









Plant <b>1.0 MTPA ALUMINA REFINERY STREAM-5</b>	Client <b>NALCO</b>	Contract Code <b>NAL</b>	Document ID <b>6695-ELT-G00-EC-0002</b>	Contract No. <b>66-6695</b>
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### ABBREVIATIONS

Abbreviations mentioned below are only a sampling of common and specific usages. Other abbreviations, if used, it is expected that its full description is understood.

EHV - Extra High Voltage	FRLS - Fire Retardant Low Smoke
HV - High Voltage	IDMT - Inverse Definite Minimum Time
LV - Low Voltage	TEFC - Totally Enclosed Fan Cooled
FLC - Full Load Current	TETV - Totally Enclosed Tube Ventilated
I/C - Incomer	CACA - Closed Air Circuit Air Cooled
CT - Current Transformer	MCB - Miniature Circuit Breaker
PT - Potential Transformer	MCCB - Moulded Case Circuit Breaker
CB - Circuit Breaker	MPCB - Motor Protection Circuit Breaker
ACB - Air Circuit Breaker	SFU - Switch Fuse Unit
VCB - Vacuum Circuit Breaker	ELCB - Earth Leakage Circuit Breaker
ONAN - Oil Natural Air Natural	REF - Restricted Earth Fault
ONAF - Oil Natural Air Forced	ASB - Auxiliary Service Board
AN - Air Natural	SPDB - Small Power distribution Board
NGR - Neutral Grounding Resistor	OCTC - Off Circuit Tap Changer
PCC - Power Control Center	OLTC - On Load Tap Changer
MCC - Motor Control Center	DOL - Direct On-Line
GIS - Gas Insulated Switchgear	SWBD - Switchboard
UPS - Un-interruptible Power Supply	FRP - Fiber Reinforced Plastic
VRLA - Valve Regulated Lead Acid	TPN - Three Phase Neutral
VFD - Variable Frequency Drive	SPN - Single Phase Neutral
RTD - Resistance Temperature Detector	ACDB - AC Distribution Board
BTD - Bearing Temperature Detector	DCDB - DC Distribution Board
SCVS - Servo Control Voltage Stabilizer	AC - Alternating Current
ICAO - International Civil Aviation Organisation	DC - Direct Current
EMLDB - Emergency Main Lighting Distribution Board	MLDB - Main Lighting Distribution Board
ESLDB - Emergency Sub Lighting Distribution Board	SLDB - Sub Lighting Distribution Board

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CBCT - Core balance / Zero Balance

Current Transformer

FLC - Full Load Current

SCVS - Servo Control Voltage Stabilizer



DCS - Distributed Control System

JB - Junction Box



S/S - Substation

rms - Root Mean Square

Ph. - Phase

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<b>1) GENERAL INFORMATION</b>		
	<p>This document provides the minimum and generally followed norms, basis, guidelines for the electrical equipment/ systems in the project.</p> <p>This document contains all the major electrical equipment/ systems. The applicable ones shall be referred to.</p> <p>Refer Key Single Line Diagram Document no. 6695-ELT-G00-FA-0001 for the project.</p>	
	<b>Design ambient temperature</b>	50°C for Electrical equipment.
<b>2) SUBSTATIONS</b>		
	Cable routing options.	With cable cellar (cables routed on cable trays).
	Ventilation:	
	a) Switchgear room.	Naturally ventilated with exhaust fans (with wire mesh)
	b) Office-room, Operation & Maintenance room, Control room.	Air conditioned.
	c) Cable Cellar.	Naturally ventilated with exhaust fans. (with wire mesh)
	d) Battery room.	Not Applicable.
	e) UPS/VFD/Rack room SCADA panels, Battery charger & Battery	Air conditioned
	Transformer bay	Enclosed bay with roof and grilled rolling shutter in front.
	Doors.	Steel doors of 2 Hour fire rating.
	Exit doors.	At every 30 m.
	Walls.	Blast proof if it is within 15 m from hazardous plant. Transformer bay walls of 4 Hour fire rating.
	Window	Windows shall be provided in substation with fixed transparent pane.
	Additional rooms inside Substation building.	Toilet block. Ground Floor: Storage of emergency spares. First Floor: Electrical shift room, General shift maintenance group room, Documentation Room. Second Floor: Storage space for VFD spares/ modules.

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Additional requirement.	Industrial duty passenger lifts of minimum 2 ton capacity. Applicable for substation with ground floor (Cable Cellar room) + two floors (switchgear room and other rooms). Monorail shall be provided for switchgear room at first floor level at loading platform.
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### 3) TRANSFORMERS

	Design Data	Main Power Transformer	Distribution Transformer			Lighting Transformer	
	No-load Voltage ratio	220/11.5 kV	11/6.9 kV	11/0.72 kV	11/0.433 kV	11/0.380 KV	0.415/0.380 KV
	Vector group	YN0yn0	Dyn11		Dyn11	Dyn11	
	Cooling	ONAN/ONAF	ONAN		ONAN	AN	
	Tap changer	OLTC	OCTC		OCTC	OCTC	
	Spare capacity (on calculated operating load)	min. 20 %	min. 20 %		min. 20 %	min. 50 %	
	HV side termination	OH conductor	Cable		Cable	Cable	
4	LV side termination	Cable	Cable	Busduct	Busduct/ Cable(for trafo rating ≤ 800 KVA)	Cable	
	Neutral earthing	Resistance Grounded	Resistance Grounded	Solidly Grounded	Solidly Grounded	Solidly Grounded	

### 4) POWER SUPPLY UTILIZATION DETAILS

AC POWER FOR NORMAL POWER DISTRIBUTION					
	Voltage Level	Voltage & Variation	Frequency & Variation	System (No. of ph. & wires)	Application
	EHV- 220 kV	220kV ±10%	50 Hz + 3% / -5%	3Ph, 3W	Switchyard
	650V<High Voltage ≤ 11kV	11kV ± 10%	50 Hz + 3% / -5%	3Ph, 3W	Distribution/ HV Loads
		6.6 kV ± 10%	50 Hz + 3% / -5%	3Ph, 3W	HV Loads
		690 V ± 10%	50 Hz + 3% / -5%	3Ph, 3W	VFD Motor Loads
	Low Voltage ≤ 650V	415 V ± 10%	50 Hz + 3% / -5%	3Ph, 4W	LV Loads
		220 V ± 10%	50 Hz + 3% / -5%	1Ph, 2W	Lighting Loads

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AC POWER FOR EMERGENCY POWER DISTRIBUTION					
	Voltage Level	Voltage & Variation	Frequency & Variation	System (No. of ph. & wires)	Application
	Low Voltage	415 V ± 10%	50 + 3% / -5%	3Ph, 4W	Emergency Loads
CONTROL POWER SUPPLY					
	AC/ DC	Voltage & Variation	Frequency & Variation	System (No. of ph. & wires)	Application
	AC	240 V ± 10%	50 Hz + 3% / -5%	1Ph, 2W	Panel space heater supply & other auxiliary loads. Control ckts. of motor feeders (from Control Bus fed from 2 nos. of control Transformer with auto-manual facility, per bus section).
	AC	230 V ± 1%	50 Hz ± 0.5%	1Ph, 2W	Instrumentation loads, Telephone commu. system, Wireless commu. system, PA, FA, SCADA system, Transducer Panel and other critical systems
	DC	110V + 10% - 15%	-	-	Indication & control supply of all feeders of EHV, HV & ACB feeders of LV switchgear and DC critical lighting.



#### 5) N G R

	Earth fault current shall be limited to	11 kV: 900 A or FLC of transformer whichever is lower. 6.6 kV: 200 A or FLC of transformer whichever is lower.
	NGR rated current & time	Earth fault current for 10 seconds
	Material of NGR	Stainless steel



#### 6) METERING

Parameters to be monitored Feeder Type		I/C + LINE PT (also refer Note vii)			Bus Coupler HV/ LV	Bus PT HV/ LV	Capacitor HV/ LV	Trafo. Sec. voltage ≥ 433V	INDUCTION MOTOR (Also refer Notes i, ii, iii, vi, vii)			Diesel Gen. I/C		Distribution (Also refer Notes viii)
		HV	LV PCC	LV MCC					HV	LV		LV/ HV		
										≥ 30kW & ≤ 55 kW	≥ 75 kW	≤ 1000 kVA	> 1000 kVA	HV/ LV ( > 250 A)
	I	Y(C) (vii)	Y(C) (vii)	Y(C) (vii)	Y (C) +(D/A)	N	Y (D/A)	Y (C/D)	Y(C)+ A	Y(iii)	Y(C) (vi, iii)	Y(C) (vii)	Y(C) (vii)	Y(C/D) (iv) + A



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Parameters to be monitored		Feeder Type	I/C + LINE PT (also refer Note vii)			Bus Coupler HV/ LV	Bus PT HV/ LV	Capacitor HV/ LV	Trafo. Sec. voltage $\geq 433V$	INDUCTION MOTOR (Also refer Notes i, ii, iii, vi, vii)			Diesel Gen. I/C		Distri- bution (Also refer Notes viii)
			HV	LV PCC	LV MCC					HV	LV		LV/ HV		
											$\geq 30kW$ & $\leq 55 kW$	$\geq 75 kW$	$\leq 1000 kVA$	$> 1000 kVA$	
	V	Y(C) (vii)	Y(C) (vii)	Y(C) (vii)	Y (C)	Y (D/A)	N	N	N	N	N	Y(C) (vii)	Y(C) (vii)	N	
	Hz	Y(C)	Y(C)	Y(C)	Y (C)	N	N	N	N	N	N	Y(C) + AA	Y(C) + AA	N	
	PF	Y(C)	Y(C)	Y(C)	Y (C)	N	N	Y(C)	N	N	N	Y(C)	Y(C)	Y(C) (viii)	
	MW	Y(C)	Y(C)	Y(C)	N	N	N	Y(C)	Y(C)	N	Y(C) (vi)	Y(C)	Y(C)	Y(C) (viii)	
	MWh	Y(C)	Y(C)	Y	N	N	N	N	N	N	N	Y(C)	Y(C)	Y(C) (viii)	
	Hour run	N	N	N	N	N	N	N	Y	N	Y	Y	N	N	
	MVAr	Y(C)	N	N	N	N	Y (D/A)	N	N	N	N	N	Y(C)	N	
	MVAh	Y(C)	N	N	N	N	N	N	N	N	N	N	Y(C)	N	
	MVA	Y(C)	N	N	N	N	N	N	N	N	N	Y(C)	Y(C)	N	
NOTES :															
(C) : Composite meter, (D) : Digital meter, Y : YES, N : NO, (A) : Analog Meter with Selector Switch, (AA) : Analog meter															
i)	Motor Current display for all motors $\geq 15\text{ kW}$ (11kV, 6.6kV, 415V) and all agitators shall be provided at Plant DCS (in CCR) & also at Operator terminal for each substation.														
ii)	Current measurement shall be provided at PCC/ Switchgear for all motors $\geq 30\text{ kW}$ , all agitators & critical drives.														
iii)	Field ammeters are required for all motors rated $\geq 5.5\text{ kW}$ & for all agitator drives.														
iv)	Need not be provided if distribution board is in same substation.														
v)	Composite/ Digital Meters shall be provided with communication Port for SCADA connectivity.														
vi)	Multi-function meter (communicable type) shall be provided for all HV, LV (PCC/ MCC) incomers, bus couplers & DOL motors $\geq 30\text{ kW}$ (11 kV, 6.6 kV, 690V & 415 V) .														
vii)	For HV and LV incomers separate analogue ammeter and voltmeter with selector switches shall be provided in addition to composite meters.														
viii)	All lighting feeder incomers (MLDB & EMLDB) shall have separate metering (I, MWh) .														

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## 7) PROTECTION

### RELAY NUMBERS & DESCRIPTION



2	Timer	51N	IDMT Earth Fault Relay (Residual connection)
25	Synchro-check Relay	59	Over Voltage Relay
27	Under Voltage Relay	60	Voltage or Current Balance Relay
32	Directional Power Relay	64R	Restricted Earth Fault Relay
46	Negative Phase Sequence Relay	67	Directional Over Current Relay
49	Thermal Overload Relay	67N	Directional Earth Fault Relay
50	Instantaneous Overcurrent Relay	86	Tripping Relay
50G	Instantaneous Earth Fault Relay	87	Differential Protection Relay
50L/R	Locked Rotor Protection Relay	95	Trip Circuit Supervision (Separate Relay)
50N	Instantaneous Earth Fault Relay	96	Transformer Auxiliary Relay
51	IDMT Overcurrent Relay	80	DC Supervision Relay
51G	IDMT Earth Fault Relay		

### PROTECTION (For HV Switchboards, LV PCC/ MCC panels)

Relay No. & Descr.	Feeder Type	I/C + LINE PT HV/ LV	Bus Coupler HV/ LV	Bus PT HV/ LV	Capacitor		Transformer Feeder		Induction Motor Feeder		Diesel Gen I/C		Distri-bution with CB/ fuse
					HV	LV (ACB Feeder)	Sec. voltage > 433 V	Sec. voltage ≤ 433 V	HV	LV	LV		
											≤ 1000 kVA	> 1000 kVA	
	51	Y	Y	N	Y	Y	Y	Y	N	N	Y(xiv)		Y
	51N	Y	Y	N	Y	Y	Y (viii)	Y (viii)	N	N			Y
	51G (sec. neutral)	Y (i)	N	N	N	N	(i)	(i)	N	N	Y(xv)		N
	50	N	N	N	Y	Y	Y	Y	N	(xiii)	N	N	Y
	50N	N	N	N	Y	Y	Y (ix)	Y (ix)	N	(xiii)	N	N	Y
	50G	N	N	N	N	N	N	N	N	Y (xiii)	N	N	N
	49, 50, 50N, 46, 50L/R, 50G	N	N	N	N	N	N	N	Y (xi)	Y (xi)	N	N	N
	49	N (xviii)	N	N	N	N	N	N	N	N	Y (xvi)		N

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	Feeder Type  Relay No. & Descr.	I/C + LINE PT HV/ LV	Bus Coupler HV/ LV	Bus PT HV/ LV	Capacitor		Transformer Feeder		Induction Motor Feeder		Diesel Gen I/C		Distri-bution with CB/ fuse
					HV	LV (ACB Feeder)	Sec. voltage > 433 V	Sec. voltage ≤ 433 V	HV	LV	LV		HV/ LV (see note xxi)
											≤ 1000 kVA	> 1000 kVA	
	64R	Y (i & x)	N	N	N	N	Y (i & x)	Y (i & x)	N	N	Y (xv)		N
	87	N	N	N	N	N	Y (ii)	N	Y (xii)	N	N	Y (xvii)	Y (xviii)
	86 (Sep. relay)	Y	Y	N	Y	Y	Y	Y	Y	N	Y		Y
	95 (Sep. relay )	Y	Y	N	Y	Y	Y	Y	Y	N	Y		Y
	96	N	N	N	N	N	Y	Y	N	N	N		N
	27 (80%) + 2	Y	N	Y	(vi)	N	N	(vi)	(vi)	(vi)	N	N	N
	27 (20%)	N	N	Y	N	N	N	N	N	N	N	N	N
	59	N	N	Y (v)	Y (v)	N	N	N	N	N	N	Y	N
	25	N	Y (iv)	N	N	N	N	N	N	N	N	N	N
	60	N	N	N	Y (vii)	N	N	N	N	N	N	N	N
	46	N	N	N	N	N	N	N	N	N	Y	Y	N
	32	Y(iii)	N	N	N	N	N	N	N	N	N	Y (iii)	N
	67	Y (iii)	N	N	N	N	N	N	N	N	N	Y (iii)	N
	67N	Y (iii)	N	N	N	N	Y (viii)	N	N	N	N	Y (iii)	N
	80	N	Y	N	N	N	N	N	N	N	N	N	N
	NOTES :												
i)	51G & 64R are transformer protection relays located in the Incomer panel, for incomers fed from transformers, shall trip upstream breaker.												
ii)	For transformers rated 5 MVA and above.												

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iii)	32, 67, 67N shall be provided where paralleling of feeders is envisaged.	
iv)	For switchgear having bus transfer scheme, where continuous or momentary paralleling is envisaged.	
v)	Time delayed over voltage (59) protection to be provided if there are capacitor feeders on the Bus.	
vi)	The following feeders shall be tripped on sustained undervoltage, by undervoltage relay on Bus PT: a) HV capacitor feeders. b) HV & LV ACB controlled motor feeders or contactor feeders with DC control supply. c) Rectifier feeders.	
vii)	In case of HV Capacitor bank feeders, 60 (Neutral displacement) relay shall be Current operated for Double star connection and Voltage operated for Single Star connection with RVT.	
viii)	51N for delta primary/ directional IDMTL 67N for star primary.	
ix)	50N (with stabilizing resistance) shall be provided only for transformers with delta primary	
x)	64R shall be provided for transformers rated 1 MVA & above.	
xi)	• Overload Relay Type:	
	Electronics overload relay	< 7.5 kW
	Digital Motor protection Relay with display & fault record (46, 49, 50, 50N, 50G, 50 L/R)	7.5 kW ≤ Motor kW < 75 kW
	Digital Motor protection Relay with display & fault record (46, 49, 50, 50N, 50G, 50 L/R)	≤ 55 kW for agitator motors
	Comprehensive numerical Motor Protection Relay (46, 49, 50, 50N, 50G, 50 L/R)	Motor kW ≥ 75 kW
	Comprehensive numerical Motor Protection Relay (46, 49, 50, 50N, 50G, 50 L/R)	> 55kW for agitator motors
	• Bimetallic relay shall not be used.	
xii)	For motors rated 1000 kW and above.	
xiii)	Instantaneous O/C protection shall be achieved with fuse for motor rating ≤ 200kW. Earth leakage relay connected to CBCT shall be provided for motor rating 5.5 kW & above.	
xiv)	Voltage restrained overcurrent relay shall be provided for Diesel Generator feeders.	
xv)	51G shall be provided for Generators, 500 kVA and above. 64R shall be provided for generators rated 1000 kVA and above.	
xvi)	49, Temperature protection (through RTD) shall be provided for generators 1000 kVA and above.	
xvii)	For generators rated 1600 kVA and above.	
xviii)	In general differential protection shall be provided for critical/ long cable feeders where distance is >1 km. However differential protection shall be provided for all outgoing feeders from new 11kV switchgear building to Plant substations of 5 <sup>th</sup> Stream Alumina Refinery.	
xix)	Thermistor Relay shall be considered for Motors provided with thermistors.	
xx)	Each bus section shall be provided with Bus Differential Relays (87B) and BUS wire supervision Relay (95B) for HV Switchboards connected directly to generation buses or critical buses.	
xxi)	51N shall be provided for LV fuse/ MCCB distribution feeders above 250 A. 50G shall be provided for non-motoring loads rated above 5 kVA.	
xxii)	LV Air Circuit breakers shall be provided with external numerical protection with CT's. These shall not have any breaker mounted CT with releases.	
xxiii)	50N shall be provided with stabilizing resistance.	

#### 8) SWITCHYARD EQUIPMENT BASIC SPECIFICATION (220 kV)



Rated short time withstand current	40 kA for 3 seconds
Creepage distance	7595 mm (Minimum).
Lightning Impulse withstand voltage	+/-1050 kVP
Power frequency withstand voltage	460 kV (rms)
Minimum clearance	As per CBIP
Type of busbar	ACSR Single, Zebra
Main Bus configuration	Single Busbar

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a	<b>Circuit Breaker</b>			
	Rated current	630 A Minimum		
	Short circuit capacity, kA	<b>Short time withstand</b>	<b>Breaking</b>	<b>Peak/ Making</b>
		40/ 3 s	40	100
	Type	SF <sub>6</sub>		
	Operating mechanism	Spring assisted, motorized		
b	<b>Isolator</b>			
	Type	Double break, Gang operated, Center post Rotating		
	Operating mechanism	Motorised & Manual		
	Earth switch	Yes, Interlocked with Isolator (E/M)		
c	<b>Potential Transformer</b>			
	Type	Oil filled dead tank type		
	Secondary Voltage	110V/ $\sqrt{3}$		
	Accuracy class	0.2 for Tariff Metering, 3P for Protection		
	Continuous/Short time Overvoltage factor	1.2 / 1.5 for 30 s		
d	<b>Current Transformer</b>	<b>Metering</b>	<b>Prot.</b>	<b>Differential/ REF</b>
	Secondary current	1 A	5 A	1 A
	Accuracy class	CL 0.2	5P20	CL PS
	Type of Construction	Oil filled live tank type		
e	<b>Metering</b>			
	Parameters to be monitored	EHV-220 kV		
	I	Applicable, Composite meter and refer note 1.		
	V	Applicable, Composite meter and refer note 1.		
	Hz	Applicable, Composite meter.		
	PF	Applicable, Composite meter.		
	MW	Applicable, Composite meter.		
	MWH	Applicable, Composite meter.		
	Hour run	Not Applicable.		
	MVAR	Applicable.		
	MVAH	Applicable.		
	MVA	Applicable.		
	Harmonic analyzer (up to 25th harmonic)	Applicable.		
	<b>Note:</b>			
	1. Separate Digital ammeter and voltmeter shall be provided in addition to composite meters.			
f	<b>Protection</b>			
	Relay No. & Descr.	EHV-220 kV		
	51	Applicable.		
	51N	Applicable.		
	51G (sec.neutral)	Applicable, refer note 1.		
	50	Applicable.		
	50N	Applicable.		
	64R	Applicable, refer note 1.		
	87T	Applicable		

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	86 (Sep.relay)	Applicable.
	95 (Sep.relay)	Applicable.
4	67, 67N, 87B	Applicable.
	27 (80%)+2, 27 (20%)	Not Applicable.
	<b>Note:</b>	
	1. 51G & 64R are transformer protection relays located in the Control Relay panel.	
g	Insulators	Porcelain
h	Lightning Arrester	Station Class Heavy Duty ZnO, Gapless
i	Switchyard equipment supporting structure material	MS hot dip galvanized
j	Earthing material	MS hot dip galvanized
<b>9) HIGH VOLTAGE BUSDUCT</b>		
	Type	Phase segregated
	Material of Enclosure	CRCA sheet steel
	Degree of protection of enclosure	Outdoor IP55 & Indoor IP52
	Short time rating	40 kA for 3 second
	Material of Busbar & Max. current density	Aluminum 0.8A / mm <sup>2</sup>
	Sleeve requirement of Busbar	Heat shrinkable Sleeves
	Material & Type of flexible	Fusion bonded (Hot pressure welded) copper
	Material of flexible & Max. current density	Cu 1.2Amp / mm <sup>2</sup>
<b>10) HIGH VOLTAGE SWITCHGEAR (11 kV, 6.6kV, 690V)</b>		
	Type of Switchgear	Metal enclosed (air insulated)
	Degree of enclosure protection	min. IP4X
	Type of circuit breaker	For 11kV & 6.6kV, VCB, motorized For 690V, ACB, motorized
	Motor switching device	For 11kV, VCB for $\geq 1000$ kW , For 6.6kV, Vacuum Contactor with HT fuse for $< 1000$ kW, For 690V, MCCB with shunt realises.
	Short time rating of switchgear	40 kA for 3 second (11kV, 6.6kV) Minimum 50 kA for 1 second (690V).
	Type of Main Protection Relay	Numerical (IEC 61850 compliant)
	Internal Arc testing	40 kA for 1 second (11kV, 6.6kV)
	Material and arrangement of Busbars	Aluminum, Double bus: For Main 11kV panel located in new 11 kV switchgear building Single bus: For 11kV Panel at down stream substation.
	Sleeve requirement of Busbar	Heat shrinkable Sleeves with shrouds over busbar joint.
	Surge suppressors to be provided for motor feeder	In case of Vacuum CB/ Vacuum contactor feeders
	Supply changeover system	Auto/ manual with momentary paralleling
	Control voltage for Circuit breaker & relays	110 V (DC)
a	<b>Short circuit capacity of circuit breakers</b>	
	Symmetrical breaking	40 kA (rms) (11kV,6.6kV)
	DC component	Approx. 30 %



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	Making capacity	100 kA (peak) (2.5 times Breaking capacity) (11kV,6.6kV)		
b	<b>Spare feeders</b>	Min. 1 of each outgoing type		
c	<b>Potential Transformer</b>			
	Type of construction	Epoxy resin Cast		
	Mounting of bus PT	Drawout, separate panel		
	Mounting of Line PT	Drawout, with I/C CB		
	Continuous over voltage factor	1.2		
	Short time over voltage factor	1.9 for 30 s for non-Effectively grounded		
		1.5 for 30 s for Effectively grounded		
	Accuracy Class : Class 1 for metering and Class 3P for Protection			
d	<b>Current Transformer</b>	<b>Metering</b>	<b>Prot.</b>	<b>Differential/ REF</b>
	Secondary current	1 A	5 A	1 A
	Accuracy class	CL 1	5P15	CL PS
	Type of Construction	Epoxy resin Cast		
<b>11) LOW VOLTAGE SWITCHGEAR</b>				
	Type of construction	Floor mounted, Drawout type (For PCC, MCC)		
	Front	Single front		
	Cable Entry	Bottom		
	Degree of enclosure protection	IP 42 for MCC panels, IP 4X for ACB panels		
	Supply changeover system	Auto/ Manual (with momentary paralleling)		
	Type of Protection Relay for ACB feeders	Numerical		
	Spare feeders	20% with min. 1 of each rating		
	Control supply for ACB Feeder	110 V DC		
	Control supply for Contactor	240 V AC (through control transformer)		
	Space heater supply	240 V AC		
	Motor switching	i) Air Break Contactor - Below 75 kW (Contactor rating shall be one size higher than that recommended by the Type 2 Coordination of switchgear vendor). ii) Vacuum Contactor - 75 kW to 200 kW & Agitator motor.		
a	<b>Type of isolating device</b>			
	a) Incomer feeder	ACB, 4P (PCC, MCC > 400 A) SFU (MCC ≤ 400 A)		
	b) Bus coupler	ACB, 4P (PCC, MCC > 400 A) SFU (MCC ≤ 400 A)		
	c) Outgoing feeder			
	1) Motor feeder	SFU ≤ 200 kW		
	2) Distribution feeder	ACB > 400 A; SFU ≤ 400 A		
b	<b>Method of motor starting</b>			
	DOL	Upto & including 200 KW.		
	Star delta/ DOL/ Soft starter	NA.		
	Any other type	VFD- to be selected based on process requirement. Soft Starter- NA		
c	Material of busbars	Aluminum		
d	Sleeve arrangement of Busbar	Heat shrinkable Sleeves		



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e	Short time rating of switchgear	Rated switchboard fault level for 1sec		
f	<b>Short circuit breaking capacity of circuit breakers</b>			
	Symmetrical	As required kA (rms)		
	DC component	30% Approx.		
	Making capacity	2.1/ 2.2 times breaking capacity		
g	<b>Current Transformer</b>	<b>Metering</b>	<b>Prot.</b>	<b>Differential/ REF</b>
	Secondary current	1 A	5 A	1 A
	Accuracy class	CL 1	5P15	CL PS
	Type of Construction	Epoxy resin Cast		
<b>12) LOW VOLTAGE BUSDUCT</b>				
	Type	Less than 4000 A: Air Insulated, Non Phase segregated, Interleaved >2500 A. 4000 A and above: Sandwich type		
	Degree of protection	Outdoor IP55 & Indoor IP52		
	Short time rating	As required kA for 1 second		
	Material of Busbars	Aluminum		
	Material, type of flexible	Copper, Fusion bonded		
	Sleeve requirement of Busbar	Heat shrinkable Sleeves for Air insulated		
	Material of enclosure	CRCA Sheet Steel		
<b>13) UN-INTERRUPTIBLE POWER SUPPLY</b>				
	Configuration	Parallel redundant with SCVS		
	Output voltage	230 V AC, 50 Hz, 1 phase, Neutral earthed		
	Input isolation transformer	To be provided		
	Batteries	Double Bank with common battery sharing feature.		
	Battery backup duration	60mins (for the combined set of batteries).		
	Spare capacity to be considered for UPS sizing	Min. 50 %		
	Type of batteries	VRLA		
	Construction of ACDB	Sheet metal enclosed, modular, compartmentalised		
	Spare outgoing feeders for ACDB	Min 20 % with 1 of each rating.		
	Connectivity with computer / SCADA to be provided	Yes		
<b>14) SQUIRREL CAGE INDUCTION MOTOR (LV &amp; HV)</b>				
a	<b>Power supply for motor rating (DOL)</b>			
	Below <u>0.37</u> kW	Single Phase, <u>230</u> V AC		
	<u>0.37</u> kW to <u>200</u> kW	Three Phase, <u>415</u> V AC		
	Above <u>200</u> kW & below <u>1000</u> kW	Three Phase, <u>6.6</u> kV AC		
	<u>1000</u> kW & above	Three Phase, <u>11</u> kV AC		
b	<b>Power supply for motor rating (with VFD)</b>			
	Upto 200 kW	Three Phase, 415 V AC		




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	Above <u>200</u> kW to <u>630</u> kW	Three Phase, <u>690</u> V AC	
	Above <u>630</u> kW & below 1000 kW	Three Phase, <u>6.6</u> kV AC	
	<u>1000</u> kW & above	Three Phase, <u>11</u> kV AC	
c	<b>Starting duty cycle</b>	<b>Up to 200 kW</b>	<b>Above 200 kW</b>
	Equally spaced starts per hour from cold condition	4 nos.	3 nos.
	Successive starts from cold condition	3 nos.	2 nos.
	Successive starts from hot condition	2 nos.	1 no.
d	<b>Winding insulation/ Temperature Rise</b>		
	Insulation Class	F	
	Temperature rise limited to limits of class	B	
	Over voltage withstand capacity for stresses	<u>150</u> % rated voltage due to Bus Transfer	
e	<b>Minimum permissible voltage in percent of rated voltage for:</b>		
	Starting at Full Load	80%	
	5 minute running without overheating	75%	
f	Requirement of separate Canopy & material	FRP, for outdoor motors open to sky.	
g	Separate terminal box for space heater thermister,RTD/BTDs	Yes	
h	<b>LV Squirrel Cage Induction Motor (Specific requirement in addition to a, b, c, d, e, f &amp; g above)</b>		
	Cooling & Degree of protection	TEFC, IP56	
	Energy efficiency type	Min. IE2 as per IS:12615	
	Provision of space heater	30 kW and above	
	Thermistor to be provided for	≥ 75 kW and VFD operated Motors	
	Noise level	To be limited to <u>85</u> dB max.at <u>1</u> meter distance*	
	Starting current (Inclusive of IS/ IEC tolerance )	8.4 times Full Load Current (Max.)	
	If required, starting current shall be restricted to lower values based on voltage dip calculations.		
f	<b>HV Squirrel Cage Induction Motor (Specific requirement in addition to a, b, c, d, e, f &amp; g above) (690V, 6.6kV, 11kV)</b>		
	Cooling & Degree of protection	TEFC/ TETV/ CACA & IP56	
	Starting current (Inclusive of IS/ IEC tolerance )	6.6 times Full Load Current (Max.)	
	If required, starting current shall be restricted to lower values based on voltage dip calculations.		
	Main / Neutral terminal box type	Phase segregated/ Non Phase segregated resp.	
	Winding Protection	<u>2</u> nos. RTDs per Phase (Duplex)	
	Bearing protection	RTDs 1 each for DE & NDE bearing (Simplex)	
	Vibration monitoring for motor rating	<u>1000</u> kW and above	
	Noise level	To be limited to <u>85</u> dB max.at <u>1</u> meter distance*	
	*Special measures to be implemented (in coordination with Rotating Machinery group) in case noise level cannot be limited to 85 dB at 1m.		
<b>15) LOCAL CONTROL STATION AND LOAD BREAK SWITCH</b>			
	<b>A) LOAD BREAK SWITCH</b>		
	1. For flameproof type (Ex-d)	Die cast Aluminium (Applicable for Flame proof Area “Fuel/ Oil handling”).	

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	2. For Industrial type	Stainless steel (SS-304)
	Enclosure protection	IP 65
	Additional canopy	Yes, same as Enclosure Material
	<b>B) LOCAL CONTROL STATION</b>	
	1. For flameproof type (Ex-d)	Die cast Aluminium (Applicable for Flame proof Area "Fuel / Oil handling").
	2. For Industrial type	Stainless steel (SS-304)
	Enclosure protection	IP 65
	Additional canopy	Yes, same as Enclosure Material
	Type of stop Push Button	Stay put type with Mushroom head pad with locking facility
	Ammeter shall be provided for motor rating	5.5 kW and Above. And also for all agitator drive.
	Note: Glass, Cover & Dial shall be replaceable on damage	
	Type of indicating lamps	Clustered chip LED type
	Control device for breaker operation	TNC Switch
	Hardware material	Stainless steel
	Enclosure protection	IP 65
	Local-Off-Remote-Switch	NA
	Note: Load break switch with pad lock facility shall be provided near each LT motor & Load break switch to motor connection shall be through flexible copper (EPR) cable.	

#### 16) CABLES

a	<b>High voltage power cables (Above 1100V grade)</b>	
	Voltage grade for Solidly grounded system	Earthed Grade
	Voltage grade for Resistance Grounded System	Unearthed Grade
	Conductor material	Aluminum
	Conductor screen/ Insulation screen	Required
	Insulation	XLPE
	Inner sheath	Extruded PVC
	Armouring & type	Round/ Flat, Galv. steel for multi core, Al for 1 core
	Outer sheath	Extruded PVC, FRLS
	Max. conductor size for 1C/ 3C cables	For 11kV & 33kV - 1000 mm <sup>2</sup> for 1C / 300mm <sup>2</sup> for 3C For 6.6kV - 630 mm <sup>2</sup> for 1C For 690 & 415 V - 300 mm <sup>2</sup> for 3C
	Type of termination kit	Heat shrinkable
b	<b>Low Voltage Power cables</b>	
	Voltage grade	1.1 kV
	Conductor material & Type	Al for 6 sq. mm and above / Cu below 6 sq. mm, Stranded
	Minimum conductor size	2.5 sq. mm for Cu, 6 sq. mm. for Al
	Insulation	XLPE
	Inner sheath	Extruded PVC
	Armouring & type	As per IS, Galv. steel for multi core, Al for 1 core
	Outer sheath	Extruded PVC, FRLS
	Max. conductor size for 1C/3C cables	Up to 630 mm <sup>2</sup> for 1C & up to 300 mm <sup>2</sup> for 3C
c	<b>Control cables</b>	
	Voltage grade	1.1kV

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	Conductor material/ type/ size	Cu/ stranded/ Min. 2.5 mm <sup>2</sup>
	Insulation	PVC
	Inner sheath	Extruded PVC
	Armouring & type	Round
	Outer sheath	Extruded PVC, FRLS
	Spare core	20% with minimum 2 core
<b>d</b>	<b>Lighting sub-circuit cables</b>	
	Voltage grade	1.1kV
	Type, Conductor material & type	XLPE insulated, Cu – Solid conductor
	Conductor size	2.5 sq. mm
<b>e</b>	<b>Cable laying Philosophy</b>	
	Hazardous Plants	Not Applicable
	Non-hazardous Plants	Cable trays on Racks
	a) Major part on cable trays in air on pipe racks	Yes
	b) Cable trays in Built-up(RCC/ Brick) trenches to suit layout	Yes, Only if overhead routing not possible.
	c) Cable buried direct underground, with earth soil & sand	For street lighting, High mast lighting.
	d) Cable rack/ trays(ladder type) in built up (with RCC/ Brick) trenches & filled with sand	Yes, Only if overhead routing not possible.
<b>f</b>	<b>Short circuit withstand capacity to be considered for Cables:</b>	
	HV incoming cables to Switchboard	40 kA for <u>1</u> s
	HV CB distribution feeders	
	i) Capacitor feeder	40 kA for <u>0.25</u> s
	ii) Motor feeder	40 kA for <u>0.25</u> s
	iii) Transformer feeder	40 kA for <u>0.6</u> s
	HV contactor feeder with fuse backup	Let through energy of fuse
	690 & 415V Incomer to SWBD (Transformer Incomer)	Rated switchboard fault level for 1sec
	690 & 415V ACB Motor/ distribution feeders	Rated switchboard fault level for 0.25sec
	690 & 415V fuse backed feeder	Let through energy of fuse
	690 & 415V MCCB/ MPCB feeder (Current limiting type)	Let through energy of MCCB/ MPCB
<b>g</b>	<b>Maximum voltage drop for running condition for Cables between:</b>	
	Transformer & switchboard Busbars	0.5%
	PCC & MCC/ Auxiliary switchboard located in same substation	1%
	PCC & MCC/ Auxiliary switchboard located in different substation	3%
	HV Switchboard and HV motor	3%
	HV switchboards situated in same S/S	1%
	HV switchboards situated in different S/S	3%
	HV switchboard & Transformer/ Capacitor	2%

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	PCC and motor	5%
	MCC located in same substation as feeding PCC and motor	5%
	MCC located remote from feeding PCC and motor	3%
	Auxiliary Sevices board/ MLDB and SLDB	2%
	Lighting panel to last light fitting	5%
	DC supply Circuit	5%
	UPS outgoing circuit	5%
	Control cables	3%
h	<b>Maximum voltage drop in cable during motor starting</b>	15%

#### 17) EMERGENCY DG SET


	Application	Plant Emergency Loads and Emergency lighting
	Auto mains failure panel to be provided	Yes
	Time for voltage built-up after start command	10 seconds (max.)
	Preferred speed of DG set	1500 rpm
	Type of cooling for engine	Radiators
	Type of fuel	High speed diesel
	Type of Excitation system	Brushless, self excited
	Max. noise level	As per PCB norms with latest regulation
	To be paralleled with grid / other generator	No
	Exhaust arrangement	As per PCB norms with latest regulation
	Method of starting	Battery
	Sound proofing requirement	Acoustic enclosure
	Installation	Indoor on skid with shed
	Spare capacity to be considered	min. 20 %

#### 18) DC SYSTEM



a	<b>Station Batteries for Protection, Metering &amp; Control</b>	
	Nominal output voltage	110 V
	Type	VRLA
	Back up duration	60 minutes for charger. (4 hours for Switchyard S/S).
	Individual cell voltage (nominal)	2 V
	End cell voltage	1.85 V for 2 V cell
	Spare capacity to be considered	Min. 25%
b	<b>Battery Charger</b>	
	Configuration	Dual Float cum Boost Charger with common battery
	Normal loading of each float charger	50%
	Spare capacity	Min. 25%
	Operating Philosophy	
	i) Normal	Both chargers sharing the load & float charging the battery
	ii) One charger failure	Healthy charger supplying the load & float charging the battery
	iii) One charger failure and battery	Healthy charger supplying the load & float charging the

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	discharged	battery	
c	<b>DCDB</b>	Sheet metal, separate DCDB panel	
<b>19) CAPACITOR BANK (HV &amp; LV) FOR POWER FACTOR IMPROVEMENT &amp; HARMONIC FILTER</b>			
		<b>HV</b>	<b>LV</b>
	Overall power factor to be achieved at 11kV	0.95 lag	-
	Voltage level, Power factor to be obtained	6.6 kV, 0.95 to 0.98	415 V, 0.95 to 0.98
	Connection	Star-Star/Delta	Delta / Star
	Die-electric for capacitors	Poly-propylene	Poly-propylene
	Series Reactor	Yes	Only for Harmonic Filters
	Reactor construction	Air cooled	Air cooled
<b>20) LIGHTING</b>			
a	Lighting transformer to be provided	Yes	
b	Max. Allowable fault level in lighting circuit	9 kA	
c	<b>Construction of</b>		
	MLDB/ EMLDB	Sheet metal enclosed, Fixed type, floor mounted, Compartmentalised, bottom cable entry.	
	SLDB/ ESLDB	Sheet metal enclosed, Fixed type, Column/wall mounted, non compartmentalized, bottom cable entry.	
d	Switching device for MLDB/ EMLDB		
	Incomer	SFU/ ACB	
	Outgoing	SFU	
e	Switching device for SLDB/ ESLDB		
	Incomer	SFU	
	Outgoing	10 A MCB	
f	Earth Leakage protection	One ELCB common for each Phase & Neutral	
g	Max. load on each Single phase circuit	1 kW	
h	<b>Lighting cables for</b>		
	SLDB to JB or lighting fixture	3C x 2.5 sq. mm (YWY) min.	
	JB to JB	3C x 2.5 sq. mm (YWY) min.	
	JB to light fitting	3C x 2.5 sq. mm (YWY) min.	
	Street lighting	4C x 16 sq. mm (A2XWY) min.	
i	<b>Philosophy of cable laying</b>		
	Lighting in plant areas	Cleated on structure or laid in Perforated cable tray 50/ 100/ 150 mm wide	
	Buildings with false ceiling	Conduit/ Cable tray	
	Substation	Conduit/ Cable tray	
j	<b>Emergency Lighting</b> (Plant, Substation & Control Room)	Min. 20% of normal lighting (It will be energised by DG set).	
k	<b>DC critical lighting</b>		
	Sources, Voltage rating	110 Volts DC	
	Type of Critical lighting	LED.	

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	Type of Exit/ Panic Lights		Battery backed up LED.	
	Areas to be considered for DC Critical Lighting		Control rooms, Substations, DG room, Fire station, Fire pump house, First aid room, staircase of closed building (i.e substation & control room).	
I	Type of Luminaires			
	AREA	TYPE OF FIXTURE	TYPE OF LAMP	WATTS
	Indoor lighting for control room with false ceiling, Lab	Decorative recess mounting, mirror optic	LED	20/36/45/60/80 W
	Indoor lighting for office with false ceiling	Decorative recess mounting, mirror optic	LED	20/36/45/60/80 W
	Indoor lgt. for substation/ office without false ceiling	Industrial mirror optic tube light	LED	20/36/45/60/80 W
	Open process	Well Glass	LED	35/80/100/150 W
	Closed process plant with high ceiling below 10 m height	Medium Bay Well glass for local lighting	LED	50/80 W
	Closed process plant with ceiling above 10 m height	Medium Bay Well glass for local lighting	LED	80/100/150 W
	Ware houses	Medium Bay / High Bay	LED	20/36/45/50/60/80 W
	Open vast areas	Flood Light / High mast	LED	10/30/60/80/120/ 160W
	Conveyor Gallery	Well glass	LED	20/36/45/60/80 W
	Battery Room	Corrosion resistant	LED	20/36/45/60/80 W
	Transformer cell	Industrial Tube	LED	20/36/45/60/80 W
	Substation/ MCC room periphery	Street light Fittings	LED	35/45/60/72/90/120/134/ 150/170/210 W
	Switchyard	Flood light / High mast	LED	10/30/60/80/120/160 W
	Tank farm/ Area lighting	Flood light	LED	10/30/60/80/120/160 W
	Notes: 1) Enclosures shall be as per “Equipment Selection for Hazardous Area”.			
	2) Illumination system for Flame proof area “Fuel / Oil handling”.			
m	Street Lighting			
	ROAD SIZE	POLE HEIGHT / TYPE OF LAMP		
	Upto 6 m wide	8 m high/ Solar-LED		
	10 - 12 m wide	10 m high/ Solar-LED		
n	Maintenance Factor for Lighting Design (Indoor / Outdoor) : 0.8/ 0.7			
o	Aviation Lighting : As per ICAO			
p	Illumination Levels			
	AREA	LUX LEVEL (AVG.)		WORKING PLANE (in metres)
	Process areas, attended	50-100		0.7
	Unattended areas in process plant	50		0.7

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	General Open areas in Process Plant	20	FFL
	Compressor house	150	0.7
	Unattended Platforms in plant areas	50	0.7
	Attended / Process operation platforms	50 - 100	0.7
	Piperack	50	0.7
	Pump house	50 - 100	0.7
	Cell house	150	0.7
	Ware house	100 - 150	0.7
	Street Lighting	10 / 20	FFL
	Sub station in front / back of panels	150 - 200 / 50	0.5
	Control Room, Laboratory	300	1.2
	Sub station cable cellar	50	0.7
	Transformer Bay	100	0.5
	Battery room	100	0.7
	Switchyard – lighting	50 (operating areas) / 20 (Non operating areas)	0.5
	Rectifier room	150 - 200	0.5
	DG room	150	0.5
	Workshop	150	0.5
	Offices	300	1.2
	Machine shop	300	1.2



## 21) AUXILIARY SERVICE BOARD (ASB)

	Construction	Fixed, Floor mounted, Compartmentalised, Sheet metal enclosure.
	Cable entry	Bottom
	Enclosure protection	IP55
	Incoming feeder type	SFU
	<b>Outgoing feeder type for</b>	
	i) Exhaust fan, minor power sockets	SFU
	ii) Welding Sockets / Machines	SFU
	Short time rating of busbar	20 kA for 1 second
	Spare feeders	20 % (with min. one of each rating)

## 22) PREFABRICATED CABLE TRAYS


22) PREFABRICATED CABLE TRAYS		Perforated	Ladder
	Thickness of cable tray	2 mm	2.5/ 3 mm
	Side flange height of the cable tray	65 mm	75/ 100 mm
	Standard sizes	50/ 100/ 150 mm	300/ 600/ 750/ 900 mm
	Material	Hot-dip galvanised mild steel(Sheet steel)/ FRP (Acid areas)/ MS epoxy painted (Areas with heavy Caustic seepage)	
	Material for hardware accessories for trays	Stainless steel (SS304)	
	Maximum Support span for cable tray:		
	Horizontal Run	<u>Galvanized steel/ SS304</u> 3 m	<u>FRP</u> 2 m
	Vertical Run	2 m	1 m
	Requirement of Cable tray covers	Only for top tray in slurry area	
	Electrical continuity between tray sections	Coupler plate & Earthing jumper	




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	Minimum Bending radius for Cable Trays	300 mm
	Margin in tray size for future cables	Minimum 20%
	Cable to be secured to trays by	UV resistant heavy duty nylon cable ties at least every 1500 mm on horizontal runs and 900 mm on vertical runs.
	Cable laying philosophy on Cable Trays	
	HV Cables, > 1 kV	Single layer
	LV Power/ Control Cables > 50 V	2 layers with side flange height of 100 mm
	LV Signal Cables upto 50 V	3 layers with side flange of 100 mm
	Cable tray spacing - HV to LV or LV to LV or LV to Signal Cable Tray	300 mm
	HV Power to Low Power / signal	600 mm
<b>23) CABLE GLANDS (3 Core cables)</b>		
	Material	Nickel plated Brass
	Type of glands for indoor installation	Single compression for unarmoured cables and double compression for armoured cables.
	Type of glands for outdoor installation	Double compression
<b>24) EARTHING &amp; LIGHTNING PROTECTION SYSTEM</b>		
a	Material of earthing grid conductor	MS hot dip galvanized Strip
b	Fault current withstand duration of conductor	1 second
c	<b>Earth Electrodes</b>	MS hot dip galvanized Pipe (Hardware/termination of Stainless steel)
d	<b>Maximum resistance of earthing system for</b>	
	Switchyard & Main substation	1 ohm
	Plant area	5 ohms
	Neutral earthing	5 ohms
	Instrumentation earthing	1 ohm
	Lightning Protection	5 ohms
<b>25) PUBLIC ADDRESS SYSTEM (Loudspeaker interconnection system)</b>		
	<b>Paging System shall consist of:</b>	
	Central exchange along with Power Supply System (through UPS)	
	Master station along with Loudspeaker, microphone etc.	
	Desk type and outdoor pole/ wall mounted type call stations along with microphone and external loudspeaker for installation in Building. It shall be dust proof, pilfer proof & weather proof protection cover suitable for outdoor installation.	
	Wall/ column mounting type call stations for hazardous/ safe area with external loud speaker as per operational requirement	
	Spare capacity in Central Exchange for future : min 10 %	
	Acoustic Hoods shall be considered for high noise level areas : Yes	
	System Communication	Paging and Private modes.
	Architecture	Zone wise- common bus architecture, while communication with Central unit shall be of "Star topology"
	Amplifier	Distributed type




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	Loud Speakers	To be provided
	Loud Speakers Talk back	To be provided
<b>26) TELEPHONE SYSTEM</b>		
	Intercom system type	Microprocessor based Programmable type with Digital PCM/TDM technology
	Capacity of EPABX	P&T lines, internal lines
	Telephone system shall consist of	
	a) Telephone handsets	
	b) Main junction box	
	c) Telephone cables	
<b>27) WIRELESS COMMUNICATION SYSTEM</b>		
	Wireless system	VHF/ UHF band with necessary frequency license from WPC
	Wireless system with rechargeable batteries, antennas, battery chargers and other accessories	
	a) Repeaters	Covering distance between 2nos. of repeaters shall be 5 km
	b) Stationary Radio	Covering distance between 2nos. stationary radio shall be of 5 km
	c) Handheld Radio	Covering distance between 10nos. handheld radio shall be of 2 km
<b>28) FIRE ALARM SYSTEM</b>		
	Fire alarm system type	Addressable (Microprocessor based).
	<b>Main components of fire alarm (FA) system shall be:</b>	
	Main/ Master control panel for entire plant	Yes - In the control room.
	Repeater panel(s)	Yes - In Fire station.
	Manual call points	Located at strategic locations with access of 60 m along all exit routes and roads.
	Sirens	Yes.
	Detectors	Yes – In closed rooms.
	Fault isolator	Yes .
	Provision for future expansion	Minimum 10% - 1 No. spare loop.
	Auto-dialer	Yes.
<b>29) SCADA</b>		
	The new SCADA shall monitor and control 11kV switchgear in the new 11kV building and in downstream substations of 5th stream alumina refinery units.	
	System configuration	Centralised server with RTU's located in individual Plant substations.
	Server	Redundant - In new 11 kV switchgear building.
	EWS	Yes – In Existing Control room in the CDS substation.
	Operating stations	Yes – In Existing Control room in the CDS substation and One in each substation of Alumina refinery.
	Topology	Distributed RTU's in various Plant substations with redundant connection to centralized server.
	Numerical relay	Shall communicate on IEC 61850 protocol.
	Meters	Shall be connected on Modbus.

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<b>30) MISCELLANEOUS SYSTEMS/ EQUIPMENT</b>		
<b>a</b>	<b>Variable Speed AC Drives</b>	
	Device Type	a. Rectifier – Thyristor (For 6 Pulse) IGBT (For Active front end, 18 & 36 Pulse) b. Inverter – IGBT
	Type of VFD	
	a. <132 kW, 415V	6 Pulse with Linechoke, THD (Current) limited to 30%
	b. $\geq 132\text{kW} \leq 200\text{kW}$ , 415V	Active front end, THD (Current) limited to 5%
	c. $> 200\text{kW} \leq 630\text{kW}$ , 690V	Active front end, THD (Current) limited to 5%
	d. $> 630\text{kW} < 1000\text{kW}$ , 6.6kV	18 Pulse minimum.
	e. 1000kW and above, 11kV	36 Pulse minimum.
	Output filter	Choke irrespective of cable length
	Speed variation signal	4 – 20 mA
	Bypass arrangement	Yes for all LV drives(415V, $\leq 200\text{kW}$ )(Including pan filter area) Except in Evaporation batteries package & Calcliner area
<b>b</b>	<b>Cathodic Protection System</b>	
	Criteria for providing	
	i) For buried pipeline & vessels	Soil resistivity < 5000 $\Omega\text{cm}$ as per IS 8062
	ii) For above ground tanks	Containing saline water or Resting directly on soil
	iii) Type of system	
	Sacrificial Anodes	For buried pipe, equipment, tank base
	Impressed current system	For network of pipes and equipment
	System configuration for impressed current	100% redundant rectifier system
	Monitoring	Reference cell permanently installed
<b>31) PAINTING</b>		
<b>a</b>	<b>Surface Pretreatment</b>	
	For equipment : Seven tank process	
	For site steel : As per site painting procedure	
	Primer : Epoxy based (Minimum 2 coats)	
	Final Paint : Epoxy based (Minimum 2 coats)	
<b>b</b>	<b>Final paint shade</b>	
	For outdoor / Indoor Equipment : 632 of IS 5/ RAL 7032, 355 of IS 5 for Flameproof IIC	
	For fire fighting Equipment : RED	
<b>32) INSTALLATION</b>		
<b>a</b>	<b>High Voltage Switchgear</b>	
	Space for future expansion	Min. 2 Panel extension on each side
	Minimum clear space in front	1500 mm
	Minimum clear space between two rows	2500 mm front to front
	Minimum clear space at the back	800 mm
	Minimum space between HV and LV	2000 mm
	Min. space between two ends of switchgear	800 mm (after considering space for future panels)
<b>b</b>	<b>Low Voltage Switchgear</b>	
	Space for future expansion	Min. 2 Panel extension on each side unless there is space

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		constraint			
	Minimum clear space in front / back	1500 mm/ 800 mm			
	Minimum clear space between two rows	2000 mm front to front			
	All round clearance for transformer	1000 mm			
c	<b>UPS, VFDs, Inverter panels, Battery chargers, ACDB, MLDB, APDB etc.</b>				
	Minimum clear space in front	1200 mm			
	Minimum clear space at the back	800 mm			
	Minimum clear space between two rows	2000 mm			
	Minimum space between two ends	800 mm (after considering space for future panels)			
d	<b>Battery room requirement</b>	No separate battery room, VRLA batteries to be installed on racks adjacent to Charger/ UPS.			
	Ventilation of battery room	Exhaust Fan			
	Battery room flooring & walls	Alkali proof tiling			
	Min. space between two rows of batteries	750 mm			
	Min. space between battery stand & Wall	750 mm			
	Batteries installation arrangement	Two tier			
<b>33) MISCELLANEOUS</b>					
	Coverage radius for Welding Socket	50 m			
	Coverage Radius for Single Phase Sockets	25 m			
	Max. Number of Welding Sockets allowed in Outgoing circuit	3 Nos.			
	Max. Number of Single phase Sockets allowed in Outgoing circuit	4 Nos.			
	Rating of Welding Socket	415 V, 60 A, TPN			
	Rating of Single Phase Socket	240 V, 20 A, SPN			
	Hand lamps and portable tools	240/ 24 V Transformer 100 VA			
<b>34) EQUIPMENT SELECTION FOR HAZARDOUS AREA</b>					
	The electrical equipment for hazardous areas shall be selected as per IS-5571 and petroleum rules. The minimum requirement is summarised as below.				
		<b>Zone 1</b>		<b>Zone 2</b>	
	<b>Equipment</b>	<b>Gas Group IIA, IIB</b>	<b>Gas Group IIC</b>	<b>Gas Group IIA, IIB</b>	<b>Gas Group IIC</b>
	LV Motors	Ex-d	Ex-d	Ex-d/ Ex-de/ Ex-e	Ex-d/ Ex-de/ Ex-e
	HV Motors	Ex-d/ Ex-p	Ex-d/ Ex-p	Ex-d/ Ex-p/ Ex-e*	Ex-d/ Ex-p/ Ex-e*
	Push Button Station	Ex-d	Ex-d	Ex-d	Ex-d
	Motor Starters	Ex-d	Ex-d	Ex-d	Ex-d
	Plug & Socket	Ex-d	Ex-d	Ex-d	Ex-d
	Welding Receptacle	Ex-d	Ex-d	Ex-d	Ex-d
	<b>Lighting Fixtures</b>				
	a) Integral	Ex-d	Ex-d	Ex-d	Ex-d
	b) Non Integral				
	Control gear	Ex-d	Ex-d	Ex-d	Ex-d

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	Luminaire	Ex-d	Ex-d	Ex-d	Ex-d
	Junction Boxes	Ex-d	Ex-d	Ex-e	Ex-e
		<b>Zone 1</b>		<b>Zone 1</b>	
	<b>Equipment</b>	<b>Gas Group IIA, IIB</b>	<b>Gas Group IIC</b>	<b>Equipment</b>	<b>Gas Group IIA, IIB</b>
	Hand Lamps				
	i. Light fitting	Ex-d	Ex-d	Ex-d/ Ex-e	Ex-d/ Ex-e
	ii. Transformer Unit	Ex-d	Ex-d	Ex-d	Ex-d
	iii. Plug & Socket	Ex-d	Ex-d	Ex-d	Ex-d
	Break Glass Unit (Fire Alarm System)	Ex-d	Ex-d	Ex-d	Ex-d
	Lighting Panel/ Power Panel	Ex-d	Ex-d	Ex-d	Ex-d
	Transformers	Hermetically sealed with surface temperature not exceeding 200° C			


**NOTES:**

1	The increased safety motors (Ex-e) fed by VFDs shall be certified as combination for the Specified location by Independent test house and shall be certified by authorities.
2	In case of Flameproof Motors, the Motor and VFD combination need not be certified together if direct temperature control by embedded temperature sensors are provided, which will disconnect the Motor.
3	* Ex-e motor can also be provided if the motors are tested as per latest IS/ IEC. Pre-start purging arrangement shall be made based on risk analysis. Auto start requirement shall be checked in case of pre-start purge requirement.
4	Electrical equipment in fired heater area shall be Ex-d irrespective of zone classification. Gas group shall be appropriately selected.

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## Annexure-I (Earthing Schedule)

Srno.	Type of Equipment	Earth Conductor Size	Number of Earthing Connections
1.	Main Earthing Grid - Burried in Ground / Finished Floor, including Earthing Stub-ups	75 x 12 mm, HDGI Strip (65kA,1Sec) 75 x 10 mm, HDGI Strip (50kA,1Sec)	As per the relevant Earthing Layouts.
2.	Main Earthing Grid - Above Ground, including Earthing Risers	75 x 12 mm, HDGI Strip (65kA,1Sec) 75 x 10 mm, HDGI Strip (50kA,1Sec)	As per the relevant Earthing Layouts.
3.	Main Earthing Conductor on Cable Trays	75 x 12 mm, HDGI Strip (65kA,1Sec) 75 x 10 mm, HDGI Strip (50kA,1Sec)	As per the relevant Earthing Layouts.
4.	Transformer Tank ,HV & LV cable box & Rail: Power & Distribution Trafo.	75 x 12 mm, HDGI Strip (65kA,1Sec) 75 x 10 mm, HDGI Strip (50kA,1Sec)	As per Installation standards-Earthing.
5.	HV Switchgears (HT), LV (PCC, EPCC, MCC) Switchgears, LV Busduct , HV PFIC, HV VFD (6.6kV, 11kV) and Neutral Grounding Resistor	75 x 12 mm, HDGI Strip (65kA,1Sec) 75 x 10 mm, HDGI Strip (50kA,1Sec)	2 nos. each.
6.	DG SET: Alternator, LV terminal box, AMF Panel (with isolating breaker).	75 x 12 mm, HDGI Strip (65kA,1Sec) 75 x 10 mm, HDGI Strip (50kA,1Sec)	As per Installation standards-Earthing.
7.	<ul style="list-style-type: none"> <li>Transformer: Mashalling Box, OLTC Panel, Fan Control Panel.Control Panels: RTCC, Fire Alarm, Public Address, Package units (HVAC &amp; Others) &amp; other Communication systems.</li> <li>Small Power Distribution Boards in Substation: ASB, PDB, MLDB, UPS, ACDB, Battery rack, Battery Charger, DCDB, Heat tracing Distribution Boards &amp; LV PFIC.</li> </ul>	40 x 5 mm G.I. Strip	2 nos. each.

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Srno.	Type of Equipment	Earth Conductor Size	Number of Earthing Connections	
8.	Motors upto 37 kW & Corresponding Load Break Switches	10 mm (3/8") Dia. G.I. Wire Rope	2 nos. each.	
9.	Motors above 37 kW & upto 200 kW & Corresponding Load Break Switches	16 mm (5/8") Dia. G.I. Wire Rope	2 nos. each.	
10.	Motors above 200 kW HV Motors Main terminal box & Neutral terminal box.	16 mm (5/8") Dia. G.I. Wire Rope	2 nos. each.	
11.	Storage Tanks, Vessels & Heat Exchangers	40 x 5 mm G.I. Strip	Equipment Dimension (D or H)	No. of Connection
			< 20 Mtrs.	2 nos. at 180 deg
			≥ 20 < 30 Mtrs.	3 nos. at 120 deg
			≥ 30 Mtrs.	4 nos. at 90 deg
12.	Small Power Distribution Boards in Plant (PDB), Field Lighting ( SLDB) & Instrument Panels.	10 mm (3/8") Dia. G.I. Wire Rope	2 nos.	
13.	LCS	8 SWG Solid G.I. Wire	1 no.	
14.	Street lighting Poles	8 SWG Solid G.I. Wire	1 no.	
15.	Lighting & Other Dry Type Transformers	40 x 5 mm G.I. Strip	As per Installation standards-Earthing.	
16.	Grounding of piperack & structure column (steel).	40 x 5 mm G.I. Strip	At every 20 Mtrs.	
17.	Welding receptacles	10 mm (3/8") Dia. G.I. Wire Rope	2 nos.	
18.	VFD Panels (< 200 kW, 415V )	10 mm (3/8") Dia. G.I. Wire Rope	2 nos. each.	
19.	VFD Panels (200 kW ≤ 630 kW, 690V )	16 mm (5/8") Dia. G.I. Wire Rope	2 nos. each.	
20.	Power Junction Box	10 mm (3/8") Dia. G.I. Wire Rope	2 nos. each.	
21.	Bonding of Pipes/ Cable tray	10 mm (3/8") Dia. G.I. Wire Rope	As per Installation standards-Earthing	
22.	Loading platforms, Rail (Crane), Hoist, Monorail	16 mm (5/8") Dia. G.I. Wire Rope	1 no.	
23.	Handrail, metallic stairs, 1 phase socket 16/20 A	8 SWG Solid G.I. Wire	1 no.	