

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02
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	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client
	Library Code: 303-E03-0000-00-EL-DCA-001-02	Vendor
	Document Title: ELECTRICAL DESIGN CRITERIA	
		Date: 2026-06-23
		Page 2 of 34

Tabulation of Revised Page

Sheet	Revisions							Sheet	Revisions						
	00	01	02	03	04	05			00	01	02	03	04	05	
1	x	x	x					38							
2	x	x	x					39							
3	x	x	x					40							
4	x	x	x					41							
5	x	x	x					42							
6	x	x	x					43							
7	x	x	x					44							
8	x	x						45							
9	x	x	x					46							
10	x	x						47							
11	x	x	x					48							
12	x	x	x					49							
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26	x	x	x					63							
27			x					64							
28								65							
29								66							
30			x					67							
31			x					68							
32								69							
33								70							
34								71							
35								72							
36								73							
37								74							

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 3 of 34

1. GENERAL	6
1.1. INTRODUCTION	6
1.2. DOCUMENT PRIORITY	6
2. SITE CONDITIONS	6
2.1. GENERAL SITE LOCATION	6
2.2 SITE DESCRIPTION	7
2-2-1- LITHOLOGY:.....	7
2.3. OBJECTIVE AND SCOPE	7
3. Standards and Codes	8
4. General Philosophy.....	8
4.1. DESIGN APPROACH.....	8
4.2. EQUIPMENT SELECTION.....	9
4.3. ENVIRONMENTAL CRITERIA.....	9
4.4. ELECTRICAL LOAD LIST	9
5. Power System Configuration.....	9
5.1. GENERAL.....	9
5.2. VOLTAGE LEVELS	10
5.3 INGRESS PROTECTION DEGREE (IP)	11
5.4. EMERGENCY POWER.....	11
5.5. POWER SYSTEM DISTRIBUTION.....	12
5.5.1. INCOMING 33KV SUPPLY	12
5.5.2. PLANT DISTRIBUTION.....	13
5.6. EMERGENCY POWER DISTRIBUTION	13
5.7. CABLE ROUTE APPLICATION METHOD.....	14
6. ELECTRICAL EQUIPMENT	14
6.1. TRANSFORMERS.....	14
6.2. NEUTRAL GROUNDING RESISTORS	15
6.3. 33KV SWITCHGEAR	15
6.4. 6.6 KV SWITCHGEAR	15
7. Equipment Selection and Sizing.....	16
7.1. TRANSFORMERS.....	16
7.2. LV SWITCHGEAR.....	17
7.2.1. 400V SWITCHGEAR.....	17
7.2.2. WIRING	17
7.2.3. NAMEPLATES.....	18
7.3. HV/ MV SWITCHGEAR.....	18
7.4. MOTORS.....	18
7.5. CAPACITOR BANK.....	19
7.6. VARIABLE SPEED DRIVE.....	20
7.7. LOCAL CONTROL BOX (LCB)	21
7.8. JUNCTION BOXES	21

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 4 of 34

8. Protection and Metering	22
8.1. GENERAL.....	22
8.2. GENERATORS.....	22
8.3. TRANSFORMERS.....	23
8.4. MOTORS.....	23
8.5. FEEDER UNIT.....	23
9. Electrical Power Study	23
10. Essential Power supplies.....	24
11. DC System	24
12. AC UPS System	24
13. Cables and Cable Installation	24
14. Cable Trays and Ladders	26
15. Bus duct	27
16. Allowable Voltage Drop	27
17. Earthing and Lightning Protection	27
18. CATHODIC PROTECTION (IF APPLICABLE).....	27
19. Lighting.....	28
19.1. LIGHTING FIXTURES.....	29
19.2. LIGHTING EQUIPMENT	29
20. socket Outlets and Plugs.....	30
21. Electrical Heat Tracing.....	30
22. Closed Circuit Television System (CCTV)	31
23. Telephone, Paging and LAN System.....	31
23.1 IP-PBX.....	31
23.2 PA&GA SYSTEM.....	32
23.3 LAN (LOCAL AREA NETWORK)	32
24. Telecommunication system notes.....	32
24.1. INTERCONNECTING CABLING SYSTEM.....	32

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 5 of 34

24.2. TELECOM SYSTEM INTEGRATION.....

33

24.3. TELECOMMUNICATION TIE-IN.....

33

25. Fire Detection system

34

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		Page 6 of 34

1. GENERAL

1.1. INTRODUCTION

“Nominal” and “Design” capacity of the project is equal to 2340 dtph and 2700 dtph fresh ore feed conditions respectively. The plant is “Designed” to accommodate the “Maximum” conditions.

1.2. DOCUMENT PRIORITY

In case of conflict between documents, the order of precedence shall be:

- Material Requisition
- Data sheet
- Drawings
- Specification
- Design Criteria
- Code and standards
- In any case the vendor shall inform purchaser and obtain clarification before proceeding with any work.

The Vendor shall notify the Buyer of any apparent conflict between this specification, the Codes and Standards and any other specification noted herein. Resolution and/or interpretation of precedence shall be obtained from the Buyer in writing before proceeding with the design/manufacture.

Alternatives proposed by the Supplier will receive careful consideration if they improve performance and reliability.

2. SITE CONDITIONS

2.1. GENERAL SITE LOCATION

- ✓ Site Location: Elevation: about 2500 meters above sea level.
- Temperature:
 - ✓ Max. (Summer): 35 °C
 - ✓ Design Max (indoor and outdoor) 40 °C
 - ✓ Min. (Winter): -25 °C
 - ✓ Design Min.(outdoor): -25 °C
- Relative Humidity:
 - ✓ Humidity: 30 % @ 33°C
 - ✓ Max.: 70 %
 - ✓ Min.: 23 %

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 7 of 34

For specific indoor area (above open sumps and flotation cells and above thickeners) due to special condition (water evaporation and water spraying) relative humidity shall be considered 100 %.

- Wind Condition:
 - ✓ Max. Wind Velocity already recorded: 130 Km/h
 - ✓ Prevailing Wind Direction:
 - ✓ Winter: Between South and South West
 - ✓ Summer: Between North and North East
 - ✓ Stormy days per annum: 10
- Rainfall:
 - ✓ Average: 500 mm/a
 - ✓ Design: 500 mm/a
 - ✓ Rainfall Intensity: 76 mm/h
- Snowfall:
 - ✓ Average: 100 mm/a (as water)
 - ✓ Design Intensity: 150 mm/a (as water)
 - ✓ Frost Line: 1200 mm below grade

2.2 SITE DESCRIPTION

2-2-1- LITHOLOGY:

The Site lithology consists of colluviums or slope wash overlying a deep volcanic weathering profile.

The Site lithology is summarized in below table:

Unit	Description	Top of Unit (m)	Approx. thickness (m)
1	Colluvium/ Slope wash	Surface	1-3
2	Residual Solids	3	5-10
3	Volcanic Rocks	10	>10

2.3. OBJECTIVE AND SCOPE

The purpose of this document is to identify the electrical systems, and methods for the design of electrical systems and services for the Copper Concentrator Expansion Plant.

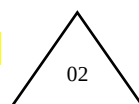
This plant includes below Area:

- Stockpile Area
- Grinding Area (Phase III and IV)
- Flotation Area (Phase III and IV)
- Lime and Reagent Area



	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 8 of 34

- Dewatering Area
- Molybdenum Area
- Air Compressor Room (in north of Flotation Area)
- Cooling Tower Area (in Lime and Reagent Area)



The scope of electrical work covers all electrical supplies, power distribution, emergency generation, protection, earthing & lightning, power and control cabling, cable tray & ladder, lighting, UPS system, DC supply system, small power distribution and wiring, materials, equipment and any other electrical items necessary for the satisfactory, completion of the works within the overall scope of the project.

3. STANDARDS AND CODES

Except where indicated otherwise in this philosophy the design, manufacture, testing transportation and installation of materials shall conform to the requirements of the latest edition of the following standards and codes where applicable.

The equipment covered by this Specification, including all components and auxiliaries shall be designed, manufactured and tested in accordance with the latest IEC Standards wherever they may apply, and in particular: unless otherwise specified, the design, equipment, materials, installation, inspection and testing shall be conformed to the requirements of the latest edition of the followings:

- International Electro technical Commission (IEC)
- Institute of Electrical and Electronic Engineers (IEEE)
- British Standard (BS)
- National Electrical Manufacturers Association (NEMA)
- VDE
- DIN

The specific listing of applicable codes and standards will be specified by number in the individual equipment specification. In case of conflicts, interference, or discrepancies between the listed codes standards and specifications the company will decide on the procedure to be utilized.

All Documents, Drawings, Data Sheets, etc. relating to this project shall be submitted in English, with the units of measurement in (SI) Metric System.

4. GENERAL PHILOSOPHY

4.1. DESIGN APPROACH

The electrical equipment and system design will be based on the above standards and codes. Necessary calculations shall be made to ensure that all equipment is suitable for the duty required.

Safety of personnel and facilities will be a priority in the design.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 9 of 34

4.2. EQUIPMENT SELECTION

Equipment and materials shall be specified, supplied and tested in accordance with IEC or other equivalent internationally recognized Standards and Codes. Specifications will be prepared for major electrical equipment to ensure suitable, reliable and cost-effective installations. Equipment supplied will be new and drawn from standard industrial ranges with proven operating experience in similar environments.

Voltage drops calculations, for the steady state and motor starting condition, shall be performed on the supply network. All loads connected to the supply network shall be considered at their maximum. Also, Power switchgears and motor control centre and circuit breakers shall be suitably rated, to withstand the possible levels of short circuit currents.

Generally, Substations and all facilities such as transformers, switchgear, motor control centre, etc shall be sized and rated with 20% spare capacity to cater for future loads.

Setting and selection of protective devices, including relays and fuse gears, shall be coordinated to ensure proper sensitivity in fault detection and selectivity in isolating and tripping the faulty circuit and thereby minimizing disturbances in the power supply network.

4.3. ENVIRONMENTAL CRITERIA

Electrical installations will be suitable for operation at continuous maximum rating under the extremes of ambient temperature and humidity imposed by the local environmental conditions, under the project environmental specification.

4.4. ELECTRICAL LOAD LIST

Electrical load list will be produced taking into account equipment rating absorbed power, efficiency, and power factor service factor and diversity factor. Also, electrical load list will be showing operation duty for loads, starting methods for motors and equipment nameplate. Entries for diversity are: (100%) for continuous loads, (0%) for standby loads and (25~75%) for intermittent loads refer to Process Discipline Design. The total designed load shall be calculated by adding, the 100% of continuous loads, plus the largest standby load or 10% of the standby loads whichever is higher (only for LV electrical consumers) and 25-75% of the intermittent loads as per project requirement. Load list shall be specified for each individual switch house i.e. AC, DC, normal and emergency.



5. POWER SYSTEM CONFIGURATION

5.1. GENERAL

The electrical system shall feature economic design for durable & continuous service and reliable operation. Considerations for safety of personnel and reliability of system & equipment during operation and maintenance shall be of prime concern. Ease of maintenance and operation, minimal

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 10 of 34

power loss, appropriate protection and safety features, interchangeability of equipment & components, minimal fire risk, adequate provisions for future extensions and modifications shall be considered in the design stage of electrical systems, as far as practicable.

There are HV switchgear 33 KV in the upstream substation and also noted that the output from upstream is within the limit of work of the contractor.

To fulfil the requirements for safe and reliable power supply generation and distribution, provision shall be made for:

- Power cables shall be separated from instrument cables and be fitted with proper fixing devices when following the same route.
- Spare power capacity
- Required switching facilities for power
- Selective protection systems
- Provision of uninterruptible power supply (AC) and (DC) systems with back up float charged battery.
- Provision of emergency generators with automatic start-up in case of mains failure.
- Use of fire-resistant cables (to IEC 331) for safety services and fire alarm system cables.

5.2. VOLTAGE LEVELS

The following voltage levels will be selected for the electrical system at rated frequency of 50 Hz. Motor shall be sized so that start and operate normally with 80% of nominal voltage and the other equipment will be suitable for continuous operation with voltages variation within +5% and -5% of nominal value for 33kV and within +10% and -10% of nominal values for 6.6kV and 0.4kV and frequency variation within +5% and -5% (Stationary: $\pm 2\%$ / Instantaneous: $\pm 5\%$).

Incoming power supply to the plant: 33kV-3 phase

Main power distribution system: 33Kv-3 phase

Intermediate power distribution system: 6.6kV-3 phase

Low Voltage Power Distribution System: 400/230 V, 3-Phase

Insulation voltage:

40.5kV (according to IEC) @ 33kV and 12 kV @ 6.6 kV and 1KV @ 0.4kV switchgears.

Lightning Impulse Withstand Voltage:

185kV (according to IEC) @ 33kV, 75kV @ 6.6Kv and 6Kv @ 0.4kV Switchgears.

1 Min. Power Frequency Withstand Voltage (R.M.S):

95kV (according to IEC) @ 33kV, 28kV @ 6.6kV and 1.89kV @ 0.4kV Switchgears.

Large and heavy duty MV motors: 6.6kV or 3.3kV-3 phase

Large VFD Medium Voltage Distribution: 6.6kV 3 phase

Large VFD Low Voltage Distribution: 690V or 400V 3 phase

Emergency power generation: 400V 3 phase

Motors ≤ 250 kW: 400V 3 Phase

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 11 of 34

Motors up to 0.4 kW:

230V 1 Phase or 400V 3 Phase

Lighting system: 230V-1 phase 50Hz-3 wire (1 phase, neutral, earth) or

400V-3 phase 50HZ-5 wire (3 phase, neutral, earth)

Power socket outlets: 230V 50 HZ- 3 wire (1 phase, neutral, earth) cable entry

Power socket outlets box: 400V 50 HZ- 5 wire (3 phase, neutral, earth) cable entry

Including:

- One welding socket outlet, 400V, 32A, 50HZ, 5 pin (3Ph+N+E)

- Two convenience socket outlet, 230V, 16A, 50HZ, 3 pin (1Ph+N+E)

Moreover, one MCCB 400V-40A as incoming, one RCBO 400V-32A-300mA along with two RCBO

230V-16A-30mA

Voltage of control and protection circuits for 33kV and 6.6kV SWGs including (Incoming, Coupling and Outgoing feeders): 110V DC From DC-Charger

Voltage of control and protection circuits for 0.4kV MCC SWGs including (Incoming and Coupling feeders): 110 V DC supplied from the DC Charger system (where a DC Charger is provided in the substation). Otherwise, 230 V AC supplied from the AC UPS system is acceptable.

Voltage of control and protection circuits for 0.4kV MCC SWGs including (Outgoing feeders):

230V AC From 400/230V Transformer Located in Relative 0.4kV SWG

Telecommunication Equipment: 48V DC

Control Voltage of PLC: 24V DC (for Digital signal) 4-20 mA (for Analog signal)



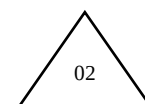
5.3 INGRESS PROTECTION DEGREE (IP)

The following protection classes shall be acceptable as a minimum unless specifically mentioned otherwise:

- IP42 for Indoor area (Such as: offices, control rooms, electrical switchgear rooms)

- IP55 for Outdoor area (Such as Industrial Buildings (Factory-Warehouse-workshop ...), Transformer and diesel generator Rooms, HVAC Rooms, Deluge Rooms)

- IP65 for Hazard and Heavy Pollution Areas (Such as: Stockpile Tunnel, Pebble Crusher, Transfer Tower) Only for Socket, Socket Box and Junction Boxes.



5.4. EMERGENCY POWER

The emergency power supply system will provide emergency power for supply the following loads on the failure of normal supply:

- Electrical loads essential for the safe shutdown of the utility plant

- Emergency lighting

- Some component of the HVAC package unit such as fans.

- Electrical Heat Tracing System



	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 12 of 34

- AC UPS system

- DC Charger system

- Loads critical for process, plant and personal safety

- and other emergency load as specified in electrical load list on failure of the normal power supply.

The emergency diesel generator shall operate in parallel with the normal power supply system only during test runs and for a short period after restoration of normal power supply (Back to normal operation).

When the diesel generator set is required, the relevant LV switchgear shall be supplied by two normal utility feeders and one emergency diesel generator feeder. The switchgear shall consist of three bus sections (A, B, and E) interconnected by two bus couplers, with load distribution across all sections to ensure operational flexibility and continuity of supply. Accordingly, the LV switchgear shall be designed based on a 3-out-of-5 switching arrangement.

In case of power failure of both incoming lines or normal power failure the bus section of emergency loads (E) shall be separated automatically and all emergency loads shall be supplied via distinct feeding line from emergency power generator.

The Genset shall be suitable for fully automatic starting and shall support unattended operations.

Over-sizing coefficient for emergency load shall be 25% of maximum initial emergency load.

Reacceleration of emergency loads or critical loads shall only be initiated after the voltage is restored to at least 90 % of nominal voltage. Engine shall be diesel type, and will be independent from other sources of supply.

Generator will be brushless type, and complete with automatic and manual voltage regulator and automatic speed governor. Voltage regulator and speed governor will be suitable to allow synchronized operation of emergency generator, with main power if required.

The diesel generators shall contain all controls necessary for automatic starting, stopping, fault monitoring, alarm indication and all the required equipment and accessories.

The emergency generator shall be self-ventilated, and Class F insulation with Class B temperature rise.

The complete engine generator unit shall be free from critical and torsion vibration within the operating speed range.

5.5. POWER SYSTEM DISTRIBUTION

5.5.1. INCOMING 33KV SUPPLY

Power will be distributed to extension areas of the plant as required. The terminal point will be in main 33kV substation.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 13 of 34

5.5.2. PLANT DISTRIBUTION

33kV switchgear will be used to distribute power to the mill power transformers and MCC distribution transformers in concentrator area.

This distribution will be from a line-up of 33kV. It will consist of two buses, each connected to one of the main transformers. There will be a tie breaker located between the buses to provide increased system reliability.

The system will be worked based on 2 out of 3 configurations.

There are 6.6kV switchgears in project plant, there are located in grinding area, flotation area and dewatering area.

The supply to the 6.6kV switchgears will be from two 33 to 6.6kV transformers. This distribution will be from a line-up of 6.6kV switchgears consisting of breakers and be used to supply power to the large synchronous/asynchronous motors. It will consist of two buses; each being fed from a separate transformer. There will be a tie breaker located between the buses to provide increased system reliability. The tie breaker will work based on 2 out of 3 configurations with fast transfer facilities.

Low voltage switchgears will be fed from 33/0.4kV distribution transformers. The 400V LV switchgear will be used to provide power to the 400/230 V loads in the plant area. These switchgears will be equipped with a main incoming breaker for isolation and protection. It will also contain spare feeders and combination starters for possible future loads.

There are several switchgears in different areas such as stockpile area, grinding area, flotation area, and etc. The LV switchgear will operate based on a 2-out-of-3 configuration, while the LV switchgears equipped with DG will operate based on a 3-out-of-5 configuration.

The main incoming breaker to the lighting or emergency power distribution system will be four pole types with all necessary protection and metering and interface to control system.

5.6. EMERGENCY POWER DISTRIBUTION

In the event of a power outage, emergency generators of 400V, 3 phases, 50Hz will be available in the plant. 6 sets of DGs will be used in these areas (Grinding Area, Flotation Area, Molybdenum plant, and Dewatering). The scheme of these switchgear with DGs is 3 out of 5. In this configuration, we have three incoming feeders, each connected to their associated bus sections, and two bus couplers between the three bus sections. All loads (Outgoing Feeders) are divided between the three mentioned bus bar sections. In normal operation, the IN A & IN B circuit breakers and bus coupler (A/E) are closed, while the IN E and coupler (A/B) circuit breakers are open. In normal operation the bus tie (A/E) is always closed and Bus-bars A & E are supplied from incoming A and bus-bar B is supplied from incoming B. When one of the incoming feeders (A or B) fails (e.g., due to an under-voltage fault, etc.), transfer from the circuit breaker of the faulty incoming feeder to the coupling circuit breaker (A/B) will take place and three bus bar sections are supplied from the other live incoming

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 14 of 34

feeder. Whenever the de-energized incoming feeder is available again, the back to normal condition will be executed locally by using of synchronizing check relay and opening of Bus coupler (A/B) circuit breaker.

In Auto Mode and when two main incoming feeders A & B are de-energized, this situation will be recognized by Genset controller via receiving of sample voltage from PT's placed in main incoming feeders and after a few seconds the diesel generator will be started and when reached to it's nominal conditions, the Genset control panel will send close command to GCB (Generator circuit breaker) and IN C of MCC switchgear. in this condition the bus couplers (A/E & A/B) circuit breakers are blocked and they are not permitted for closing.

5.7. CABLE ROUTE APPLICATION METHOD

All of cables in underground shall be run in trench, and/or conduit bank and/or energy tunnel; and for above ground shall be run in tray/ladder/conduit.

Between 33kV switchgear and distribution: Insulated cables in tray in cable trench. Transformers inside concentrator building will be used.

Between two 33kV switchgears the cable will be used. The cable shall be extended by joint up to new places; the testing and erection of all cable will be in the scope.

Between 6.6 kV switchgear and 6.6 kV loads (motors, transformers): Insulated cables in tray in cable trench.

Between 400V MCCs and 400V loads: Insulated cables in tray or trench.

Between 230V Panels and 230V loads: Insulated cables in tray or conduit.

All 33kV and 6.6kV cables will have terminating stress cones, and 36kV and 12kV isolation.

6. ELECTRICAL EQUIPMENT

6.1. TRANSFORMERS

Transformers will be used to distribute electricity to the Concentrator plant and other areas around the site. The transformers, in general, will be outdoor, three phase, 50 Hz, 33 kV/6.9 kV, 33 kV/400 V, oil filled and hermetically sealed or conservator type units shall be confirmed by the client representative.

The selection of the transformer type will be indicated in the relevant data sheet. Oil immersed transformers, with KVA ratings of up to and including 2500KVA shall be sealed type.

Transformer below 500KVA can be cast resin, dry type. The transformers will be fed from a 33kV distribution breaker by a power line or an insulated cable in tray in cable trench. Protective relays and metering devices will be installed at each transformer distribution breaker. The transformers will also come with trip and alarm contacts to allow for the tripping of distribution breakers and monitoring of various alarms where required.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 15 of 34

6.2. NEUTRAL GROUNDING RESISTORS

A neutral grounding resistor (NGR) will be connected between the secondary common wye point to ground of the 33kV/6.6kV transformers. The NGR is designed to limit the ground fault current to a maximum of 200A for a duration of 10 seconds. Accordingly, the NGR rating is specified as 200A/10 s, with a resistance value of 19.05Ω.

On the 6.6 kV secondary side of the transformer, the phase-to-neutral voltage is 3.81kV. The required NGR resistance is determined by limiting the maximum ground fault current to 200A, as follows:

$$R = V_{ph} / I_g = 3.81 \text{ kV} / 200 \text{ A} = 19.05 \Omega$$

Therefore, an NGR with a resistance of 19.05Ω will limit the single-line-to-ground fault current to 200A for up to 10 seconds.

Transformers with a 400 V secondary will have the neutral solidly grounded and will not require an NGR.

6.3. 33KV SWITCHGEAR

The switchgear will consist of metal clad circuit breakers which will have control circuitry that will operate with a control voltage of 110 Vdc. The line-up will contain an extra cubicle, complete with a breaker, for use as a spare and to availability for future expansion. Busbars shall be sized for worst case scenarios of loading and interrupting capacity. This switchgear must be withdrawable type.

Item	Description
Nominal Voltage	33 kV, 3 Phase
Layout	Two buses connected by a tie breaker
Metering (Main): (metering center)	kW, kW hour, kVAR, power factor, frequency, voltage, current
Relay Protection Metering (Feeder)	kW, kVAR, kW hour, current as per single line diagram

6.4. 6.6 KV SWITCHGEAR

The switchgear will be metal clad, withdrawable and have control circuitry which will operate with a 110 Vdc control voltage. Busbars shall be sized for worst case scenarios of loading and interrupting capacity.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 16 of 34

Item	Description
Nominal Voltage:	6.6 kV, 3 Phase
Metering (Main):	kW, kW hour, kVAR, power factor, frequency, voltage, current
Metering (Feeder):	kW, kVAR, kW hour, current, power factor (for synchronous/asynchronous mills)
Relay Protection	as per single line diagram

7. EQUIPMENT SELECTION AND SIZING

7.1. TRANSFORMERS

The application of transformation is as follows:

- Oil immersed transformers, with KVA ratings of up to and including 2500KVA shall be sealed type.
- For oil immersed transformers with ratings above 2500KVA, the choice between sealed and conservator type (with air bag or diaphragm) shall be confirmed by the client representative. The selection of the transformer type will be indicated in the relevant data sheet.
- All transformers shall be considered with Dyn11 vector group.
- All Power transformers shall be considered ONAN type and equipped by off-load tap changer. ($\pm 2 \times 2.5$ % on the primary winding).
- All distribution transformers shall be considered ONAN type and equipped by off-load tap changer. ($\pm 2 \times 2.5$ % on the primary winding).

Transformers will be suitable for continuous operation at full load on a system with the voltage and frequency variations indicated and the environmental conditions stated in the relevant data sheets and the minimum rating of power transformers will be 120% of the continues demand.

All transformers shall be suitable for area classification of the location in which they are to be installed.

The neutral point of secondary windings rated 400 V and less shall be solidly earthed.

Power transformers shall be equipped with air filled disconnecting chambers and cable terminal boxes on the high and low voltage sides.

All transformers shall have Class A insulation.

The maximum temperature rise at site service conditions and under directs sunlight shall be:

Windings (measured by resistance): 65°C

Top oil (measured by thermometer): 60°C



	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev		Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor	Page 17 of 34
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00	
	Document Title: ELECTRICAL DESIGN CRITERIA			

Power transformers shall be in accordance with the equipment specification for transformers.

7.2. LV SWITCHGEAR

7.2.1. 400V SWITCHGEAR

The 400V main switchboards will be metal closed multitier cubicle type and will consist of air insulated circuit breakers, contactors MCCB's and thermal relay, fuse switches, protection degree IP42.

All units except soft starter or variable speed drive feeders will be of the withdrawable type. All switchgear will be installed in adequately air-conditioned rooms.

Circuit breakers for main incoming feeders and bus-couplers shall be motorized air circuit break type (motorized ACB Type).

Starters for three phases, 400 V motors shall be combination type consisting of a MPCB or MCCB and contactor(s), and components for protection, metering, controls and indication, etc., as per pertinent specification, and single line diagrams.

Feeder circuits for lighting panel boards and power distribution boards rated 630 A and below shall be MCCB type. For circuits rated above 630A, air circuit breakers shall be utilized. Each MCC shall be provided with 20% spare units each in different modular sizes. **The number and type of spare feeders for each MCC shall be finalized during the detailed engineering phase, based on agreement between the Contractor and the Consultant.**

400/230 V distribution panels shall be used for distribution of power to lighting fixtures, receptacles, and other small power users.

All material and equipment shall be suitable for the area classification in which they are to be installed.

All protective relaying for LV system shall be solid state, plug-in, modular type, with setting plugs or switches, complete with hand reset, and indicating flag, or lights for tripped status. Conventional relays may only be used for specific applications, upon approval by the Purchaser.

All relay modules of the same function shall be interchangeable.

The modules shall be so designed that removal of each module automatically short circuits current.

Test blocks complete with facilities for monitoring and secondary injection testing shall be provided for each unit assembly.

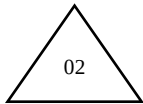
Switchgear device function identification numbers will be according to ANSI/IEEE Standard C37.2. Otherwise, equivalent IEC device numbers will be acceptable.

List of relaying and metering devices (types and quantities) shall be submitted for Purchaser's approval, by the bidder.

7.2.2. WIRING

Panels are to be equipped with:

- Terminal blocks for internal and external connections.



	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 18 of 34

- 15% spare terminal blocks.
- Internal ground lug, for min 2.5mm² wire.
- Panel board wire shall be class 5 cables, stranded copper, 90°C and 600 V insulation rating.
- Instrument cable pairs are individually shielded and rated for 300V. All conductors are identified with sleeve type labels.

7.2.3. NAMEPLATES

All labels are in English text. These include nameplates, warning and instruction plates. Where practical, the nameplate shall be mounted in the top right area of the equipment.

All labels are to be engraved to ensure indelibility and are constructed from either stainless steel or plastic laminated plates.

All back panel devices such as relays, fuses, terminal strips, circuit boards, etc. are to be appropriately labelled.

7.3. HV/ MV SWITCHGEAR

MV switchgear shall be “metal enclosed” and “metal clad” type & protection degree IP42. equipped with draw-out power Components in accordance with the equipment specification for switchgear and all of the same rating breakers shall be the same type.

For development plant circuit breakers shall be used for incomers and bus tie, Transformers, and feeder supply units.

Power circuit breakers and contactors will be vacuum type with provisions of surge protection devices to eliminate switching over voltages.

All units will be suitable for local and remote operation.

7.4. MOTORS

Generally, motors will be premium efficiency (Min. IE3), heavy duty, industrial type, squirrel cage, induction and TEFC (totally enclosed fan cooled) (IC411). These items could be change based on manufacturer's recommendations and technology. Exceptions apply to larger motors. For example, mill motors could be synchronous/asynchronous and the crusher motor may be wound rotor in order to have a higher starting torque. Motors using variable frequency drives will have special, appropriately designed insulation systems and will be adequately sized to provide the required speed turn down ratio without overheating. Separate cooling fans may be employed in certain cases.

Three phase electric motors shall generally be squirrel cage induction type with enclosure degree of ingress protection IP55 according to IEC 60034-5 for non-hazardous area and IP65 for hazardous area. The degree of protection for motor terminal boxes and bearing housing shall be IP55 or better, in all cases.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 19 of 34

Motors shall be capable of operating continuously at their rated torque and under the specified ambient conditions, and with voltage and frequency variations as follows:

- 10% of the rated voltage
- 5% of the rated frequency ($\pm 2\%$ Stationary and $\pm 5\%$ Instantaneous)

In general, all MV motors shall be equipped with space heaters. LV Motors equal and above 45kW or where specified on the data sheet shall be provided with space heaters.

All motors shall have Class F insulation, but with temperature rise of Class B.

For starting method, the datasheet of motors shall be considered.

The motors with rating equal and smaller than 250KW should be selected 400/690V and for rating with greater than 250KW should be selected 3.3 or 6.6 KV.

Also, all process motor (equal and above 5.5kW) feeders in MCC panels shall be equipped by Unit Protection and Control Device (UPCD).

7.5. CAPACITOR BANK

The capacitor bank shall be gas / dry type. The assembly shall consist of 3 phase capacitor bank, Double Star connected ungrounded for MV capacitors and delta connection for LV capacitors. The capacitor bank will be switched through a breaker to the main bus (nominal voltage phase to phase).

The control units shall contain a power factor relay (A.P.F.R) to measure the reactive power in the incoming feeder. In the event of the actual value differing from preset value, the relay shall activate contactors to switch capacitors in and out in steps required. The capacitor rating shall be chosen so that on average the required power is attained.

The capacitor shall be factory assembled in a panel with a protection degree of IP 42 or better suitable for indoor installation or installed in suitable structure for outdoor installation.

Where additional items are inserted in series with the capacitor to reduce the effects of harmonics etc., the effect of such items must be taken into account when assigning an r.m.s. rated voltage to the capacitor. Steep fronted over- voltages at power frequency may occur during transient system disturbances.

Except as stated above, the increase in the r.m.s. current through the capacitor arising as a result of variation in supply voltage, supply frequency and the presence of harmonic voltages will be restricted 130% of the normal current through the capacitor at rated sinusoidal voltage and normal

In this project capacity and number of steps of MV capacitor banks shall be finalized after determine harmonics sources such as Rectifiers, VFD and

Total harmonic distortion After Compensation with Capacitor Bank Shall be less Than 5%, and the measured $\cos\phi$ should be 0.95.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 20 of 34

7.6. VARIABLE SPEED DRIVE

The system shall be energy efficient, provide very high reliability, high power factor, low harmonic distortion, low vibration, wear and noise. It shall be easy to install with minimum time and expense and no special tools shall be required for routine maintenance.

The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristic of the load, with the input supply variation of $\pm 5\%$. The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit.

The drive system shall be designed to operate in one or more of the following operating modes to meet process requirements.

- Variable torque changing as a function of speed; i.e. Speed squared.
- Constant torque over a specific speed range.
- Constant power over a specific speed range where the torque decreases when the speed increases.

The drive controller shall be equipped with microprocessor based digital regulator with programmable functions.

The power control regulator logic shall provide for acceleration/deceleration current limits curves and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.

The Total Harmonic Distortion (THD) of the voltage and current at inverter output shall be as per IEC 61000 and IEEE 519 and the same shall be considered in the design of the motor.

The system shall be suitable for operation on a supply system with a short circuit rating as calculated based on the converter transformer (if provided).

The controller output overload capacity shall be 150% of rated current of motor for 10 seconds for variable torque applications and 110% of rated current for 60 second for constant torque applications. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and the voltage to the motor to guard against overload. If the load demand exceeds the current limit for more than 60 seconds, the drive shall shutdown to prevent motor overheating and drive damage.

During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in set point within a time limit of 5-120 seconds.

The integrator action of the set point alteration shall be independently adjustable both as upward and downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 seconds.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 21 of 34

It shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation. Short time voltage dips up to 80% of nominal, shall not cause the control system to stop functioning.

The drive shall trip in case of speed exceeds 105% of the maximum operational speed and reduce to 90% of the minimum operational speed for more than 10 seconds.

Maximum noise level from the drive at one meter distance, under rated load with all normal cooling fans operating shall not exceed 70 db.

Variable speed drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for startup adjustments and trouble shooting. Noise levels shall be in accordance with IEC 60034-9. Suitable silencers shall be provided as required to limit the motor noise level to conform the above limits.

Motors for VFDs will require de-rating, depending on the speed turndown ratio. The driven equipment vendor shall confirm the motor DOL start kW rating and the motor rating for the VSD duty with the bid document.

Motors shall be selected from the standard range of motors. They shall not be specially wound to improve the efficiency of the motor/ drive combination.

7.7. LOCAL CONTROL BOX (LCB)

Motor Control shall be carried out by local control stations, installed close to the motor and complete with:

- Start – Stop push button.
- Local – off – remote (or Manual – off – automatic) selector switch according to process requirements.
- Forward/Reverse Start.
- In special case some of LCB should be equipped by ammeter & control speed knob.

Control stations shall have mechanical protection degree IP54 minimum, with drain facilities. Control stations shall be suitable for the area classification where they are installed.

7.8. JUNCTION BOXES

Junction Boxes shall have a minimum protection IP54 in exposed and outdoor locations and also IP42 for indoor application.

Terminals shall be adequately rated for the cable conductor size and current rating.

In corrosive areas the material of JB body shall be stainless steel or GRP/FRP, and in other areas die cast aluminium shall be used. Plastic material is forbidden for all areas.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 22 of 34

8. PROTECTION AND METERING

8.1. GENERAL

The protection system will be designed such that a faulty circuit is identified and disconnected safely and quickly without adversely affecting the stable operation of other healthy circuits and plant.

The setting of protective devices will be selected to be stable during motor starting and transient conditions caused by current surges in circuits outside the protected zones.

For the purpose of protection co-ordination, the characteristics of the protective devices shall be plotted on a time, current diagram for the full range of fault levels to confirm selectivity and protection. Manufacturers relay curves, fuse curves and circuit breaker characteristics shall be used for this purpose.

Digital protective relays shall be selected and shall be positioned on main LV breakers which will be specified in single line diagrams.

Protective relays and metering will be used on the switchgear in the locations as shown on the single line diagram. Protective relays are used to trip breakers in case of fault conditions such as those shown on the single line diagram. Metering relays will display data such as kW, kW hour, kVAR, kVAR hour, power factor, frequency, voltage, and current.

The protection relays will be finalized in detail design.

All multi-function relays in 33/6.6/0.4kV switchgears are connected to PDCS by ethernet with IEC61850 protocol in order to send & receive the monitoring & control signals.

All measuring centres in 33/0.4kV switchgears, and all measuring centres in Incoming and Capacitor Banks Feeders in 6.6kV switchgears are connected to PDCS with Modbus RTU-RS485.

Diesel generators, DC charger, AC UPS are connected to PDCS by MODBUS RTU-RS485 in order to send & receive the measuring signals.

All measuring centres in motor feeders in 6.6kV switchgears are connected to DCS with Modbus RTU-RS485.

All RTD boxes in 6.6 kV switchgears are connected to DCS by MODBUS RTU-RS485 in order to send & receive the measuring signals.

All UPCDs and VFDs in MCC switchgears are connected to DCS by PROFINET in order to send & receive the monitoring & control signals.

The status on incoming feeders of main lighting panels and main HVAC panels are sent to PDCS systems.

8.2. GENERATORS

Emergency generator shall have as minimum the following protective and metering devices:

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	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 23 of 34

Reverse power, under voltage and over voltage, earth fault, over current, lock out hand reset relays, trip circuit supervision function, synchronizing check relay. 3 phase Ammeter, voltmeter with phase selector switch, watt-hour meter, wattmeter (2 elements), VAR meter, Frequency meter, power factor meter.

8.3. TRANSFORMERS

The main power transformers shall have as a minimum the following protective and metering devices: Lockout, hand reset relay, trip circuit supervision function. Alarm and trip relay for transformer oil/winding temp, Buchholz relay for non-sealed transformer.

Wattmeter, (2 elements), ammeters, (3 phase).

8.4. MOTORS

The following motor protection and metering shall be provided as minimum requirements.

- Less than 5.5kW: magnetic motor protection circuit breaker (MPCB).
- 5.5kW up to 18.5kW: motor protection circuit breaker (MPCB), 1 phase ammeter, unit protection and control device (UPCD).
- 18.5kW up to 45kW: magnetic motor protection circuit breaker (MPCB), Earth fault relay, ammeter (1 phase), over heat protection (RTD), unit protection and control device (UPCD).
- 45kW Up to 132kW: molded case circuit breakers (MCCB), Earth fault relay, ammeter (1 phase), over heat protection (RTD), unit protection and control device (UPCD), space heater.
- 132kW Up to 250kW: molded case circuit breakers (MCCB), Earth fault relay, ammeter (3 phase), over heat protection (4*PT100), unit protection and control device (UPCD), space heater
- for MV motors above 1000kW differential protection shall be considered.

8.5. FEEDER UNIT

Underground feeder cables will have as a minimum over current protection and 1 ammeter for nominal current more than 80 A.

9. ELECTRICAL POWER STUDY

The electrical calculations shall be performed according to IEC standards and includes the followings:

- | | |
|--|------|
| • Harmonic Study | ETAP |
| • Short Circuit Study | ETAP |
| • Motor Starting Study | ETAP |
| • Relay Coordination Study and Relay Setting Table | ETAP |
| • Load Flow Study | ETAP |

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 24 of 34

10. ESSENTIAL POWER SUPPLIES

Essential supplies will be via battery backed up systems rated to maintain the supply for a predetermined duration in the event of a mains failure.

Essential loads are mainly control system, PDCS, and F&G and CCTV, telecommunications (AC UPS supply), Electrical Power Control and Protection System (DC supply).

11. DC SYSTEM

A 110Vdc sealed battery and charger system will be used to provide 110Vdc control power to the 33kV and 6.6kV and 0.4kV switchgear. The 110Vdc will be used to operate the opening and closing of the circuit breakers and will allow breaker operation during a power outage or for scheduled maintenance. Each system shall consist of two 50% battery sets, two 100% battery chargers (dual parallel redundant) With 60 minutes backup time. The battery, units shall be split for individual off-line boost charging only and shall automatically return to service in the event of an emergency. They shall consist of fixed units, assembled to have an integral type panel with mechanical protection degree IP42.

The battery chargers shall be fully automatic type suitable for supplying the load and float charging the battery. Interlocks will be provided to inhibit automatic battery boost charge if battery room ventilation is out of service. Batteries and battery chargers shall be in accordance with the equipment specification for battery and chargers. Batteries shall be nickel - cadmium type.

12. AC UPS SYSTEM

The UPS system shall consist of two 100% UPS with common 2X100% battery bank of 60 minutes autonomy period.

Each UPS will consist of Two battery charger, Two dc/ac inverter, and one back-up bypass transformer, isolating transformer and AC (UPS) distribution system panel board in accordance with equipment specification for UPS systems.

They shall consist of fixed units, assembled to have an integral type panel with mechanical protection degree IP42.

Suitable static transfer switches shall be used to interconnect the static units and transformer.

Static switch shall be fully automatic and shall be designed to reduce to a minimum the transfer time.

Batteries shall be nickel - cadmium type.

13. CABLES AND CABLE INSTALLATION

Cable shall be suitable for such use and be duly protected against mechanical wear and be coated against environmental factors. The cables that are deemed to be damaged shall pass through steel pipe which shall be of flexible type at the connection points.

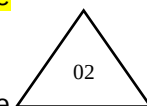
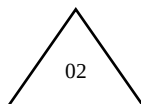
	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 25 of 34

All cables shall be located on strong cable ladders & trays or in ducts & trenches. The coating of conduits and cable ladders shall be hot deep galvanized, whereas, all cables and wires shall be labelled approved by NICICO.

An appropriate distance of at least 30 cm shall be considered between the power and control cable ladders as well as between power, instrumentation and network cables. In this regard applicable and well-known standards shall be fully followed by the contractor.

Type of Cables Should be as below:

- MV Cable: **N2XSY**
- LV Cable: N2XY
- Main Cable for VFD input: N2XY
- Motor cable from output VFD: N2XCY
- Lighting Cable: NYY or **N2XY**
- Control Cable: NYY
- LAN: CAT-7
- Fiber Optic: Single Mode
- Communication Cables (including telephone, paging, intercom, etc.): Annealed copper conductor, twisted pair with Aluminum shield and PE insulated.
- CCTV Cable: STP CAT 6a or better.
- Fire alarm cable will be fire resistance type based on I.E.C Standard with 1.5mm² cross section and mineral insulation.
- *** for more information refer to relevant specifications.
- Distance between MV cable and control/instrument cable shall be considered 60cm.
- **Armoured cables shall be used for cables directly buried in the ground and where they are exposed to mechanical damage.**



For underground cable MV & LV & Control cable: copper conductor with cross linked polyethylene (XLPE) insulation, lead sheathed single steel wire armoured with overall PVC jacket.

Cables installed in process areas handling condensate shall be protected by sealing the paving slabs over the cable trench or installing cables in ducts and sealing cables within ducts at draw pits.

Cables for underground installation in paved areas shall normally be laid in concrete trenches filled with fine sand, for the main routes of the cable, with concrete block covers.

Cabling in the offsite and other non-essential areas can be directly buried in trenches and back filled with fine sand and covered with concrete blocks and soil 'back fill'.

Cabling shall be protected by concrete duct bank(s) with suitable pipe sleeves when crossing roads and pipe racks.

Above ground cables shall be installed in cable ladder rack and tray or in open conduits.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 26 of 34

Cables shall be segregated according to voltage groups and routed on separate cable rack.

Cable glands shall be used both ends for terminations.

The cable sizing shall be selected taking into consideration the cable thermal limits both in normal services and in short circuit conditions, the allowable maximum voltage drops, the type of cable protection (fuses, circuit breakers or relays), the depth of laying, the soil thermal resistivity, and grouping factors.

The cables shall be sized to withstand without damage the maximum short circuit thermal stress for the full clearance time of the protective devices. The cable derating factors, related to thermal limits and laying conditions shall be according to the IEC and/or equivalent standard, cable chart shall be provided for all utilized cables.

The minimum current carrying capacity of cables after being derated shall be as follows:

- The transformer feeder cables shall have a current carrying capacity equal to the transformer rated current in ONAF condition when applicable.
- The motor feeder cables shall be selected based on motor nameplate rating taking into account the cable derating factors for ground temperature, ambient temperature, depth of laying, grouping, soil thermal resistivity below ground, or grouping and solar radiation above ground.
- All the remaining cable not mentioned above shall have a current carrying capacity equal to the maximum current demand of duration not shorter than one hour.

14. CABLE TRAYS AND LADDERS

Cable trays and ladders have to be used for the cabling on the crane.

Cable trays shall be installed on the external surface of structure and near walkways and platforms as far as possible.

Cable trays and ladders shall be provided with covers.

All cable trays cover and ladders shall be manufactured from hot dipped galvanized steel or stainless steel.

Cable trays and trays covers and ladders shall be manufactured from hot dipped galvanized steel or stainless steel.

Cable trays and trays covers shall have no sharp edges or sharp corners in order to protect the wiring and cabling.

Cable trays shall appropriate partitions to separate power and control wires, and be fitted with proper fixing devices to prevent excessive wire motion in the trunks.

Cable trays shall be designed to prevent water ingress. Nevertheless, the trays shall not trap any water inside in case of water ingress.

Cable ladders and trays shall be filled up to a maximum of 70%.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 27 of 34

All cable trays and ladders shall be earthed.

15. BUS DUCT

Bus ducting may be applied to transformer secondary connections equal and above 2500KVA. Bus ducting systems shall have provision for completing the installation on site to the “as built” dimensions of the substation and the “as installed” transformer.

16. ALLOWABLE VOLTAGE DROP

Total voltage drop to terminal of 400V motors shall not exceed 15% during starting period, and 5% in normal running condition.

Voltage drop between lighting panel board and farthest fixture shall be less than 3%.

Voltage drop between 400V MCC and lighting panel board shall not exceed 2%.

17. EARTHING AND LIGHTNING PROTECTION

Earthing loop system with radial taps to equipment shall be installed to ensure safety to personnel and equipment, in case of electrical failure, and to provide a path to earth for lightning and or static electricity.

Every electrical equipment enclosure, cable armoured, vessel, mechanical equipment and structures shall be connected to the earthing network.

A separate isolated earthing system shall be provided at each control room for electronic instrument system.

Lightning protection will be provided for stacks. Towers and structures lightning should be according to IEC 61024, NEC17-102 standards.

The lightning protection system shall be connected to their own earthing rods and also interconnected to adjacent general earthing network.

Sufficient earthing wells and/or rods shall be provided for the earthing system.

The earthing system resistance shall be according to BS-7430 or equivalent IEC standard.

The earthing system shall be TN-C-S system.

The measured resistance of earthing system shall be less than below parameters:

For all electrical system below than 2 ohm.

For instrument and control system below than 1 ohm.

The resistance of lightning grounding system should not exceed 7 ohm.

18. CATHODIC PROTECTION (IF APPLICABLE)

The cathodic protection shall be an impressed current system with manual control, and shall be designed for continuous operation of at least 20 years of operation.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 28 of 34

For steel structures, the usual criterion of protection is -0.85 V (without allowance for IR drop error) relative to a copper/copper sulphate reference electrode. Where anaerobic conditions occur and sulphate reducing bacteria may be present, a more negative value of -0.95 V (without allowance for IR drop error) should be adopted.

Design of cathodic protection system shall be such as to prevent stray current flow in the unprotected facilities if any.

In cases where elimination of stray current is impossible the structures affected by stray current shall be protected by bond or installation of sacrificial anodes.

The cathodic protection system shall be compatible with the grounding system.

Test points shall be provided to measure the potential of protected metallic structures, tanks and pipes at suitable intervals.

Available power will be 400 volts, three phase, 50 Hz and/or 230 volts, single phase, 50Hz.

19. LIGHTING

An emergency power supply including one 100% generator will be provided to supply emergency lighting on failure of the normal power supply. Approximately 30% % of the lighting fixtures at different locations will be fed from emergency power panels except for control room, emergency diesel generator room, substations, firefighting house which 50% of total lighting fixtures shall be considered as emergency. In addition, Emergency lights complete with battery and battery charger shall be provided in the following locations. These emergency lights shall be supplied either from a central battery system or the integral battery type shall be used. The back-up time of the battery shall be 30 minutes.

- Control rooms (20% of total lighting fixtures in the rooms)
- Substation switchgear rooms (20% of total lighting fixtures in the rooms)
- Emergency diesel generator room (20% of total lighting fixtures in the rooms)
- Fire Fighting House (20% of total lighting fixtures in the rooms).

The illumination levels shall be generally in accordance with API-RP-540 and/or other internationally approved standards.

Minimum illumination levels on each area shall be as below:

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02
	Document Title: ELECTRICAL DESIGN CRITERIA	00
		Date: 2026-06-23
		Page 29 of 34

Location:	Illumination level (Average)	unit
control rooms	400	lux
electric and instrumentation rooms (substation, HVAC room, local electrical room)	300	lux
Lime & Molybdenum Area	150	lux
Street and Road	50	lux
house, same building	150	lux
Office, canteen, guard	300	lux
Production area (concentrator saloon, pebble crusher, transfer tower, apron feeder, primary crusher, tunnel of stockpile and sacrificial belt)	150	lux
stairways and walkway of conveyor	30	lux
Outdoor area	20	lux

Lighting circuits shall generally be 230 V, single phase, 50 Hz supplied from either 400/230 V three phase or 230 V single phase panel boards, with separate neutral & earthing system. Branch circuit protection shall be provided by miniature circuit breakers (MCB's).

19.1. LIGHTING FIXTURES

The fixture and lamp selection shall favour a better quality light (more natural light) for inside plant buildings and offices, and higher lumen per watt output (more efficient) for outdoor lighting. The following fixture types shall be used for the various plant areas:

- Office, canteen, clinic, control rooms, substation, and same building areas: Fluorescent LED, with warm white-lamps. Warm lights provide a more suitable light for an office environment.
- Workshops and process area (Inside areas): LED fixtures.
- Exit lights: LED fixture.
- Outdoors: LED fixture.

19.2. LIGHTING EQUIPMENT

The lighting fixtures for outdoor installation shall be IP55 minimum and for indoor installation IP42. Lighting methods and materials shall be suitable for the area classification in which they are installed. Each lighting panel board shall be 400/230V, three wires and supplied from two individual fused switches or circuit breakers in 400V, from distribution switchboard and another one from emergency diesel generator.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 30 of 34

For control room built in battery fixture type shall be used to prevent total darkening during start of emergency diesel generator.

Lighting panel boards shall be equipped with four pole main circuit breaker and two pole branch miniature circuit breakers. Earthing bar shall be provided within the panel boards.

Branch circuits shall be two wire and earth 230V phase/neutral, with earth wire. The total estimated load shall not exceed 80% of the branch circuit rating.

Type of lamps and fitting shall be kept to the minimum.

Feeders to lighting panel boards shall be armoured, flame retardant cables laid on ladder rack and tray in accordance with the equipment specification for cable.

Underground cables may be laid in a trench.

20. SOCKET OUTLETS AND PLUGS

Socket outlets and their associated plugs, operating at different voltage levels, shall not be interchangeable. Each receptacle shall be suitable for the area classification in which it is installed.

Power socket outlets shall be rated 230V 50 HZ – 3 wire (1 phase, neutral, earth) and Power socket outlets box shall be equipped with one 400V, 50Hz, 5 wire (3 phase, neutral, earth) and two 230V, 50Hz, 3 wire (1 phase, neutral, earth). Including: One welding socket outlet, 400V, 32A, 50HZ, 5 pin (3Ph+N+E) and Two convenience socket outlet, 230V, 16A, 50HZ, 3 pin (1Ph+N+E).

Socket outlets shall be available at a distance of 30 meters from any point in the plant and in required locations.

Convenience outlets will be 16A rated 230V 1 phase connected phase/neutral to the two wire and earth lighting supply. They will have mechanical degree of protection according to the classification of the area where they will be installed.

230V socket outlets shall be installed in electrical Switchgear/Control Room at a distance of 7.5 m with minimum of two per room.

For office buildings, a minimum of three socket outlets shall be installed in each room.

Not more than 8 socket outlets shall be supplied by one circuit.

All 230 V, 16 A, sockets are supplied from lighting distribution panel.

NOTE: just in a wet & high risk area such as boiler room. earth leakage shall be considered for all lighting & socket feeders. In this area RCBO with 30mA as its sensitivity will be used instead of MCB.

21. ELECTRICAL HEAT TRACING

This project shall use Seft-Regulated heat trace cable thermostatically controlled to provide freeze protection. It is sensitive to temperature changes and adjusts its power consumption (watts) accordingly, increasing or decreasing it based on temperature variations. Due to the variable temperature of heat tracing cables throughout the year, using self-regulated heat trace cable,



	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 31 of 34

compared to constant wattage heat trace cable, leads to reduced energy consumption and, consequently, lower electricity costs. Its flexibility and easy installation and the ability to operate with standard voltage are considered key features.

To provide freeze protection the design requires that;

- Pipelines are insulated
- The system is temperature controlled.
- After the pipeline has been designed, the heat trace parameters can be established.

Sizing calculations require information on the following:

- Pipeline size and type (plastic or steel)
- Insulation type and thickness
- Process fluid type
- Temperature differential

With this knowledge in hand, the manufacturer would normally perform the calculations to recommend cable rating and control.

22. CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

The Process and Security IP-based CCTV Systems include cameras and switches. The security CCTV system can provide effective monitoring and enable proactive, real-time response through advanced pattern-based analytics.

The main CCTV System will be located in the CCTV room of the Flotation Building of each phase. The main monitoring room will be located in the control room of the Flotation Building of each phase.

The design will be considered based on the star topology.

23. TELEPHONE, PAGING AND LAN SYSTEM

23.1 IP-PBX

The IP-Based PABX will serve as the main call control agent within the plant, handling all calls coming into or out of the plant. All calls made within the plant over wire-line phones will be switched through the PABX and PA&GA will be switched through the PABX to other wire-line plant phones or to and from outside the plant.

The PABX will use the tried and true Time Division Multiplexed call processing architecture.

The PABX will have redundant call processing and memory system architecture. It will have a hard disk media storage device to back up its latest office image as well as load its operational software. It will provide a non-blocking switching matrix for all trunks and lines, which is preferred to be redundant.

The PABX system will connect to most of the phone sets throughout the plant location and to the buildings via the Fibre Optic Network or copper cable and shall be capable of connecting to the PSTN.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 32 of 34

The near telephony users shall be connected to central equipment through a copper cable backbone (CAT-6A distribution network). The outdoor line shall be used as a copper distribution backbone. All the analog/digital trunks associated with the PABX and the PA&GA system will also terminate in the control room MDF/Patch panel. The main PBX System will be located in the Telecom room of the Flotation Building of each phase.

23.2 PA&GA SYSTEM

The Public Address and General Alarm System is a critical system concerning personnel safety. The system shall be operational during an emergency. The system is required to remain operational and allow safe evacuation of the facility during an ESD level 0 event (if any). The PA&GA system shall broadcast alarm tones, pre-recorded messages, emergency voice messages, and routine voice messages to all or only to selected areas of the facility (industrial and non-industrial). The broadcasting shall be done using loudspeakers, in a reliable and safe mode. The Public Address and Alarm System shall cover all the indoor and outdoor areas. The paging system shall consist of a complete system of loudspeakers, power amplifiers, equipment racks, matching transformers, volume controls, a call station (built-in speaker), intercom stations, and The backbone cabling for the PA&GA system shall be copper cable. The main Paging System will be located in the Telecom room of the Flotation Building of each phase.

23.3 LAN (LOCAL AREA NETWORK)

The LAN system shall be distributed through copper cable and FO cable (wherever copper cable is not suitable), backbone. The distribution backbone will include Patch Panels (FO and/or CAT-6A), OCDFs (if applicable), cable (FO and/or CAT-6A), RJ-45 socket outlets, switches (both core and access), and servers. Each switch will be patched to the Fiber Optic Network (through OCDF and FO patch panel, if there is one) and to the RJ-45 socket outlet (through RJ-45 patch panel). The LAN and Telephony services will be broadcast on the Ethernet network. The LAN system will be designed based on the star topology.

In the case of ring topology, it shall be possible to reroute the Ethernet packet in both directions around the Fiber Optic ring to the destination addresses. The main LAN System will be located in the Telecom room of the Flotation Building of each phase.

24. TELECOMMUNICATION SYSTEM NOTES

24.1. INTERCONNECTING CABLING SYSTEM

The Interconnecting Cable for the Telecommunication Equipment will be a combination of several different types of cables for each of the components.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 33 of 34

The Fiber Optic Network will use single-mode fiber. The backbone cabling for all the Telecommunication systems will be combined within the same backbone cable route and/or duct where possible.

All cables within and outside the plant must be suitable for direct burial, cable trays, or cable ladders (if any).

The Phone and LAN wiring within each building will use CAT-6A Foil Twisted Pair (FTP). The CAT-6A cabling will connect to a patch panel (voice and data) at the buildings. Voice and data circuits will be patched to the Fiber Optic Network/copper distribution network in buildings, and then will be patched in the PABX.

The fire resistance copper cable shall be used for the PA&GA system.

All indoor cable shall be low smoke zero halogen.

All outdoor cable shall be Armor.

24.2. TELECOM SYSTEM INTEGRATION

The integration of the telecom systems with each other will be in the Contractor's/Vendor's scope of work. The contractor/Vendor shall prepare documents related to integration issues and the client will deliver all other contractors' documents related to the Telecom system in order to provide the requirements as per the Telecom scope of work in the contract. The physical integration of the telecommunication systems is required too.

24.3. TELECOMMUNICATION TIE-IN

There are some interfaces between telecommunication systems and other disciplines. The connection between telecommunication systems and other systems will be applicable but the Tie-In is the Terminal block or patch panel of the telecom systems.

The telecommunication equipment will be integrated via fiber optic cable. That is the scope of the contractor/vendor work.

- For each outgoing/incoming FO cable, the tie-in is the location of the main system. The connection of the main system to other sub-systems, both the engineering and construction are in the contractor/vendor scope of work.
- The passive and active equipment of fiber optic cable and both the engineering and construction is the scope of the contractor/vendor work.
- 2+2 Fiber optic cable will be considered for the client in the new server room.

	Client No: 28C3-D-4IN-DCR-090-0000-00-EL-0001	Rev	Date: 2026-06-23
Class: FA	Document No: 12002-D-EL-DCA-303-GNL-001	Client	Vendor
	Library Code: 303-E03-0000-00-EL-DCA-001-02	02	00
	Document Title: ELECTRICAL DESIGN CRITERIA		
			Page 34 of 34

25. FIRE DETECTION SYSTEM

The fire detection system will comprise of fire alarm, control and indicating panel, smoke and heat detectors in relevant areas and manual local fire alarm call points and alarm bell. This system is addressable type.

The alarm panel will be located at a central point of the plant, preferably with permanent presence of personnel, e.g. at the control room.

General characteristics:

Power supply: 230 VAC ($\pm 5\%$), 50 Hz

Operating voltage: 24 VDC

battery backup: 30 minutes in operation mode and 24 hours in standby mode

Operating temperature range: 0 °C ~ 40 °C

Fire Detecting panel IP: IP54 for outdoor and IP42 for indoor

Protection of fire alarm devices: IP54 for outdoor and IP42 for indoor

Applicable standard: NFPA, IEC 61439 & 60529