breaker tripping, circuit breaker tripping should be verified once every two to three years.

Other Electrical Boards

These smaller boards (panelboards, mini power centers, distribution panels, lighting panels, switchracks, etc.) are basically low voltage and only require cleaning and lug tightening similar to MCCs and switchgear assemblies. The schedule should be in a range of three to six years, tending towards six years, based on the consequence of a failure and on experience.

Batteries

Lead acid storage batteries generally require preventive maintenance on a monthly basis. Per the manufacturers recommendations, cell measurements can be done monthly on a pilot cell and quarterly on all cells. Rack and mechanical maintenance can probably be performed yearly. Wide variations in battery maintenance frequency would

be justified as between personnel carts and UPS applications. Examples of battery preventive maintenance are as follows:

1) removal of dirt and corrosion products.

2) Restoring proper electrolyte levels.

3) Examination for cell casing cracks.

4) Recording room and cell temperatures, voltage, amperes, and specific gravities.

5) Terminal torques and connection resistances.

Meters - Instruments

Most electrical meters located within the electrical distribution system are for indication only and require no rigorous scheduled calibration. Meters - instruments which are used in a control loop (even if the loop utilizes the operator) should be calibrated yearly until experience dictates otherwise. An example is the backup diesel oil pressure and temperature instrumentation.

Backup Diesel Generators

The diesel generators are housed in their own enclosure. The enclosures should be kept clean and maintained the same as switchgear assemblies and the other general components (circuit breakers). The following specific maintenance requirements apply to the diesel engine and for the rotating electrical equipment.

Diesel Engine

The manufacturers' maintenance instruction should be followed. The instructions will generally cover the following items which are similar to maintenance performed on an automobile.

Quarterly:

1) Check for cleanliness and obstructions.
2) Check liquid levels.
3) Lubricate moving parts.
4) Check filters and belts.

Annually:

1) Replace liquid and air filters.
2) Replace oil and coolant.

3) Replace belts.
4) Instruments that have a control function shall be calibrated.

Biennial:

1) Disassemble portions of the engine and perform manufacturers recommended measurements and replacements.

Generator

The generator is maintained as any electrical rotating equipment. The bearing can be lubricated along with the diesel engine lubrication. The preventive maintenance for the electrical wiring is similar to transformers; that is, inspect and clean. On a semiannual basis, the winding should be cleaned with vacuum, brush, cloth, and vendor recommended solvent. Compressed air should not be used. Electrical connections on generators and control boards should be checked for tightness.

Central UPS

Preventive maintenance is to be performed in accordance with the EPS-2000 O&M manual. When replacing batteries, use the same model and manufacturer.

Underground Switchgear:

1) Switchgear Stations: Follow recommendations for Switchgear Assemblies.

2) Portable Power Centers: Follow recommendations for Switchgear Assemblies.

3) Mini Power Centers: Follow recommendation for Other Electrical Boards.

Federal Mine Regulators require continuity and resistance of underground grounding systems to be recorded annually and after modification or repair.

In-Service Inspection

In the Electrical Distribution System, in-service inspection is performed without disturbing the system or component. It is an inspection of the operating system. A comprehensive program can reduce the corrective and preventive maintenance down time by anticipating performance problem from systematic observations and trends recorder in monitoring instruments. Besides considering non invasive tools, like infra red scanning, the following inspections for specific equipment should be performed as listed below.

APPENDIX B – MAINTENANCE SCHEDULES

Liquid Filled Transformers

Observe the liquid levels, pressure, and temperature meters permanently installed on these transformers. These observations and a thorough search for liquid leaks should be performed monthly.

Dry Transformers: 13.8 kV and 480 V

Observe where provided temperatures, cleanliness of cooling areas, and evidence of water once a month.

Switchgear Assemblies

Every six months where possible without de-energizing, open the external doors and observe the following:

1) Internal electrical devices
2) Cables and insulators
3) Cooling paths
4) Cleanliness, dryness, rodents, reptiles, etc

Harmonic Filter

This system is totally outdoors and can be observed for broken insulators, bulging capacitor cases, and general cleanliness every three months.

Motor Control Center (MCC)

Meter switches should be manipulated to verify operability. Feel the switch and panel for overheating, observe ground wires, and water leaks. Frequency should be every three to six months.

Other Electrical Boards

On a six month schedule follow the recommendations for MCCs.

Diesel Engine

When running, liquid levels should be checked and the diesel shed area should be visited and observed during every shift. When not running, a weekly check is sufficient.

Generator

Load and frequency should be observed daily when operating.

APPENDIX B – MAINTENANCE SCHEDULES

Uninterruptible Power Supplies (UPS)

Amperes, voltage, and frequency should be observed weekly to ensure standby availability.

Underground Switchgear

1) Switching Stations: Follow recommendations for Switchgear assemblies.

2) Portable Power Centers: Follow recommendations for Substations.

3) Mine Power Centers: Follow recommendations for Other Electrical Boards.

A more frequent schedule should be considered for underground equipment.

Predictive Maintenance

Predictive Maintenance (PdM) is the technology of determining a machine/component condition without disturbing normal operations in effort to forecast required maintenance and maintenance schedules. PdM involves collecting and trending data to reduce or eliminate unnecessary repairs and unexpected failures. Numerous techniques are available for collecting data. For electrical systems, WIPP uses Infrared Thermography and Ultrasound.

Infrared Thermography is a non-contact technology that makes visible the heat differences in operating equipment. In electrical systems, thermography can detect poor connections, overloads, load imbalances and faulty, mismatched or improperly installed components.

The technology of ultrasound is concerned with sound waves that occur above human perception, usually from 20,000 Hertz and up. When there is an electrical discharge, it disturbs the air molecules around it, producing ultrasound. Therefore, in electrical systems, ultrasound is used to detect corona, tracking or arcing.

The equipment that is included in the Predictive Maintenance Program is chosen from the essential equipment list and by cognizant and maintenance engineers. Any equipment may be included at any time due to rate of failure and cost of repairs/replacement. Generally, all applicable equipment is surveyed every 6 to 12 months or even more often if warranted by history, local conditions, or need. Periodicities can be changed as conditions change.

APPENDIX C – SYSTEM INTERFACES

APPENDIX C – SYSTEM INTERFACES

The interfacing systems shall be divided into primary and secondary systems as defined below:

Primary System	The primary system in an interface is the system that requires the functions and services or support provided by others at the specific interface so that the primary system can satisfy required design criteria.
Secondary System	The secondary system in an interface is the system which provides the functions and services or support required by others at the specific interface so that the primary system can satisfy the required design criteria.

Primary System Interfacing

System ED00 is the primary system in interfaces with systems listed below:

System	Title
AU00	Underground Facility and Equipment
CM00	Central Monitoring System
FP00	Fire Protection System
GC00	General Civil & Structural
HV00	Heating, Ventilation & A/C
VU00	Ventilation
WD00	Water Distribution

Secondary System Interfacing

System ED00 is the secondary system in interface with the systems listed below. The interface between system ED00 and the systems it supplies will be at the electrical terminals of the supply distribution boards or circuit breakers. Cabling between the components of the supplied systems will also be provided by system ED00.

APPENDIX C – SYSTEM INTERFACES

System	Title
AU00	Underground Facility and Equipment
CA00	Compressed Air System
CF00	Confinement Facilities
CM00	Central Monitoring System
CW00	Chilled Water System
EM00	Effluent and Environmental Monitoring
FP00	Fire Protection
GC00	General Civil and Structural
HV00	Heating, Ventilation & A/C
PC00	Plant Communications
PP00	Plant Protection
PV00	Plant Vacuum System
RM00	Radiation Monitoring
UH00	Underground Hoisting System
VU00	Ventilation
WD00	Water Distribution
WH00	Waste Handling Equipment

Primary System Interface Detail

Underground Facility and Equipment (AU00)

AU00 provides space and structural support for electrical equipment situated in the underground. Penetrations through bulkheads and accessibility is considered in the location of underground electrical equipment.

Plant Monitoring and Communication System (CM00)

CM00 provides monitoring, control and trip functions for ED00 systems as listed:

- Plant substation (13.8 kV) switchgear
- Surface area substations switchgear
- Backup diesel generators
- Underground switchgear

The interface between the two systems is at the input terminals to the System CM00 Local Processing Units (LPUs). Signals at the interface are as follows:

- Analog information is transmitted to the LPUs in the form of 4 to 20 mA or from 5 mV to 10 V signals.

- Status signals are provided by the closure of field contacts to the associated LPU half shell.

- Outgoing control signals are provided to System ED00 from the half shell of the associated LPU.

Fire Protection System Primary Interface (FP00)

FP00 provides protection for ED00 equipment located in structures with fire suppression or detection and alarm.

General, Civil and Structural Primary Interface (GC00)

GC00 provides ED00 structural support and space for electrical equipment located in surface structures. The GC00/ED00 interface is between the ED00 equipment and the mounting location within buildings. Equipment location information is provided on WIPP or vendor drawings for structures. Structural penetrations through walls, floors, or roofs and accessibility is considered in the location of surface electrical equipment.

Heating and Ventilating System Primary Interface (HV00)

HV00 provides environmental conditions and the associated heat removal for the operation of System ED surface equipment.

Ventilation Underground Primary Interface (VU00)

VU00 provides environmental conditions and the associated heat removal for the operation of System ED underground equipment.

Water Distribution Primary Interface (WD00)

WD00 provides treated makeup water for the Diesel Generator cooling system.

Secondary Interface Details

Secondary Interfaces relate to the service provided by ED00 to other systems such that those systems meet their design requirements.

System ED00 provides electrical power, cabling, grounding and lightning protection to all other WIPP systems. The interface between system ED00 and any equipment it serves is at the terminals of the served equipment nearest to the ED00 supplying device. The supplying devices comprise the switchgear, motor control centers and distribution panels.

APPENDIX C – SYSTEM INTERFACES

Underground Facility and Equipment (AU00)

ED00 provides AU00 electric power, lighting, safety grounding and cabling for system AU00 equipment. ED00 provides backup diesel power for U/G loads - 480V, 3 phase, 60 Hz, 400 kW.

Compressed Air (CA00)

ED00 provides electric power, lighting, safety grounding and cabling for system CA00 equipment. Air compressors are located in various surface facilities. Compressed air motors and associated support equipment such as cooling water pumps or fans are supplied at 480V, 3 phase, 60 Hz. ED00 provides backup diesel power for one 250 hp air compressor motor.

Central Monitoring System (CM00)

Provide power, lighting, grounding and cabling for CMR equipment from an uninterruptible power supply (UPS). Power required - 120 Vac, one-phase, 60 Hz. Provide normal electric power, grounding and cabling for EM00 instrumentation.

Fire Protection (FP00)

Provide normal electric power and diesel backup electric power, lighting, grounding, and cabling for System FP00.

General Civil and Structural (GC00)

Provide normal electric power, lighting, safety grounding and cabling for system GC00 structures.

Heating, Ventilation, and Air Conditioning (HV00)

Provide normal and backup diesel power, lighting, grounding and cabling for system HV00 equipment. Normal and backup power requirement – 480 V, three-phase, 60 Hz.

Plant Public Address and Alarm (PC00)

Provide uninterruptible power to the public address system. Provide uninterruptible power to the site computer system. Provide cabling, conduit, and grounding for other PC00 equipment.

Plant Protection (PP00)

Provide normal and diesel backup electric power, lighting, grounding and cabling for Security control building, the Gatehouse, perimeter security lighting, and other designated security lighting. Power required - 480 V, three-phase, 60 Hz.

APPENDIX C – SYSTEM INTERFACES

Plant Vacuum (PV00)

Provide normal electric power, lighting, grounding, and cabling for system PV00 equipment. Power required for 4 Vacuum Pumps - 480 Vac, three-phase, 60 Hz.

Radiation Monitoring System (RM00)

Provide normal and UPS power, lighting, safety grounding and cabling for system RM00. Surface instrument normal power requirements - 120 Vac, one-phase, 60 Hz. UPS power requirements to ARMs and CAMs in the Waste Handling Building - 120 Vac, one-phase, 60 Hz, 13 kW. Underground instrument power requirements - 120 Vac, one-phase, 60 Hz.

Underground Hoisting (UH00)

Provide normal electric power, grounding and cabling for system UH00 equipment as follows:

Air Intake Shaft Hoist Drive	480 V, 60 Hz
Air Intake Shaft Galloway Motors	480 V, 60 Hz
Salt Handling Shaft Hoist Drive	480 V, 60 Hz
Standby Salt Handling Shaft Hoist Drive	2400 V, 60 Hz
Waste Hoist Drive	480 V, 60 Hz

Also provide backup diesel power for the above Air Intake Shaft Hoist Drive.

Underground Ventilation (VU00)

Provide normal electric power, grounding and cabling for Underground Ventilation System equipment including the main exhaust fans (3 units) - 4.16 kV, three-phase, 60 Hz, and the EFB filtration fans (3 units) – 480 V, three-phase, 60 Hz. Provide backup diesel electric power for one of the above EFB filtration fans, 235 HP.

Water Distribution (WD00)

Provide power, grounding and cabling for Water Distribution equipment.

Waste Handling Equipment (WH00)

Provide power, lighting, grounding and cabling for Waste Handling equipment and backup diesel power requirements for WHB cranes.

APPENDIX D – OPERATING LIMITS

APPENDIX D – OPERATING LIMITS

The operating limits are listed below. Proper system and component operation can not be assured if these limits are exceeded. These limits are the steady state values; abnormal values which occur during equipment starting have been accounted for in the system design.

Table B-1 Operating Limits

PARAMETER	LIMIT
Nominal 115 kV System 109.25 – 120.75 kV 58.7 – 61.3 Hz	20 MVA
Nominal 13.8 kV System 13.11 – 14.49 kV 58.7 – 61.3 Hz	20 MVA
Nominal 4.16 kV System 3.75 – 4.57 kV 58.7 – 61.3 Hz	2.5 MVA
Nominal 2.4 kV System 2.16 – 2.64 kV 58.7 – 61.3 Hz	3.0 MVA
Nominal 480 V System 58.7 – 61.3 Hz	432 – 528 V
Nominal 208 V System 58.7 – 61.3 Hz	187 – 229 V
Nominal 120 V System 58.7 – 61.3 Hz	108 – 132 V
Backup Diesel Generator – Each 432 – 528 V 57.9 – 62.1 Hz	1.1 MW
Central Uninterruptible Power Supply Output:	100 kVA/80 kW 208 VAC ± 1% (205.92 – 210.08) 120 VAC ± 1% (118.8 – 121.2) 60 Hz ± 0.1% (58.94 – 60.06)

APPENDIX D – OPERATING LIMITS

Limiting voltage Transients for 4.16 kV Motors at Start-Up

During start-up of a 4.16 kV motor, the supply voltage at the starting motor terminal shall not fall to a value less than 80 percent of the motor rated voltage.

During start-up of a 4 kV motor, the operating voltage at the terminals of any other motor operating on the 4.16 kV ac power distribution system shall be maintained above the voltage level at which the motor might stall.

APPENDIX E – PARAMETER LIST

APPENDIX E – PARAMETER LIST

Listed herein are significant parameters utilized in the Electrical System design.

Medium Voltage three-phase, 60 Hz Switchgear Rating				
Manufacturer Model	Siemens-Allis FC-500B	Siemens – Allis FSV-500B	Ensign 5120VB12DB1M	Powell Powl-VAC Series P-5000
Operating Mechanism	Magnetic	Vacuum	Vacuum	Vacuum
Ratings*				
Rated Voltage (kV)	13.8	13.8	13.8	4.16
Nominal MVA			500	250
(1) Rated max RMS voltage (kV)	15	15	15.5	4.76
(2) Rated voltage range factor	1.3			1.24
Rated withstand test Voltages				
Low freq RMS volts (kV)	36			19
Crest Impulse Voltage (kV)	95	95	95	60
Current Ratings in amps				
Continuous RMS current	1,200	1,200	600	1,200
(3) Short circuit RMS current at max kV	18,000	18,000	12,000	29,000
Closing & latching capability	37,000	37,000	20,000,	58,000
Control				
Closing	120 VAC	120 VAC	120 VAC	120 VAC
Opening	120 V cap trip	120 V cap trip	120 V cap trip	120 V cap trip
Rated interrupting time in cycles	5	5		5
Rated allowable trip delay in cycles	2	2		2
Ground	Low resistance			
Enclosure	outdoor metal-clad weatherproof aisle walk-in style			

Control Ranges

%age of rated voltage for continuous operation of AC equipment. 90 to 110% of 120 V AC
%age of rated voltage for short time operation of AC equipment. 70% of 120 V AC
* Numbers in parenthesis in the right hand column refer to notes below.

NOTES:

(1) Maximum Voltage for which the breaker is designed and the upper limit for operation.

(2) K is the ratio of rated maximum voltage to the lower limit of the rage of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage. Close & Latching rating is determined by the formula, 1.6 K x rated s.c. RMS amps.

(3) To obtain the required symmetrical interrupting capability of a circuit breaker at an opening voltage between 1/K time rated maximum voltage and rated maximum voltage, the following formula is used:
Required Symmetrical Interrupting capability = Rated Short-circuit Current X (Rated Max. Voltage)/(Operating Voltage)

For operating voltages below 1/K times rated maximum voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short-circuit current.

APPENDIX E – PARAMETER LIST

APPENDIX E – PARAMETER LIST

Medium Voltage Switchgear Instrument Transformer Ratings		
	13.8 kV	4.16 kV
Current Transformer		
Voltage Ratings in kV	15	5
Impulse Withstand Insul. Level (BIL) kV	110	65
Thermal Continuous Current Rating Factors	1.33 min @ 30 C	
Accuracy	1 min @ 55 C	
	0.3-B 0.1 metering	
Current Rating & ratios	T50 for relaying	
	Ref. to controlled drawings	Ref. to controlled drawings
Potential Transformers	70:1	40:1
Ratio	110	65
Impulse Withstand insul. Level (BIL) kV		
Accuracy		
Thermal Rating @ 30 C standard		
Voltage Ratings		

13.8 kV Interrupter Switch Ratings			
	Surface		Underground
Manufacturer	SA	W	S & C
Model	QBFSE2A	WFS	Minrupter
kV Ratings			
Nominal	14.4	13.8	13.8
Maximum Design	17.0	15.0	15.0
BIL	95.0	95.0	95.0
Current Ratings amps			
Continuous	600	600	600
Interrupting	600	600	600
Momentary Short Current	40,000	40,000	40,000
1 sec. Short current	25,000		
Fault Closing	40,000	40,000	40,000

APPENDIX E – PARAMETER LIST

APPENDIX E – PARAMETER LIST

13.8 kV/4.15 kV & 2.4 kV TRANSFORMER RATINGS		
Phase per transformer		3
Frequency Hz		60
Output (65 C rise)		2500
4.16 kV Sec. Wdg.		3125
2.4 kV Sec. Wdg.		
Cooling method		Forced air (with fans)
Winding temperature rise		
a) By resistance Deg. C		65
b) Hottest Spot, Dec. C		30
Max 24 hr. avg. ambient temp., Deg. C		30
Impedance at rated transformer MVA		
Base with standard tolerance, ± 7.5%		5.75%
Sound level, db		58
Ratings	HV Winding	LV winding
Rated Voltage	13.8 kV	4.16 kV/2.4 kV
Transformer	Delta	Resistance grounded WYE
connection Winding BIL, kV	95	65
Line bushing insulation		
Class, kV'	15	5
Line bushing BIL, kV	95	65
Neutral bushing insulation		
Class, kV		5
Neutral bushing BIL, kV		30
Taps (full capacity)		(4 no-load, ± 2.5%)
		2 above rated voltage
		2 below rated voltage

APPENDIX F – OPERATINGS GUIDELINES

APPENDIX F – OPERATIONS GUIDELINES

Infrequent Operation of the Surface Electrical Distribution System

In order to accommodate temporary loss of distribution equipment due to failures and maintenance or repair requirements alternative supply connections can be made to all area substations from the Plant substation with the exception of Sub 5 and the Salt Handling Hoist Drive supply equipment.

Power may be transferred either to or from 480 V tie lines between Sub 3 and Sub 1, and Sub 3 and the Support Building Sub in the event of the unavailability of direct 13.8 kV supply connections to any of these substations.

Power to the Emergency Operations Center (EOC) are supplied from two sources via an Automatic Transfer Switch (ATS) as follows: Normal 480 V power from Area Sub #3 or Alternate 480 V power from Area Sub #1.

Infrequent Operation of the U/G Electrical Distribution System

In order to accommodate temporary loss of distribution equipment due to maintenance or repair requirements alternative supply arrangements for each U/G switching station can be supplied from either of the feeders in the two shafts other than the one through which it is normally supplied.

In the event of loss of the feeders in any two shafts all switching stations can be connected to a supply from the feeder in the remaining shaft.

All switching stations can be completely isolated electrically from the Underground electrical distribution system. Load transfers can be made so that when a switching station is isolated the principal loads it supplies can be transferred to other power sources.

Infrequent Operation of the Backup Power System

Special provision must be made to allow the occasional use of equipment which requires significant power during operation under Backup Power conditions. Loads which require such attention include the following:

AIS personnel hoist Drive

- 200 HP electrical fire pump
- Guard and Security services
- Dynamic Lowering/Hoisting in Salt and Waste Hoists

APPENDIX F – OPERATING GUIDELINES

Prior to the introduction of an additional major load an evaluation must be made of the magnitude and priority of the existing loads on the diesel generator. Based on this evaluation a decision would be made as to what loads (if any) need to be disconnected.

If the diesel is operating at more than 900 kW it should be progressively unloaded to that power level by the disconnection of lower priority loads.

The Fire Water pump is supplied from Substation 4 which is not energized in the initial backup power lineup.

The Atlas-Copco air compressors are supplied from Sub 5 or from Sub 8 which can be supplied through PS CB-8 or PS CB-10. Should operation of these compressors become necessary during backup power operation, the electrical distribution system must be configured accordingly.

The use of the Salt Hoist in a dynamic braking mode requires power from Sub 5 supplied through PS CB-8 or from Salt Hoist Substation Switchgear 38P-SWG05/1 supplied through PS CB-1. During backup power operation, this will require the electrical distribution system to be configured accordingly. The load on the diesel generator should be checked and if necessary adjusted to provide for the additional 50 kVA needed. The hoist may then be operated in the dynamic lowering mode.

The Waste Hoist main power is supplied from the Waste Hoist Sub. Control power for the Waste Hoist is supplied via MCC 31P-MCC04/1 which is powered from the Support Building Sub. An additional 13.5 kVA is required to be supplied from the backup diesel generator to this MCC for operation in the dynamic hoisting mode.

Off-normal Events and Recovery Procedures

The electrical distribution system is designed to minimize the impact of failures in power supply and of distribution system components on overall availability. Such failures, considered "Off-normal events," are characterized by the equipment they immobilize or the system impact they result in. This characterization is irrespective of source or origin of the failure. The source of such failures varies from such things as equipment failures, natural phenomena (e.g., tornados or lightning) or man made events (e.g., vehicle collisions or fires).

A failure mode and effects analysis (FMEA) is provided in the Engineering File Room under a System ED00 FMEA Report folder. The intent is to show the adequacy of the design and its effects on the operation and safety of the public and operating personnel. The analysis assumes only single failures within components or systems as shown on the legend and presents the consequences of those failures.

APPENDIX F – OPERATING GUIDELINES

Loss of Power When Hoist is in Operation

When a cage was stopped at an intermediate level due to a sudden loss of power any passengers would be retrieved as follows:

- Dynamic lowering at the Salt Handling Hoist will allow an orderly descent of the cage to the mine level.
- Dynamic hoisting at the Waste Hoist brake will allow an orderly ascent of the cage to the surface.
- Power required for dynamic lowering or hoisting will be provided from the alternate diesel or from a portable generator hookup.
- A portable diesel hoist (PDH) can be rigged over all three Hoist Shafts to allow the PDH cage to be used to evacuate personnel.

APPENDIX G – SUPPLEMENTARY CODES AND STANDARDS

APPENDIX G – SUPPLEMENTARY CODES AND STANDARDS

Standards are grouped alphabetically under the name of the issuing organization.

American Institute of Steel Construction (AISC)	
S310	Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
American National Standards Institute (ANSI)	
B16.5	Steel Pipe Flanges, Flanged Valves, and Fittings.
B31.1	Power Piping Code.
C2	National Electric Safety Code
C33.38	Safety Standards for Panel Boards
C37.06	Schedule of Preferred Ratings and Related Required Capabilities for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
C37.09	Test Procedure for AC High Voltage Circuit Breakers rated on a symmetrical current basis.
C37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (IEEE 320).
C37.2	Manual and Automatic Station Control, Supervisory and Associated Telemetering Equipment.
C37.04	Definitions and Rating Structure for AC High-Voltage Circuit Breakers Rated on a Total Current Basis.
C37.9	Test Code for AC High Voltage Circuit Breakers Rated or a Total Current Basis.
C37.13.81	Low-Voltage AC Power Circuit Breakers Used in Enclosures (IEEE 20).
C37.14	Standard for Low-Voltage Direct-Current Power Circuit Breakers and Anode Circuit Breakers.
C37.16.80	Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors.
C37.17	Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
C37.20	Switchgear Assemblies, including Metal-Enclosed Bus (IEEE 27) including supplement C37.20A, C37.20B, C37.20C.
C37.30	Definitions and Requirements for High Voltage Air Switches, Insulators and Bus Supports.
C37.32	Preferred Ratings, Manufacturing Specification, and Application Guide for High Voltage Air Switches, Bus Supports, and Switch Accessories.
C37.34	Test Code for High Voltage Air Switch
C37.46	Power Fuses and Fuse Disconnecting Switches
C37.53.1	High-Voltage Current-Limiting Motor-Starter Fuses Conformance Test Procedures
C37.90-78	Relays and Relay Sys. Associated with Electric Power

APPENDIX G – SUPPLEMENTARY CODES AND STANDARDS

	Apparatus (IEEE 313).
C39.1	Requirements for Electrical Analog Indication Instruments.
C50.10	General Requirements for Synchronous Machines.
C57.12.00	General Requirements for Distribution, Power and Regulating Transformers.
C57.12.10	Requirements for Transformers 230 kV and below.
C57.12.90	Test Code for Distribution, Power and Regulating Transformers (IEEE 262).
C57.13-78	Requirements for Instrument Transformers.
C57.16	Requirements, Terminology, and Test Code for Current Limiting Reactors.
C62.1	Surge Arresters for AC Power Circuits.
C76.1	Requirements and Test Code for Outdoor Apparatus Bushings.
C83.9	Racks, Panels and Associated Equipment.
C83.79	Tools, Crimping, Solderless Wiring Devices, Procedures for User Certification.
C89.2	Dry Type Transformers for General Applications.
MC9.1	Temperature Measurement Thermocouples.
NQA-1	Quality Assurance Program Requirements for Nuclear Facilities.
N195	Fuel Oil Systems for Standby Diesel Generators
N-512	Protective Coatings (Paints) for the Nuclear Industry.
Y32.9	Graphic Symbols for Electrical Wiring and Layout Diagrams used in Architecture and Building Construction.
Z55.1-67	Gray Finishes for Industrial Apparatus and Equipment.
American Society of Mechanical Engineers (ASME)	
PTC-17	Performance Test Code, Reciprocating Internal Combustion Engines
American Society for Non-destructive Testing (ASNT)	
SNT TC-1A	Recommended Practice.
American Society for Testing and Materials (ASTM)	
A-36	Specification for Structural Steel.
A-123	Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
A-176	Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
B3	Specification for Soft or Annealed Copper Wire.
B8	Concentric-Lay Stranded Copper Conductors, Hard, Medium Hard, or Soft.
B33	Specifications for Tinned, Soft or Annealed Copper Wire for Electrical Purposes

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B187	Standard Specification for Copper Bus Bar, Rod and Shapes.
B236	Standard Specification for Aluminum Bar for Electrical Purposes (Bus Conductor).
D117	Methods for Testing Electrical Insulating Oils.
D-129	Test Method for Sulfur in Petroleum Products (General Bomb Method).
D270	Standard Method of Sampling Petroleum and Petroleum Products.
D370	Standard Method for Dehydration of Oil-Type Preservatives
D-700	Specification for Phenolic Molding Compounds.
D-808	Test Method for Chlorine in New and Used Petroleum Products (Bomb Method).
D-975	Specification for Diesel Fuel Oils
D-1523	Specification for Synthetic Rubber Insulation for Wire and Cable, 90°C Operation.
D2671	Testing Heat Shrinkable Tubing for Electrical Use.
D2863	Test for Flammability of Plastics Using the Oxygen Index Method.
E84	Test for Surface Burning Characteristics of Building Materials.
E119	Standard Methods of Fire Tests of Building Construction and Materials.
E205	Standard Specification for Oxygen Combustion Flask.
American Welding Society (AWS)	
A2.4	Symbols for Welding and Non-destructive Testing.
A5.10	Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes.
A5.12	Specifications for Tungsten Arc-Welding Electrodes.
D1.1	Structural Welding Code.
Diesel Engine Manufacturers Association (DEMA)	
Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines.	
Hydraulic Institute (HI)	
Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocation Pumps.	
Illumination Engineering Society (IES)	
IES	Lighting Handbook
IES CP-41	Nuclear Power Plant Lighting.
IES RP-7	American National Standard Practice for Industrial Lighting (ANSI A11.1).
IES	American National Standard Practice for Office Lighting (ANSI A132.1)

APPENDIX G – SUPPLEMENTARY CODES AND STANDARDS

Institute of Electrical and Electronics Engineers (IEEE)	
28	Standard for Surge Arresters for AC Power Circuits.
32	Requirements, Terminology, and Test Procedures for Neutral Grounding Devices.
80	Guide for Safety in Substation Grounding.
85	Test Procedure for Airborne Sound Measurements of Rotating Electric Machinery.
113	Test Code for Direct-Current Machines.
114	Test Procedures for Single-Phase Induction Motors.
115	Test Procedure for Synchronous Machines.
141	Recommended Practice for Electric Power Distribution for Industrial Plants.
142	Recommended Practice for Grounding of Industrial and Commercial Power Systems.
242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
259	Test Procedure for Evaluation System of Insulation for Specialty Transformers.
270	Definitions of General (Fundamental and Derived) Electrical and Electronic Terms.
422	Guide for the Design and Installation of Cable Systems in Power Generating Stations.
450	Recommended Practices for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.
462	General Requirements for Distribution Power and Regulating Transformers.
472	Guide for Surge Withstand Capability (SWC) Tests.
484	Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations.
485	Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations.
634	Standard Cable Penetration Fire Stop Qualification Test.
837	Qualifying Permanent Connections Used in Substation Grounding.
Instrument Society of America (ISA)	
Standards and Practices for Instrumentation	
S5.1	Instrumentation Symbols and Identification.
S26	Dynamic Response Testing of Process Control Instrumentation.
S50.1	Compatibility of Analog Signals for Electronic Industrial Process Instruments.

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Insulated Power Cable Engineers Association (IPCEA)	
S-19-81	Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA Pub. N. WC3).
P-32-382	Short Circuit Characteristics of Insulated Cable.
P-46-426	Power Cable Ampacities, Volume I - Copper Conductors.
40	Ampacities; Cables in Open-top Cable Trays
S-61-402	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
S66-524	Cross-linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA Pub. No. WC7).
S68-516	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA Pub. No. WC8).
National Electrical Manufacturers Association (NEMA)	
AB1	Molded Case Circuit Breakers.
CC 1	Electrical Power Connectors for Substation.
ICS 2-83	Industrial Control Devices, Controllers & Assemblies Rev. 1-79, Rev. 2-80, Rev. 3-82.
ICS2-324	A.C. General Purpose High Voltage Class E-Controllers.
TR1	Transformers, Regulators, and Reactors.
TR27	Requirements for Dry-type Transformers 0.25 kVA and above, 600 volts and over.
ICS 4-77	Terminal Blocks for Industrial Control Equipment and Systems.
ICS 6-78	Enclosures for Industrial Controls and Systems.
LA1	Surge Arresters.
MG-1	Motors and Generators (ANSI C52..1).
PB 1	Panel Boards
PV 5	Constant Potential Type Electric Utility Semiconductor Static Inverter Battery Charges
SG3	Low Voltage Power Circuit Breakers.
SG4	Alternating-Current High Voltage Circuit Breakers.
SG5	Power Switchgear Assemblies.
ST20	Dry Type Transformers for General Application.
VE1	Cable Tray Systems.
210	Secondary Unit Substations
National Fire Protection Association (NFPA)	
30	Flammable and Combustible Liquids Code
37	Stationary Combustion Engines and Gas Turbines.
70	National Electrical Code (NEC).
72D	Proprietary Protective Signaling Systems.
780	Lightning Protection Code.

APPENDIX G – SUPPLEMENTARY CODES AND STANDARDS

101	Code for Safety to Life from Fire in Buildings and Structures.
Steel Structures Painting Council (SSPC)	
Steel Structures Painting Council, Volume 2, Systems and Specification.	
PA 1	Shop, Field and Maintenance Painting.
PA 2	Measurement of Dry Paint Thickness With Magnetic Gauges.
PS 8.01	Rust Preventive Compounds (Thick Film).
SP 1	Solvent Cleaning (Editorial Changes 1971).
SP5	White Metal Blast Cleaning.
SP10	Near-White Blast Cleaning
Vis 1	Pictorial Surface Preparation Standards for Painting Steel Surfaces.
Underwriters Laboratories (UL)	
UL 1-79	Flexible Metal Conduit, February 9, 1983
UL 6-81	Rigid Metallic Conduit, October 23, 1981
UL 20-79	General-Use Snap Switches, February 26, 1982
UL 44-83	Rubber-Insulated Wires and Cables, May 12, 1983
UL 50-80	Cabinets and Boxes
UL 67	Electric Panel Boards
UL 94	Test for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 96A	Installation Requirements for Lighting Protection Systems.
UL 98-81	Enclosed Switches, March 31, 1983.
UL 347-79	High Voltage Industrial Control Equipment.
UL 467-72	Grounding and Bonding Equipment March 26, 1982.
UL 486A-80	Wire Connectors and Soldering Lugs for Use with Copper Conductors, February 10, 1983.
UL 489	Molded Case Circuit Breakers and Circuit Breaker Enclosures.
UL 498-81	Attachment Plugs and Receptacles January 3, 1983.
UL 508-77	Industrial Control Equipment March 18, 1983.
UL 510-82	Insulating Tape, March 16, 1982.
UL 514-79	Outlet Boxes and Fittings June 1, 1982.
UL 845	Electric Motor Control Centers.
UL 924-79	Emergency Lighting Equipment May 17, 1983.
UL 1059-75	Electrical Terminal Blocks, February 11, 1982.
UL 1277-83	List of Acceptable Sunlight-Resistant PVC Compounds for Use as Insulating and/or Jacketing Material on Listed Outdoor Flexible Cords and Christmas Tree Wire and Cords, Medium-Voltage Cable, and Power and Control Tray Cable.
U.S. Department of Energy (DOE Order)	
DOE O 420.1B	*Facility Safety*

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DOE O 430.1B	*Real Property Asset Management*
DOE O 5480.5	*Safety of Nuclear Facilities*
IMD 6105	"Physical Protection of DOE Property," 9/29/77
DOE O 433.1	*Maintenance Management Program For DOE Nuclear Facilities*
DOE/EV/1830-TM	*A guide to Reducing Radiation Exposure to As Low As Reasonably Possible*
U.S. Department of Labor	
Mine Safety and Health Administration	
30 CFR Part 57	"Safety and Health Standards - Underground Metal and Nonmetal Mines"
30 CFR Part 75	"Mandatory Safety Standards - Underground Coal Mines"
Occupational Safety and Health Administration (OSHA)	
The Building Electrical Power System will be designed in accordance with the applicable standards contained in 29 CFR 1910 and 29 CFR 1926 (commonly called OSHA).	
U.S. Department of Transportation, Federal Aviation Administration (FAA)	
FAA, Advisory Circular N. 70/7460-ID	Obstructive Marking and Lighting.
U.S. Federal Standards and Specifications	
W-B-134C	Battery, Storage (Lead Acid, Industrial Floating Service).
2.12	Reliability Assurance