

DOCUMENT COVER SHEET

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KANDAHAR HELMAND POWER PROJECT
KANDAHAR BRESHNAKOT EPC SUB-CONTRACT – KDBK 73.1010

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KANDAHAR BRESHNAKOT EPC SUB-CONTRACT – 042246

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KANDAHAR BRESHNAKOT EPC SUB-CONTRACT – 042246



1.0 - INTRODUCTION

KANDAHAR BRESHNAKOT EPC SUB-CONTRACT – 042246

1.0 INTRODUCTION:

This project includes the demolition of an existing substation and the Engineering, Procurement and Construction (EPC) of a new 110/20kV Substation in the existing Kandahar Breshnakot substation located in Kandahar, Afghanistan.

The Ownership of the substation lies with Islamic Republic of Afghanistan and the functional relationship of the various agencies connected with the project is as follows:

- a. Owner's Consultant- United States Agency for International Development (USAID)
- b. Main Contractor (Purchaser) - Black and Veatch, USA.
- c. Sub-Contractor-Afghan Electric Power Corporation (AEPC) in joint venture with Drake & Scull Water Power (DWSP)
- d. Supplier of Design, Engineering and equipment - ABB (Appointed by AEPC and Drake & Scull)
- e. Erection, Testing and Commissioning by – AEPC& DSWP JV.
- f. Subcontractor for Testing & Commissioning -----Voltech India
- g. Project Delivery Period-24 months
- h. Project Starting Date-04.10.2011

The following existing equipment and facilities were dismantled to clear the area for installation of the new substation:

- a. Fairbanks-Morris Diesel Generators.
- b. Diesel Machine Repair Shop.
- c. Transformer Repair Shop.
- d. Workers Dormitory.
- e. Wall of China.
- f. Demolition of the existing concrete foundations and substructures which conflicted with the new substation design.

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Existing transmission line, 110kV and 20kV systems were kept in service until the new substation was ready for energization.

The ultimate configuration of the substation will be a three (3) diameter one and half breaker 110kV switchyard with four (4) 110/20kV step down transformer positions and two (2) line positions. Two (2) complete diameters have been installed now with three (3) transformer positions and one (1) line position. The third diameter has only bus side isolators installed to facilitate the installation of the third diameter in future. Three (3) transformers will feed three (3) new 20kV switchboards.

The fourth transformer and associated 20kV switchboard have been installed and secured on site but not energized.

20kV circuits from existing QSK, KTA-50 and MTU Diesel Generators to existing 20kV Switchgear were disconnected in a planned manner adopting an approved outage and reconnection schedule and new circuits were laid from these existing generators to new 20kV Switchboards for emergency power supply.

The following equipment were supplied by the Purchaser along with drawings and instruction manuals:

- a. 110kV SF6 Circuit Breakers – 6 nos.
- b. 110/20kV, 16/20 MVA Power Transformers – 4 nos.
- c. 20kV Metal clad Switchgears installed in pre-manufactured metal buildings – 4 nos.

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2.0 - BRIEF PROJECT DESCRIPTION

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2.0 BRIEF PROJECT DESCRIPTION:

Construction of the new Substation included the following major works:

- Construction of 2 nos. one and half breaker 110KV diameters that is expandable to three diameters.
- Construction of a two (2) short span single circuit 110KV transmission line for connecting the new substation to the existing 110KV transmission line.
- Disconnection of the existing 110KV transmission line span that crosses the canal from the existing transmission line structure and reconnection of the span to the new transmission line on the north side of the canal.
- Removal and disposal of the existing 110KV substation after energization of the new substation.
- Construction of foundation and oil collection pit and installation of four (4) nos. 16/20 MVA 110/20kV Power transformers supplied by Purchaser. The fourth transformer shall be kept as spare.
- Construction of foundation and installation of four (4) nos. 20kV switchgear containers (2 nos. type (A1 & A2) and 2 nos. type B (B1 & B2) along with construction of concrete cable trench below the containers. The 20kV kV Switchgear fed from fourth transformer has been kept as spare.
- Removal of existing seven nos. (7) 20KV getaway feeders and laying of new seven nos. 20 KV feeders from the new 20KV switchgear to riser poles outside of the substation.
- Removal of the existing 20KV circuits from the KTA-50 generators to the existing switchgear and laying a new 20KV circuit from the KTA-50 diesel generators to the new 20KV switchgear. Interconnection of the ground grid between the generating station ground grid and substation ground grid. Step up transformer at KTA-50 generating station is retained.
- Removal of the existing 20KV circuits from the QSK-60 generators to the existing switchgear and laying a new 20KV circuit from the QSK-60 generators to the new 20KV switchgear. Interconnection of the ground grid between the generating station ground grid and substation ground grid. Step up transformers at QSK-60 generating station is retained.

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- Laying of two (2) new 20KV circuits from the MTU generators located in the north west of the site to the new 20KV switchgear. Interconnection of the ground grid between the generating station ground grid and substation ground grid.
- Construction of a new control room and installation of new 110KV relay /control panels, metering panels, battery and battery chargers, AC/DC station service equipment, remote control panels for the new 20KV switchgear and PLCC panels.
- Installation of two fused disconnect switches and station service transformers to provide for the primary and secondary AC station service sources.
- Installation of oil containment system, fire containment system and storm water management system.
- Installation of substation earthing/ground grid, lightning protection and switchyard /control room lighting system.
- Execution of related civil works.

The transition from the existing 110KV to new 110KV substation and existing 20KV distribution system to new 20KV distribution system has been carried out in a systematic manner in such a way that the ultimate customer has suffered the least supply interruption.

The following were the project terminal points for the purposes of the Subcontractor:-

The Subcontractor's scope of work began and ended at the existing 110KV structure north of the canal west of the substation for the 110KV transmission line configuration work. Inclusive in the structure equipment requirements were Insulators, Surge Arresters, and the hardware necessary to attach the incoming / outgoing transmission line Conductors.

The Subcontractors scope of work began and ended at the QSK-60 switchgear existing circuits terminations for the one 20KV circuit from new 20KV switchgear feeder breaker.

The Subcontractors scope of work began and ended at the MTU switchgear circuit terminations for the two 20KV circuits from the new 20KV switchgear feeder breakers. Others will install the raceway from the demarcation pull box.

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The Subcontractors scope of work began and ended at the KTA-50 switchgear existing terminations for the one 20KV circuits from the new 20KV switchgear feeder breaker. Others will install the raceway from the demarcation pull box.

The Subcontractor replaced the existing underground distribution feeder connecting to the new switchgear. The work began at the riser structures outside the substation wall (feeder getaways) and ended at the new switchgear feeder connection. The capacity of the replaced feeder cable is equivalent to the feeder capacity of the 20KV circuit breaker.

Connection between the substation earthing grid and the generator earthing grids. The generator earthing grids will be installed by others.

Connection between substation fence and the generator fence.

Work not included under the scope:-

De-mining

110KV transmission line structure no. P3 (at the north of the canal) and all structures to the west of P3.

20KV distribution line structures

20KV temporary power connection to existing KTA equipment during construction.

The optical fiber communication channel between Durai Junction Substation and the National Load Control Center.

The OPGW on the site transmission line structures

RTU / HMI

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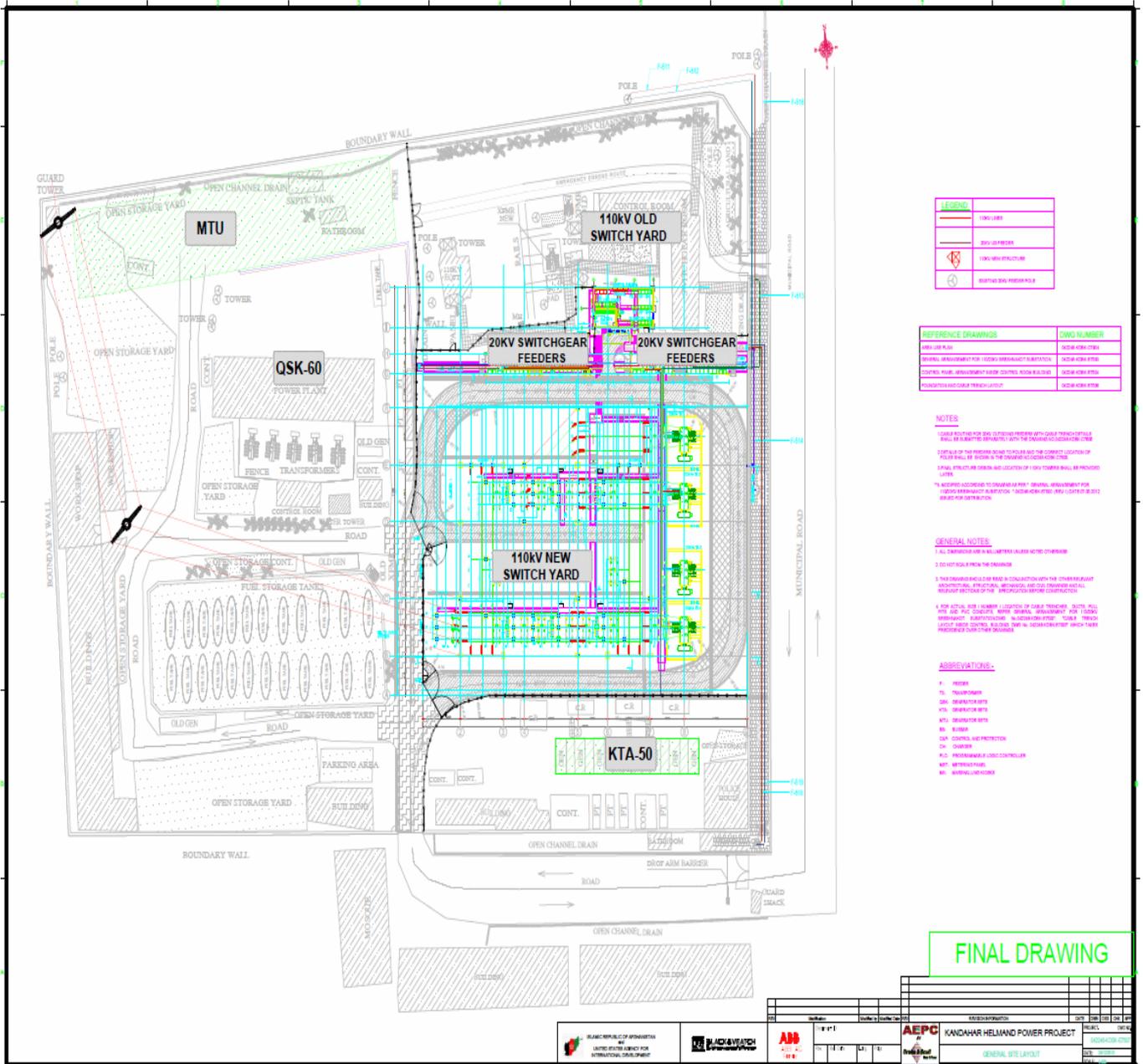
3.0 - SUBSTATION GENERAL ARRANGEMENT

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3.0 SUBSTATION GENERAL ARRANGEMENT :

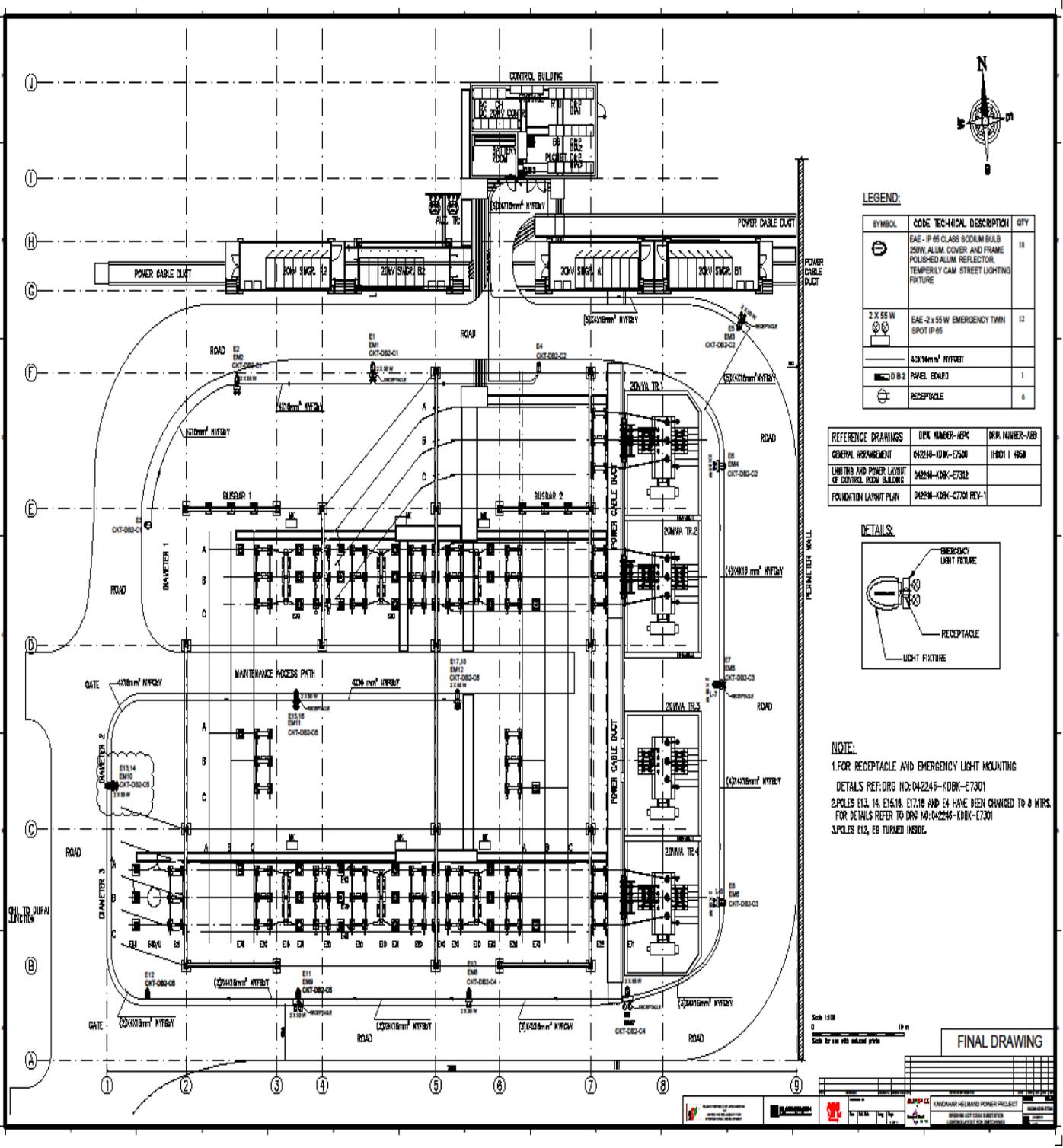
The Main SLD and Layout arrangement of the Substation are shown below. These are given for a quick view and general impression only. For detail view please refer respective detail drawings:

GENERAL SITE LAYOUT – PLAN



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110KV SWITCHYARD LAYOUT – PLAN

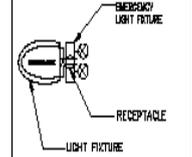


LEGEND:

SYMBOL	CODE	TECHNICAL DESCRIPTION	QTY
	EAE-IP 45 CLASS SODIUM BULB	18	
	EAE-2x55 W EMERGENCY TWIN SPOT IP 85	12	
	40x10mm 1175B		
	PANEL BOARD	1	
	RECEPTACLE	6	

REFERENCE DRAWINGS	DRK NUMBER-HEC	DRN NUMBER-ADB
GENERAL ARRANGEMENT	042246-10W-C530	11001 I 4650
LIGHTING AND POWER LAYOUT OF CONTROL ROOM BUILDING	042246-10W-E7302	
FOUNDATION LAYOUT PLAN	042246-10W-C7301 REP-1	

DETAILS:



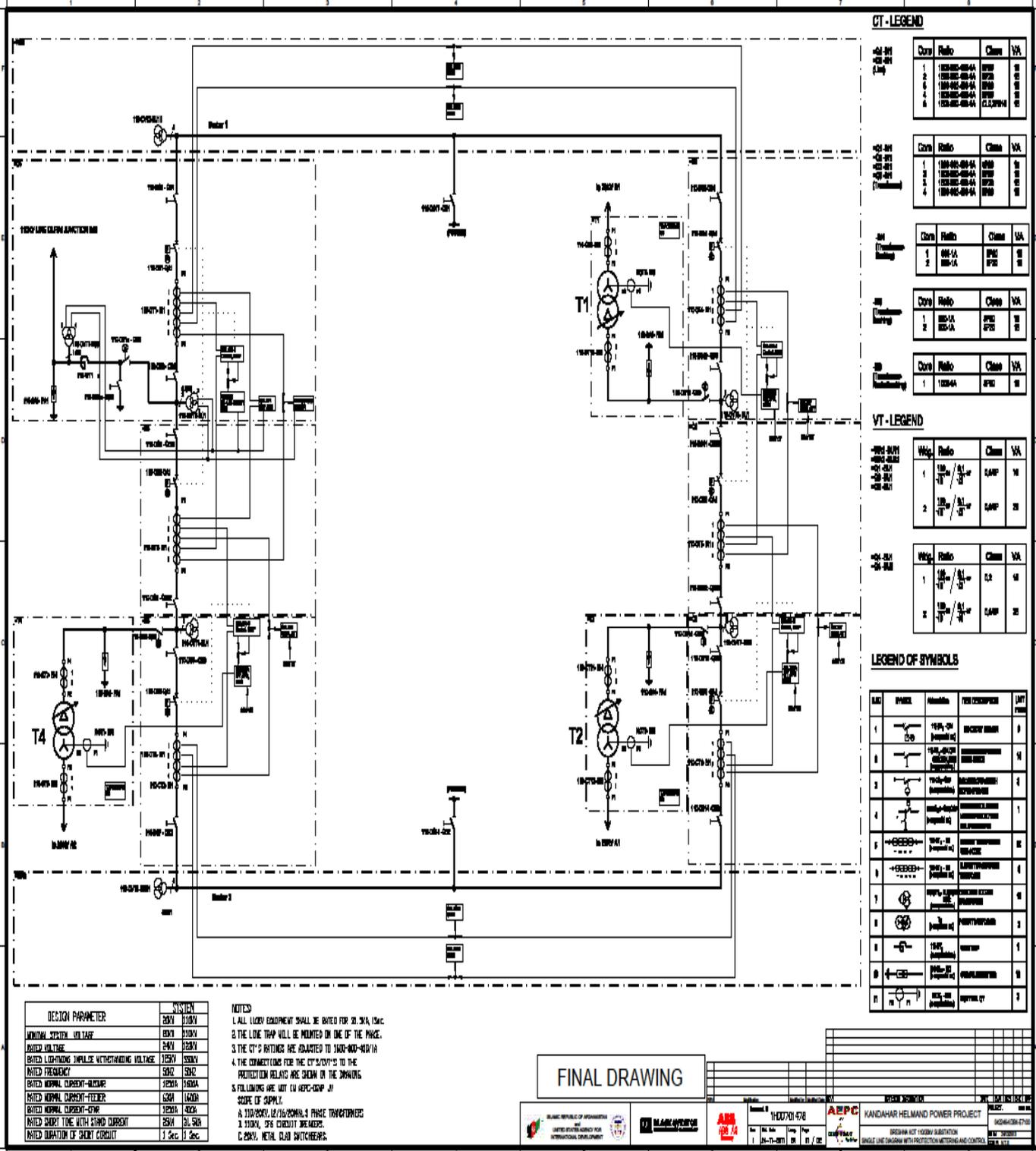
NOTE:
 1. FOR RECEPTACLE AND EMERGENCY LIGHT MOUNTING
 DETAILS REF: DRG NO: 042246-KDBK-E7301
 2. POLES E13, E14, E16, E18, E17, E19 AND E4 HAVE BEEN CHANGED TO 8 MTRS.
 FOR DETAILS REFER TO DRG NO: 042246-10W-E7301
 3. POLES E12, E2 TURNED INSIDE.

Scale 1:100
 0 10 m
 Scale for use with reduced print

FINAL DRAWING

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110KV KEY SINGLE LINE DIAGRAM

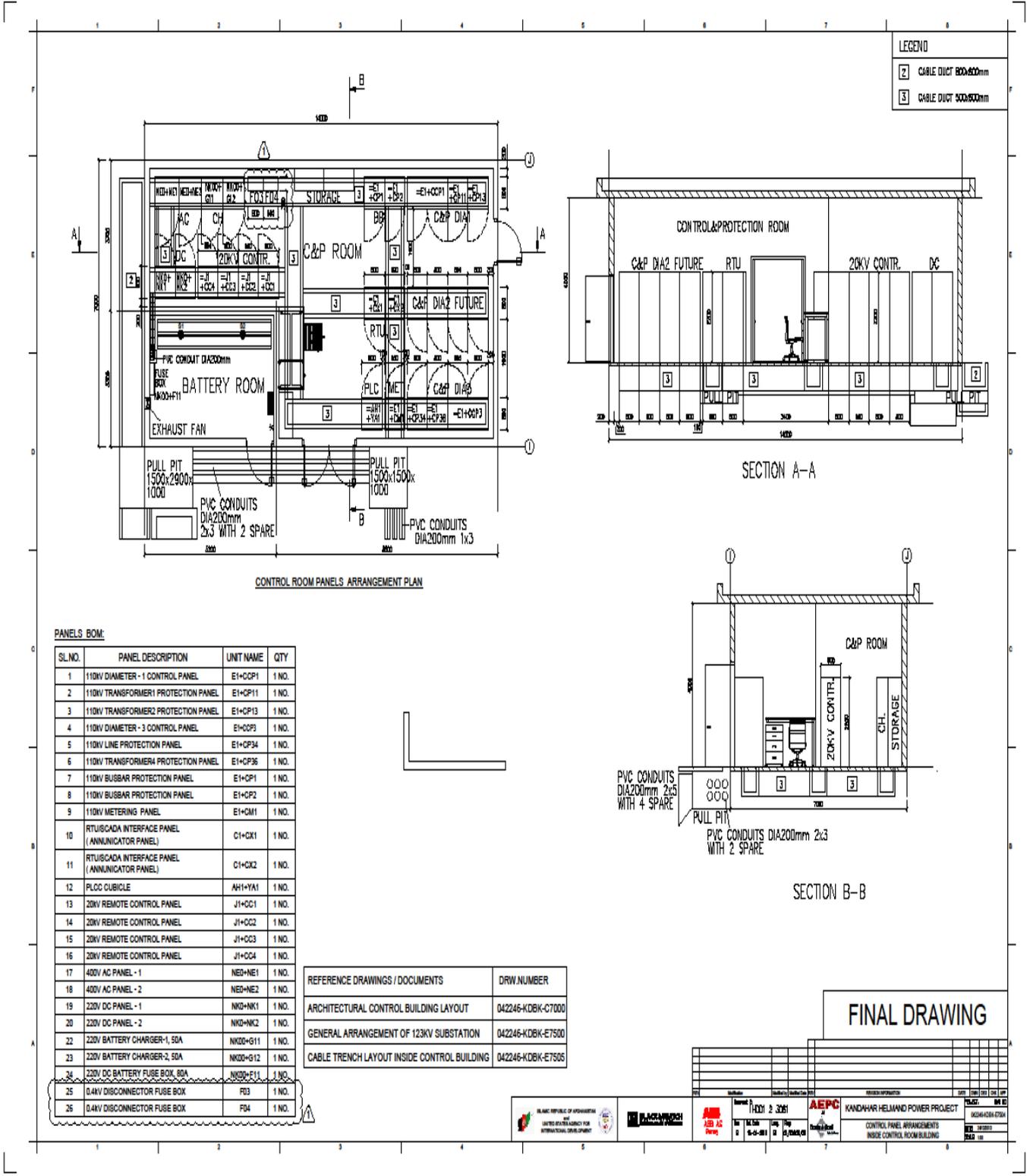


FINAL DRAWING

KANDAHAR HELMAND POWER PROJECT
 110KV/110KV SUBSTATION
 SINGLE LINE DIAGRAM WITH PROTECTION METERS AND CONTROL

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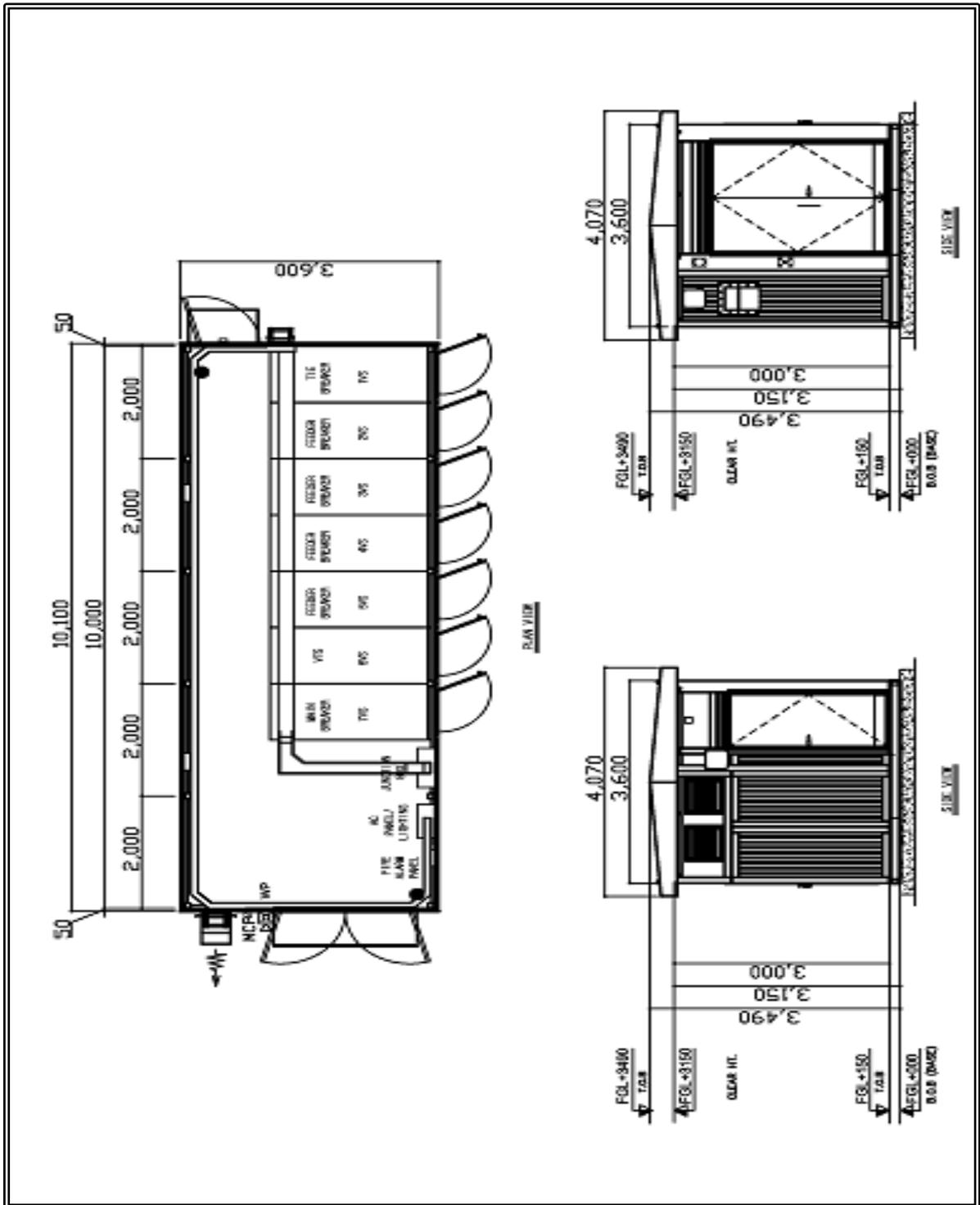
CONTROL ROOM BUILDING – PLAN



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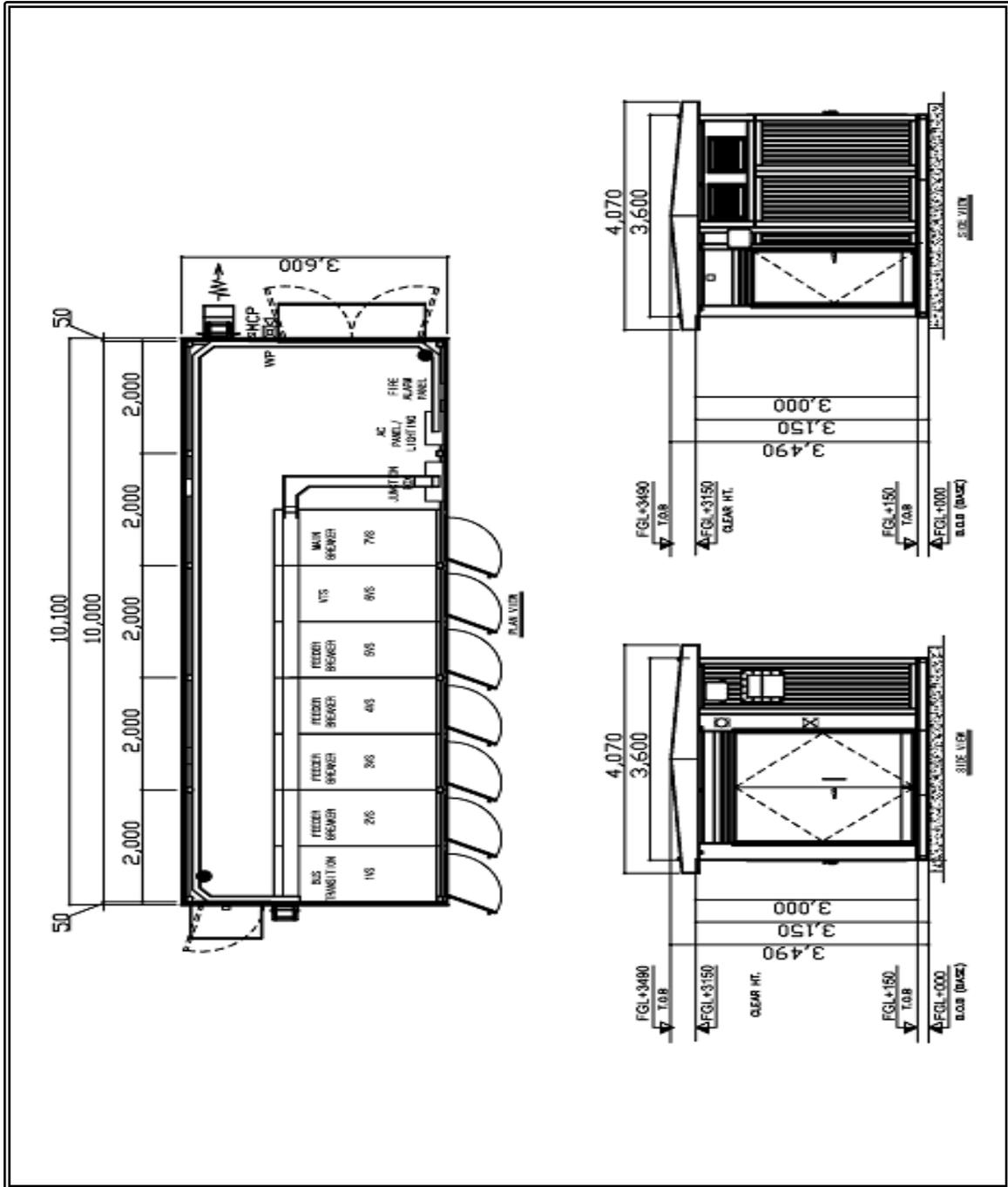
UNIT NAME	PANEL DESCRIPTION	UNIT NAME	PANEL DESCRIPTION
E1+CCP1	110kV DIAMETER-1 CONTROL PANEL	J1+CC2	20kV REMOTE CONTROL PANEL
E1+CP11	110kV TRANSFORMER-1 PROTECTION PANEL	J1+CC3	20kV REMOTE CONTROL PANEL
E1+CP13	110kV TRANSFORMER-2 PROTECTION PANEL	J1+CC4	20kV REMOTE CONTROL PANEL
E1+CCP3	110kV DIAMETER-3 CONTROL PANEL	NE0+NE1	400V AC PANEL-1
E1+CP34	110kV LINE PROTECTION PANEL	NE0+NE2	400V AC PANEL-2
E1+CP36	110kV TRANSFORMER-4 PROTECTION PANEL	NK0+NK1	220V DC PANEL-1
E1+CP1	110kV BUSBAR PROTECTION PANEL	NK0+NK2	220V DC PANEL-2
E1+CP2	110kV BUSBAR PROTECTION PANEL	NK00+G11	220V BATTERY CHARGER-1, 50A
E1+CM1	110kV METERING PANEL	NK00+G12	220V BATTERY CHARGER-2, 50A
C1+CX1	Annunciator Panel	NK00+F11	220V DC BATTERY FUSE BOX, 80A
C1+CX2	RTU/SCADA INTERFACE PANEL	F03	0.4kV DISCONNECTOR FUSE BOX
AH1+YA1	PLCC CUBICLE	F04	0.4kV DISCONNECTOR FUSE BOX
J1+CC1	20kV REMOTE CONTROL PANEL		

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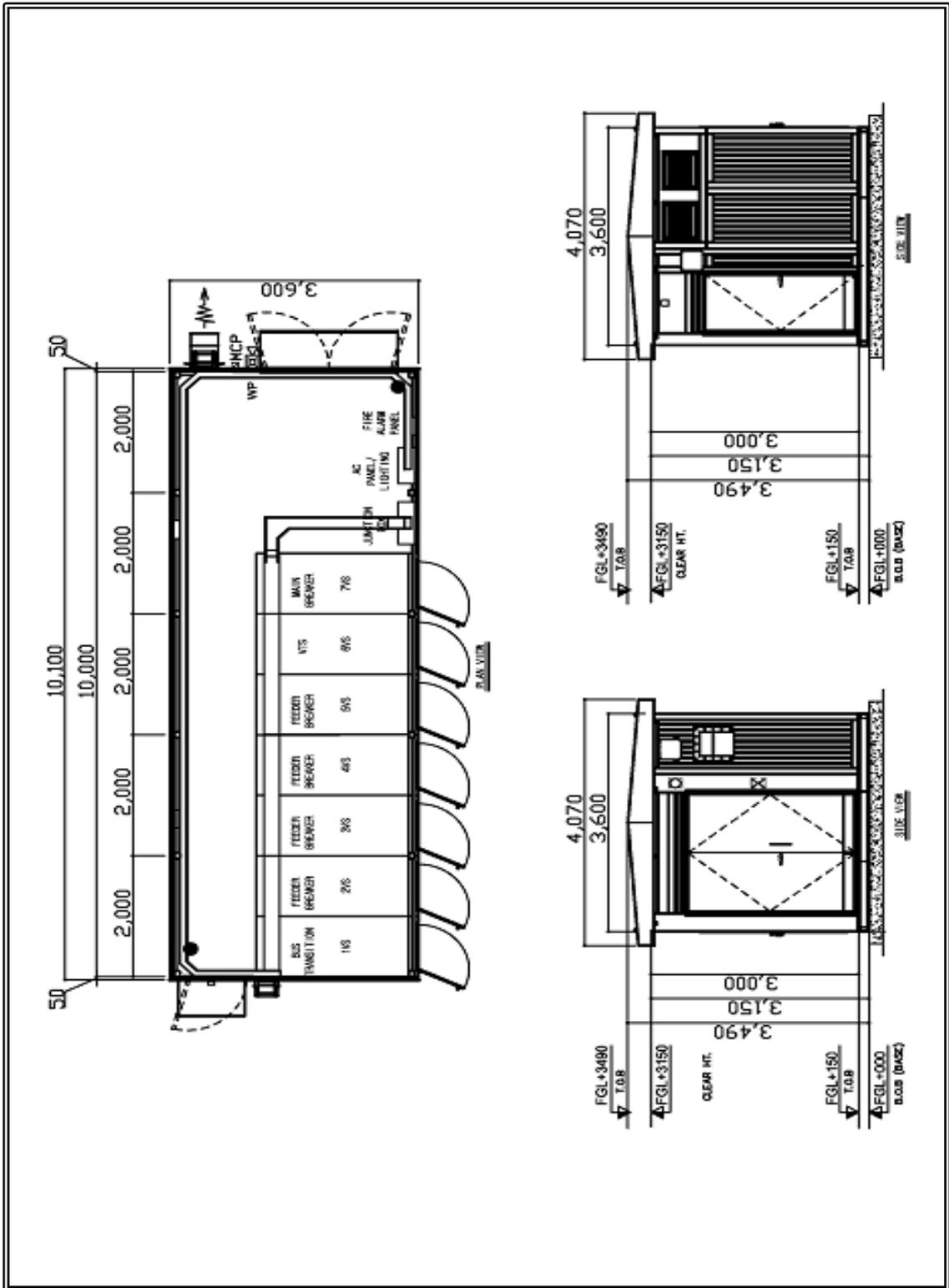
20KV SWITCHGEAR CONTAINER # A1- PLAN

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20KV SWITCHGEAR CONTAINER # B1- PLAN

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20KV SWITCHGEAR CONTAINER # B2- PLAN

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4.0 - OUTAGE AND ENERGIZATION PLAN

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4.0 OUTAGE & ENERGIZATION PLAN:**Scope:**

The project includes the de energization and demolition of an existing 110kV substation and the engineering, procurement and construction of 2 diameters of 110kV one and half breaker ring type substation and 20kV containerized metal clad VCB switchgear.

General Objective:

- A) The objective is to provide an efficient outage of an existing live transmission line.
- B) Short outage of existing 20kV circuits from the existing generators and replace existing 20kV circuits with new cables to new 20kVswitchgears. The purpose is to connect the generators (MTU, QSK-60 and KTA-50) to the new 20kV switchgear.
- C) Short outage of 20kV outgoing feeders, viz., F511, F512, F513,F514, F516, F518, F519.Disconnection of existing 20kV cables from the feeder connection poles, laying and connecting new 20kV cables on the existing poles to new 20kV switchgears.
- D) Testing, commissioning and energizing of new 110kV substation.
- E) To allow de energization and de commissioning of existing 110kVsubstation and proceed with dismantling works.
- F) To prepare a procedural flow diagram for carrying out the activity.
- G) Outage time to be minimal.

SUMMARY OF OUTAGE PLAN:**Systems to be energized:**

Following steps were taken in order to accomplish mentioned objectives:

1. Complete all construction, testing and commissioning activities in the new substation (110kV switchyard, 20kV switchgears, control building) and new 20kV feeders.
2. Supply and install new 20kV cables for existing feeders from new switchgear to the riser pole and have it ready for connection when required outage is available.

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3. Rerouting and connecting of existing 20kV generator cables from existing switchgear to new 20kV switchgears, and connect new cables to outgoing feeders, step by step as mentioned in switching instructions.
4. De-energize old 110kV substation, open 110kV OHL and install new connectors and connect to the new 110kV switchyard.
5. Energize new 110/20kV substation.
6. Energize transformers TR4 and TR1, perform required switching to energize feeders 518,512,519,513 and 516.
7. Connect new gateway for feeder 511 and test, open breaker and return feeder 511 source to Baghe Pol.
8. Connect new gateway for feeder 514 and test; open breaker and return feeder 514 sources to SIP.
9. Energize transformer TR2 and put it on no load.

Strategy followed:

The proposed outage plan had following salient features:

- A) Only one 110kV system outage was required to de-energize the existing 110 KV substation and energize the new 110kVsubstation.
- B) It required de energization of the existing QSK, KTA and MTU power plants one by one, to remove the existing cable from existing 20kV switchgears and install these cables to new 20kVswitchgears, test & commission.
- C) It required one 20kV outage for each 20kV feeder, for removing existing cables from old switchgear to the riser poles and installing new cables, testing and commissioning.
- D) Feeders 511 and 514 were supplied from Baghe Pol and SIP sources respectively. After installing new cables to new 20kVswitchgear, connection to these sources remains the same.
- E) Existing feeder cables 511 and 512 are installed in the same dead end pole, therefore cable installation work were done for both the feeders at the same time.
- F) Feeders 518 and 519 are installed in the same dead end pole therefore cable installation works were done for both the feeders at the same time.

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DESCRIPTION OF THE OUTAGE AND ENERGISATION PLAN:

This exercise had been divided into three stages:

1. First Stage - Energization of new 20 KV switchgears from existing power plants and supply power to 20 KV feeders from the source.
2. Second Stage - Energization of the new 110 KV substation.
3. Third Stage - Energization of the new 20 KV switchgears from the new 110KV substation and supply power to 20 KV feeders from the source.

Reference may be made to Annexure 2 of document no. KDBK. 73.1010 For detailed outages and switching instructions adopted for achieving the above three stages.

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**5.0 - SALIENT FEATUTURES OF
SUBSTATION DESIGN**

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5.0 SALIENT FEATURES OF SUBSTATION DESIGN:

5.1. SITE CONDITIONS AND CHARACTERISTICS:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	Purchaser’s Technical Specification Clause no. - 00752.1
2.	SITE DESCRIPTION :	The Kandahar BreshnaKot substation is located at approximately N 31°, 37’, 43.48”, E 65°, 42’, 35.30”.
3.	SEISMIC CHARACTERISTICS :	The following spectral response values are based on a 10% probability of exceedance in a 50 year period. Design Data : Occupancy Category/Importance Factor (Seismic Loads), IE – III/1.25. Short period Mapped Spectral Acceleration, S _s – 0.16g. One Second Period Mapped Spectral Acceleration, S ₁ – 0.07g.
4.	METEOROLOGY :	The site specific (outdoor) weather conditions are as follows: Average Air Temperature : +24DegC Maximum Air Temperature : +48DegC Minimum Air Temperature : -24DegC Maximum Wind Velocity : 41 m/s (148 km/h) Wind & Dust : Sand and dust storms in summer Isokeraunic Level : 19 thunderstorm days/year Altitude : Less than 1,100 meters above msl Pollution : IEC level IV Rainfall Rate : 50mm/hr.

5.2. LAYOUT:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-E7507 – General site layout
		042246-KDBK-E7500 – Switchyard layout - Plan
		042246-KDBK-E7501 – Switchyard layout - Section
		042246-KDBK-E7504 – Control panel arrangements inside control room building
		Hyundai drawing no. 11SH081L010, Layout diagram of 24kV Swgr type-A (Container type A1).

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		Hyundai drawing no. 11SH081L011, Layout diagram of 24kV Swgr type-A (Container type A2).
		Hyundai drawing no. 11SH082L010, Layout diagram of 24kV Swgr type-B (Container type B1).
		Hyundai drawing no. 11SH082L011, Layout diagram of 24kV Swgr type-B (Container type B2).
		042246-KDBK-E7504 (Page 1 of 2)- Single line diagram with metering & protection for 110kV Switchyard
		042246-KDBK-E7504 (Page 2 of 2)- Single line diagram for 20kv system
2.	BUSBAR CONFIGURATION :	110kV - One and half breaker scheme. 20kV Switchgear – Single Bus.
3.	GENERAL ARRANGEMENT OF THE SUBSTATION :	110kV - Outdoor air insulated switchyard having two (2) diameter one and half breaker substation that is expandable to three (3) diameters. Presently switchyard has one (1) incomer from DURAI junction substation and three (3) numbers 16/20MVA, 110/20kV power transformers with the forth transformer as spare. 20kv – Air insulated indoor switchboard mounted in prefabricated container. Incomer feeders from 110/20kV new transformers and existing diesel generators – KTA50, QSK60 and MTU I & II. 20kv outgoing feeders to two (2) numbers auxiliary transformer and riser poles at north-east & east sides of the substations as shown in drawing no. - 04224-KDBK-E7510 (20kv cable routing for outgoing) AC-DC auxiliary systems, control, annunciation & protection panels – housed in control building. Overall dimensions of the substation – 75.86 x 71.66 meter.
4.	CONDUCTOR SIZES :	Main bus – 2x650/45mm ² ACSR Dropper - 2x650/45mm ² ACSR 1x650/45mm ² ACSR 2x625mm ² AAC Jack bus – 2x650/45mm ² ACSR 1x650/45mm ² ACSR Equipment connection - 2x625mm ² AAC 1x625mm ² AAC
5.	CLEARANCES :	110kV Switchyard: A – phase to phase clearance – 1100mm

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	B – phase to ground clearance – 1100mm
	C – ground clearance up to bottom of insulator clearance – 2250mm
	Control Building:
	A - Front clearance – 1900mm.
	B - Rear clearance – 200mm.
	C – Panel access – from front only.
	20kV Switchgear Building:
	A - Front clearance – 1200 mm.
	B - Rear clearance - NIL
	C – Panel access – Both front and rear.
	20kV System
	Minimum phase to phase-----220mm
	Minimum phase to earth-----220mm

5.3. SYSTEM PARTICULARS:

SL.NO.	DESCRIPTION	UNIT	VALUES	
			110kV	20kV
1.	ELECTRICAL RATING :			
	Minimum clearance phase to earth	mm	1100	220
	Minimum clearance phase to phase	mm	1100	220
	Minimum clearance from ground level to base of insulation	mm	2250	--
	Minimum height of live parts above accessible areas	mm	3350	--
	Minimum horizontal clearance from live parts to outer fencing	mm	2600	--
	Creepage distance	mm	3813	--
	Nominal system voltage	kV	110	20
	Maximum rated system voltage	kV	123	24
	Rated lightning impulse (91.2/50 μ s) withstand voltage (U _{RB})	kV	550	125
	Busbar rating	A	1600	1250
	System frequency	Hz	50	50
	Rated short circuit current	kA	31.5	25
	Duration of short circuit	sec	1	1
2.	MAIN BUSBAR :			
	Material		ACSR	
	Cross section	mm ²	2x650/45	
	Continues current	A	1600	
	Maximum conductor temperature at service	°C	80	

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	Maximum conductor temperature at short circuit	°C	200	
3.	CONNECTION OF HV EQUIPMENT (LINE & DIAMETER) :			
	Material		AAC	
	Cross section	mm ²	2x625	
	Continues current	A	1600	
	Maximum conductor temperature at service	°C	80	
	Maximum conductor temperature at short circuit	°C	200	
4.	CONNECTION OF HV EQUIPMENT (TRANSFORMER FEEDER) :			
	Material		AAC	
	Cross section	mm ²	1x625	
	Continues current	A	400	
	Maximum conductor temperature at service	°C	80	
	Maximum conductor temperature at short circuit	°C	200	
5.	OVERHEAD CONNECTION (LINE FEEDER) :			
	Material		ACSR	
	Cross section	mm ²	2x650/45	
	Continues current	A	400	
	Maximum conductor temperature at service	°C	80	
	Maximum conductor temperature at short circuit	°C	200	
6.	OVERHEAD CONNECTION (TRANSFORMER FEEDER) :			
	Material		ACSR	
	Cross section	mm ²	1x650/45	
	Continues current	A	400	
	Maximum conductor temperature at service	°C	80	
	Maximum conductor temperature at short circuit	°C	200	
7.	DISC INSULATOR :			
	Material		PORCELAIN	
	Type of insulator		B	
	Size and designation of ball & socket as per IEC 120 (part – II)	mm	20	
	Outside dia. of the disc	mm	280	
	Spacing	mm	170	
	Creepage distance of the single disc	mm	330	
	Electromechanical strength of single disc	kN	160	
	Normal system voltage for single disc	kV	11	
Highest system voltage for single disc	kV	12		
	No of disc/bells in string	nos.	8 to 10	
8.	REFERENCE DOCUMENT :		AEPC-DSWP/DD/E/001 – Electrical	

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		design basis
		Technical specification (Amendment 002 - 3 of 5)

5.4. ELECTRICAL PROTECTION & METERING PHILOSOPHY:
5.4.1. REFERENCE DRAWINGS:

SL.NO.	DRAWING NO.	DETAILS
1.	SLD No. - 042246-KDBK-E7100 (SHT 01),	SINGLE LINE DIAGRAM WITH PROTECTION, METERING AND CONTROL – 110 KV.
	SLD No. - 042246-KDBK-E7100 (SHT 02),	SINGLE LINE DIAGRAM WITH PROTECTION METERING AND CONTROL – 20 KV.
2.	SLD No. – 1MCZ210762-A2Q0, (042246-KDBK-E7210)	SCHEMATIC DIAGRAM CONTROL & PROTECTION CUBICLE – 110 KV DIAMETER CONTROL (E1.CCP3)
3.	SLD No. – 1MCZ210762-A6P0, (042246-KDBK-E7213)	SCHEMATIC DIAGRAM LINE PROTECTION CUBICLE – 110 KV LINE DURAI JUNCTION S/S – E1.CP34 (Q4).
4.	SLD No. – 1MCZ210762-A3P0, (042246-KDBK-E7211)	SCHEMATIC DIAGRAM OF TRANSFORMER PROTECTION CUBICLE – 110/20 KV TRANSFORMER NO.1 – (E1.CP11).
	SLD No. – 1MCZ210762-A4P0, (042246-KDBK-E7212)	SCHEMATIC DIAGRAM OF TRANSFORMER PROTECTION CUBICLE – 110/20 KV TRANSFORMER NO.2 – (E1.Q3+CP13)
	SLD No. – 1MCZ210762-A5P0, (042246-KDBK-E7214)	SCHEMATIC DIAGRAM OF TRANSFORMER PROTECTION CUBICLE – 110/20 KV TRANSFORMER NO.4 – (E1.Q6+CP36)
5.	SLD No. – 1MCZ210762-A7P0, (042246-KDBK-E7209)	SCHEMATIC DIAGRAM OF BUS BAR PROTECTION CUBICLE – 110 KV BUS BAR WA1-E1.CP1 (WA1)
	SLD No. – 1MCZ210762-A8P0, (042246-KDBK-E7201)	SCHEMATIC DIAGRAM OF BUS BAR PROTECTION CUBICLE – 110 KV BUS BAR WA2-(E1.WA2+CP2)
6.	SLD No. – 1HDD701479, (042246-KDBK-E7107)	STATION CONFIGURATION DIAGRAM
7.	SLD No. – 1MCZ210762-AAK1, (042246-KDBK-E7213)	SCADA / RTU INTERFACE PANEL (C1.CX2)
8.	SLD No. – 1MCZ210762-ABQ0, (042246-KDBK-P7203)	SCHEMATIC DAIGRAM FOR 20 KV CONTROL CUBICLE – (JI.CC1)
	SLD No. – 1MCZ210762-ACQ0, (042246-KDBK-P7204)	SCHEMATIC DAIGRAM FOR 20 KV CONTROL CUBICLE – (JI.CC2)
	SLD No. – 1MCZ210762-ADQ0, (042246-KDBK-P7205)	SCHEMATIC DAIGRAM FOR 20 KV CONTROL CUBICLE – (JI.CC3)
	SLD No. – 1MCZ210762-AEQ0, (042246-KDBK-P7206)	SCHEMATIC DAIGRAM FOR 20 KV CONTROL CUBICLE – (J.CC4)

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9.	SLD No. – 11SH081G001-G015, 11SH082G001-G015, 11SH081G003-G015,	SINGLE LINE DIAGRAM FOR 20 KV METAL CLAD SWITCHGEAR.
	SLD No. – 11SH081Q001-Q027, 11SH082Q001-Q022, 11SH083Q001-Q022,	SCHEMATIC DIAGRAM FOR 20 KV METAL CLAD SWITCHGEAR.
	SLD No. – 11SH081R001-R024, 11SH082R001-R024, 11SH083R001-R021,	THREE LINE DIAGRAM FOR 20KV METAL CLAD SWITCHGEAR.

5.4.2. PROTECTION PHILOSOPHY:

SL.NO.	ITEM	DETAILS
1.	BRIEF DETAILS:	<p>The 110kV layout is breaker and half system with CTs mounted on one side of the circuit breaker. 110kV isolators are all hand operated except line isolators which are motor operated. Each 20MVA transformer is feeding power to a single bus 20kV VCB switchboard.</p> <p>Salient features of the Protection system are as follows :</p> <ol style="list-style-type: none"> 1. 110kV Line protection – Distance protection relay – Main I and Main II. 2. 110kV Transformer protection – Primary protection by Transformer differential relay, back up protection by Transformer differential relay and Restricted Earth Fault (REF) relay, Transformer mechanical protection by Bucholz, WTI, OTI etc. 3. 110kV Bus bar protection – High impedance type current differential relay. 4. 110kV Breaker failure protection – As integral part of main protection relays indicated herein. 5. 20kV Incomer (from Transformer) protection – Directional O/C and E/F relay.

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		<p>6. 20kV Outgoing feeder protection - Non Directional O/C and E/F relay.</p> <p>7. 20kV DG Incomer protection –Non Directional O/C and E/F relay.</p> <p>8. 20kV Bus tie protection –Non Directional O/C and E/F relay.</p> <p>9. 20kV Bus bar protection - High impedance type current differential relay.</p> <p>10. 20kV Breaker failure protection – As integral part of main protection relays indicated herein.</p>
2.	110KV LINE PROTECTION:	
	MAIN 1 PROTECTION:	Directional comparison carrier blocking scheme for phase and earth fault. Carrier signal assistance is taken to block tripping for faults beyond the protected section. Relay Type SEL 421 for phase faults distance measuring element with carrier blocking and for earth faults non-distance current operated sensitive directional earth fault relay with carrier blocking scheme are employed.
	MAIN 2 PROTECTION:	2-zone distance measuring elements for phase fault without carrier assistance and time delayed directional ground over current relay for earth fault Relay type GE D60. In addition, three pole auto reclosing, check synchronizing, power swing blocking, switch on to Fault (SOTF), Stub bus protection and fuse failure protection are available as common feature.
3.	TRANSFORMER PROTECTION:	
	PRIMARY PROTECTION:	Percentage restraint current differential relay Type – SEL 787. This relay also provides instantaneous and time delayed o/c protection.
	BACK UP PROTECTION:	Percentage restraint current differential relay Type – SEL 387A. This relay also provides REF protection for the LV winding and duplicates instantaneous and time delayed o/c protection. REF protection is for the 20kV LV winding.
	MECHANICAL PROTECTION:	Buchholz trip and alarm, winding temperature trip and alarm, oil temperature trip and alarm, PRD trip, Oil level alarm etc.
4.	110 KV BUSBAR PROTECTION:	High impedance current differential protection with main and check feature. Feature of detecting and clearing fault between the CT and the circuit breaker within the bus differential zone, is available.

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		Relay type SEL 587Z.
5.	BREAKER FAIL PROTECTION:	All the numerical relays provided in the 110kV system have breaker failure protection in them and a comprehensive breaker fail scheme has been provided for elimination of any stuck breaker, if the situation arises.
6.	20 KV SYSTEM PROTECTION:	
	20 KV INCOMER FROM 20 MVA TRANSFORMER:	Directional time delayed over current and earth fault, over and under voltage, breaker fail and synchronizing check function. Relay Type SEL 451.
	20 KV OUT GOING FEEDER:	Non-directional time delayed over current and earth fault, over voltage, breaker fail, 3 pole auto reclosing & check synchronizing. Relay Type SEL 451.
	20 KV BUS TIE FEEDER:	Non-directional over current and earth fault, breaker fail and check synchronizing. Relay Type SEL 451.
	20 KV BUS BAR PROTECTION:	High impedance current differential protection with main and check feature. However for want of a separate CT core, the check feature is actually not available. Relay type SEL-587Z.
	BREAKER FAIL PROTECTION:	All the numerical relays provided in the 20kV system have breaker failure detection feature in them and a comprehensive breaker fail scheme has been provided for elimination of any stuck breaker if the situation arise.

5.4.3. METERING PHILOSOPHY:

SL.NO.	ITEM	DETAILS
1.	110kV LINE	a) Bay control unit SEL 451-5 measures V, I, MW, MVAR, MVA, MWH, MVARH, PF b) Tariff meter NEXUS 1500 measures W, VAR, VA, PF, F, WH, VAH, VARH, WH (received), WH (delivered), record and store time of use data
2.	110kV TRANSFORMER	Bay control unit SEL 451-5 measures V, I, MW, MVAR, MVA, MWH, MVARH, PF
3.	INCOMING AND OUTGOING FEEDERS OF 20KV SWITCHGEAR	Bay control unit SEL 451-5 measures V, I, MW, MVAR, MVA, MWH, MVARH, PF

5.5. CONTROL PHILOSOPHY:

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1.	REFERENCE DRAWINGS	Refer clause no. 5.4.1 above.
2.	110 KV SYSTEM:	110kV circuit breakers are motor wound spring charged type and are suitable for remote control. 110kV isolators are manually operated except line isolators which are motor operated type and thus are suitable for remote control. 110kV earth switches are all manually operated. Three (3) levels of control are possible at 110KV level for circuit breaker and line isolator.
	a) AT 110 KV SWITCHYARD LOCALLY:	The 110kV circuit breaker and line isolator have each local / remote selector switch at its control cabinet. In local position of this switch the 110Kv CB can be operated locally at the switchyard. In remote position of the control switch, control is transferred to the diameter control panel bay control unit. The same is true for the line isolator.
	b) AT BAY CONTROL UNIT (BCU):	There is an integrated HMI in the bay control unit. The circuit breaker can be operated from the BCU HMI and interlock for the circuit breaker is integrated in the BCU. There is also a local remote selector switch in the diameter control panel. In the local position of the switch the CB can be controlled from the BCU HMI. In remote position of the switch the control is transferred to substation SCADA system or remote network control Centre. The same is true for the line isolator.
	c) AT SUBSTATION SCADA WORKSTATION / NETWORK CONTROL CENTER:	At present control from substation SCADA system workstation or network control Centre is not possible as the SCADA terminal equipment is not in place. However all equipment required to make the substation IEDs, energy meter etc. to be connected to substation SCADA terminal work station equipment have been provided. All IED's / numerical relays have been connected to an Ethernet switch, all digital inputs and outputs, analog inputs, trip / close and raise / lower signals have been wired to a SCADA/RTU interface panel.
3.	20 KV SYSTEM:	The 20kV VCB switch board has a remote control panel located in the substation control room. Three (3) levels of control are possible for the 20kV VCB :
	a) AT THE VCB LOCATION IN THE METAL CONTAINER:	With the local / Remote selector switch, located on the VCB, in local position, the VCB can be opened or closed locally with the help Trip or close push button. The push buttons activate the binary input of the IED (SEL 451) of the VCB and the binary outputs of the IED give actual trip / close command

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		to the VCB. With the local / Remote selector in remote position, the control of the VCB is transferred to remote control panel in the control room.
	b) AT THE REMOTE CONTROL PANEL IN CONTROL ROOM:	The remote control panel has its own local / remote control switch. In local position, the discrepancy switch in the control band gives trip and close command to VCB through the same IED as mentioned in (A) above. With the local / remote selector switch in remote position the control is transferred to substation SCADA terminal.
	c) AT THE SUBSTATION SCADA TERMINAL:	At present control from SCADA terminal is not possible but provision has been kept to give effect to this control through RTU interface panel. Again the binary output of the same IED as mentioned in (A) above will be activated from SCADA terminal through the RTU interface to effect tripping or closing.

5.6. BAY INTERLOCK PHILOSOPHY:

1.	REFERENCE DRAWINGS	Refer clause no. 5.4.1 above.
2.	110kV SYSTEM:	<p>110KV circuit breaker and 110KV line isolator are motor operated. 110 KV circuit breaker interlocking is integrated in the respective bay control unit (SEL 451) with the help of appropriate isolator auxiliary contacts and the check synchronizing function of the bay control unit (SEL 451). Isolator auxiliary contacts are routed through the respective bay marshalling kiosk.</p> <p>The 110KV line isolator interlocking is integrated in the respective bay control unit (SEL 451) with the help of appropriate circuit breaker and earth switch auxiliary contacts. The circuit breaker and earth switch auxiliary contacts are routed through the respective bay marshalling kiosk.</p> <p>In this case, all auxiliary contacts of CB, isolator, earth switch are routed through bay marshalling kiosk. All CT / PT input to CRP and trip / close command to CB and motorized isolator from CRP are also routed through bay marshalling kiosk.</p>
3.	20kV SYSTEM:	In the 20 KV system the interlock between VCB and the circuit earth switch is noteworthy. To effect

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		<p>circuit earthing the following operations are to be executed step by step.</p> <ul style="list-style-type: none"> • Switch off the VCB. • Withdraw it to test or isolated position. A key at the bottom of the VCB truck will then be released. • Withdraw the key and insert it to the earth switch lock also located at the bottom of the truck. • Unlock the earth switch and insert the earth switch operating handle. • Slowly close the earth switch by turning the handle after ensuring that there is no voltage on the feeder. This visual check can be performed by checking the voltmeter reading connected to the line P.T. This is a manual visual check and there is no provision of a no volt relay / coil fed electrical interlock to prevent earth switch operation in case the feeder is charged from the other end.
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5.7. MV POWER DISTRIBUTION:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-E7100 – Single Line Diagram of 20kV system
		042246-KDBK-E7100 page 1 of 2 – Single Line Diagram with Protection Metering & Control
		042246-KDBK-E7510 – 20kV Cable routing for outgoing riser poles
		042246-KDBK-E7101 – Single Line Diagram of 400V AC Distribution
		042246-KDBK-E7102 – Single Line Diagram of 220V DC Distribution

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2.	DISTRIBUTION SYSTEM :	<p>20kV power is distributed from three new 16/20MVA, 110/20kV transformers & one spare transformer of same rating to four (4) nos. 20kV Air insulated indoor switchboard mounted in prefabricated containers # A1, B1, A2, B2 through 2R#1Cx300mm² Cu XLPE cables. Bus tie feeders between A1 & B1 and those between A2& B2 are interconnected through 2R#1Cx300mm² Cu XLPE cable.</p> <p>There are seven (7) outgoing feeders (feeder nos. 511, 519, 518, 514, 512, 516, and 513) from 20kV switchgears and power is distributed from these switchgears to 5 riser poles (Pole-1, 2A, 2B, 3 and 4) through 2R#1Cx185 mm² 12/20kV Cu XLPE power cables.</p> <p>Existing Diesel Generators MTU-1 & 2, QSK-60 and KTA-50 are connected to the new 20kV switchgears through 2R#1Cx185 mm² 12/20kV Cu XLPE power cable as shown in SLD no. 042246-KDBK-E7100 .</p> <p>One outgoing feeder from switchgear A1 will feed to one auxiliary transformer1, 250kVA, 20/0.4kV and another feeder from switchgear A2 will feed to auxiliary transformer2, 250kVA, 20/0.4kV and existing DABS transformer 315kVA, 20/0.4kV. 1Cx185mm², 20kV power cable is used for auxiliary transformers and 1Cx70mm² for existing DABS transformer.</p>
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5.8. AC AUXILIARY SYSTEM:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS	<p>042246-KDBK-E7101 – Single Line Diagram of 400V AC Distribution</p> <p>042246-KDBK-E7108 – Voltage supply diagram for AC/DC.</p> <p>042246-KDBK-E7104/01 – 400/230V AC Distribution parts list.</p> <p>042246-KDBK-E7104 – 400/230V AC Distribution.</p> <p>042246-KDBK-E7109 – 400V AC 3 Line Overview diagram.</p>

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<p>2.</p>	<p>AC POWER DISTRIBUTION :</p>	<p>The 400V ACDB is made of two panel sections, Panel-1 & Panel-2. Each panel is fed by a 250kVA, 20/0.4kV Auxiliary Transformer. The two panel sections are coupled by a bus sectionalizer breaker situated in panel-1 and paralleling of the two Auxiliary Transformers is prevented by the provision of an Auto/Manual Changeover Scheme. The supply to the Auxiliary transformer is fed from 20kV VCB switchboard. A 24kV, 400A Fused Switch Disconnecter protects the HV side of the transformer and provides local isolation for maintenance. From the LV side of the Auxiliary transformer, LV cable feeds the 400V ACDB through a 0.4kV, 400A Fused Switch Disconnecter.</p> <p>Existing DABS station house transformer rated at 20/0.4kV, 315kVA are fed from the 20kV switchgear A2. This 315kVA existing transformer is feeding the DABS living quarters, offices, guesthouses, KTA generators, MTU generators and mosque etc.</p> <p>This 400V LV power is further distributed for the following purposes –</p> <ul style="list-style-type: none"> - Lighting in control building, switchyard, guard house and 20kV switchgear rooms. - Lighting and small power loads for all DABS living quarters through existing 315kVA, 20/0.4kV old transformer. - Air conditioning in control building and guard house. - Power supply to cooling fan circuits and OLTC of transformers. - Power supply to bay marshalling kiosks for its own heating and lighting circuits and further distribution of AC power to lighting and heating circuits in VT boxes as shown in 042246-KDBK-E7108 – Voltage supply diagram for AC/DC. - Power supply to various panels like – bus-bar protection panels, C&P cubicles, 20kV control cubicle, annunciator panel, RTU panel, metering panel and PLC panel as shown in 042246-KDBK-E7108 – Voltage supply diagram for AC/DC. Power supply to the oil detection system and for oil treatment of transformers.
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		<ul style="list-style-type: none"> - Power supply to battery chargers as mentioned in 042246-KDBK-E7101 – Single Line Diagram of 400V AC Distribution.
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5.9. DC AUXILIARY SYSTEM:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-E7102 – Single Line Diagram of 220V DC Distribution
		042246-KDBK-E7108 – Voltage supply diagram for AC/DC.
		042246-KDBK-E7105/01 – 220V DC Distribution Parts list.
		042246-KDBK-E7105 – 220V DC Distribution
		042246-KDBK-E7110 – 220V DC Overview diagram
2.	DC POWER DISTRIBUTION :	<p>The 220V DCDB is made of two panel sections, Panel-1 & Panel-2. Each panel is fed by a 220V DC Battery Charger. The two panels sections are coupled by a bus sectionalizer breaker, situated in panel-2.</p> <p>The 220V DCDB is made of two panel sections, Panel-1 & Panel-2. Each panel is fed by a 220V DC Battery Charger. The two panels sections are coupled by a bus sectionalizer breaker, situated in panel-2. The supply to the 220V DC Battery Charger 1&2 is coming from AC Distribution panel 1 & 2.</p> <p>In normal condition, the bus coupling (MCCB Q05) is Closed and the DCDB is fed by Battery Charger-1 through Incomer MCCB Q01. In case of Under voltage or fault in Battery Charger-1, MCCB Q01 & Q02 Opens and MCCB Q03 & Q04 Closes automatically and the DCDB is fed by Battery Charger-2 through Incoming MCCB Q03. After the fault is cleared in Battery Charger-1, MCCB Q03 &</p>

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		<p>Q04 Opens and MCCB Q01 & Q02 Closes automatically and thus the DCDB is again fed by Battery Charger-1.</p> <p>In Switchover Mode, the bus coupling (MCCB Q05) is closed and the DCDB is fed by Battery Charger-2. In case of Under voltage or fault in Battery Charger-2, MCCB Q03 & Q04 Opens and MCCB Q01 & Q02 Closes automatically and the DCDB is fed through Battery Charger-1. After the fault is cleared in Battery Charger-2, MCCB Q01 & Q02 Opens and MCCB Q03 & Q04 Closes automatically and thus the DCDB is again fed by Battery Charger-2.</p> <p>In Boost Charging condition of Battery charger-1, MCCB Q02, Q03 & Q05 are Closed and MCCB Q01 & Q04 are Opened. Thus the DCDB is fed by Battery Charger-2 and the Battery is charged by Battery charger-1.</p> <p>In Boost Charging condition of Battery charger-2, MCCB Q01, Q04 & Q05 are Closed and MCCB Q01 & Q04 are Opened. Thus the DCDB is fed by Battery Charger-1 and the Battery is charged by Battery charger-2.</p> <p>In case the coupling MCCB (Q05) trips, the MCCBs Q01, Q02, Q03 & Q04 Closes and the two sections of the DCDB will be fed by the two respective Battery Chargers.</p> <p>In case both the Battery Chargers trip or normal power supply to both the battery chargers fail, the DCDB will be fed by the Battery.</p> <p>This 220V DC power is further distributed for the following purposes –</p> <ul style="list-style-type: none"> - Power supply to cooling fan circuits and OLTC of transformers. - Power supply to bay marshalling kiosks through which dc motors of circuit breakers and disconnecter switch drive mechanisms are fed DC power supply as shown in 042246-KDBK-E7108 – Voltage supply diagram for AC/DC. - Power supply to various panels like – bus-bar protection panels, C&P cubicles, 20kV control cubicle, annunciator panel, SCADA interface panels, metering panel and PLC panel as shown in 042246-KDBK-E7108 –
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		<p>Voltage supply diagram for AC/DC. and 042246-KDBK-E7102 – Single Line Diagram of 220V DC Distribution</p> <ul style="list-style-type: none"> - Power supply to the AC switchover logic circuits of 400V ACDB as shown in 042246-KDBK-E7102 – Single Line Diagram of 220V DC Distribution
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5.10. EARTHING SYSTEM:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-P7400 – Switchyard Earthing Layout
		042246-KDBK-P7401 – Earthing Details
		042246-KDBK-P7402 – Earthing calculation.
		042246-KDBK-E7401/02 – Gantry Tower Earthing Details
		Technical Specification – Cl. No. 00753.4.5
2.	EARTHING DESIGN BASIS :	<p>Fault current – 25 KA. Current division factor – 0.9. Fault duration – 1 sec. Earth resistivity – 10 Ωm. Crushed rock wet resistivity (summer) – 3000 Ωm. Crushed rock wet resistivity (winter) – 25352 Ωm. Crushed rock minimum thickness – 150mm. Depth of burial – 2 m. Length of earth rod – 3m. Max. Conductor length in X direction – 30m. Max. Conductor length in Y direction – 52m. Distance between parallel conductors – 8m.</p>
3.	EARTHING MATERIAL DETAILS :	<p>Main earth grid conductor: Cu 1 x 120 mm². Earth riser from earth grid conductor below ground: Cu 1 x 120 mm². Earth riser above ground for HV equipment & structure: Cu 2 x 95 mm². Earth riser above ground for panels, fence & other metallic parts except HV equipment: Cu 1 x 95 mm². Tinned braided flexible earthing tapes for metal gates: 300mm length and cross-sectional area of 70 mm². Earth electrode: 20 mm dia. CU ground rod. Earth bus bar in control building: 30 x 5 mm² bare</p>

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		copper bar.
4.	EARTHING INSTALLATION DETAILS:	
	Earth Grid Spacing :	Spacing between parallel grid conductors: 8m in both directions.
	Auxiliary Earth Mat :	1000 x 800mm galvanized steel grate earth mat is provided at each disconnect & earthing switches operator location.
	Connection between Earthing Conductors :	Through Weld type T joint (D540 & D541)
	Cable trench crossing :	Through PVC pipe of 50 mm diameter.
	Road crossing :	Through PVC pipe of 100mm diameter below 900mm ground level.
	Cable duct crossing :	Through PVC pipe below 300mm ground level.
5.	RESULT :	<p>Grid conductor size – 120 mm². Total nos. of ground rod – 6 Nos. Total length of earthing conductor – 500m. Grid (earth mesh) resistance – 0.122 Ω. Tolerable step voltage – 627V. Tolerable touch voltage – 2158V. Calculated step voltage – 77.67V. Calculated touch voltage – 105.173V. (Above data are obtained from 042246-KDBK-P7402 – Earthing calculation).</p>

5.11. CABLING WORKS:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-E7318 – Cable routing
		042246-KDBK-E7505 – Cable trench layout inside control building.
		042246-KDBK-E7401 – Cable tray details
		042246-KDBK-E7341/01 – Control Protection Fixation details.
		042246-KDBK-E7511 – Generator Cable Trench layout.
		042246-KDBK-E7510 (Sheet 1 of 2) - 20KV Cable routing for outgoing riser poles.
		042246-KDBK-E7510/01 – Cable fill ratio calculation
		042246-KDBK-E7510/03 – Cable ampacity calculation for 20KV outgoing feeders.
		042246-KDBK-E7506– Cable trench layout & details.

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		042246-KDBK-C7741 – Cable trench cover layout plan.
2.	CABLE LAYING PHILOSOPHY :	
	Within Switchyard :	All power and control cables in the switchyard are laid on ladder type cable trays in trenches and for equipment connection PVC tubes of 100mm & 200mm diameter were used. For road crossing, cables are laid in 200mm diameter PVC pipe in concrete encased duct bank.
	At 20kV Switchgear :	All 20kV 1Cx300mm ² XLPE insulated power cables originating from 20MVA transformers are routed through ladder type cable trays in trench upto 20kV switchgears. All 20kV 1Cx185mm ² XLPE insulated power cables originating from 20kV Switchgear for the outgoing riser poles are partly laid through cable trench, partly through directly buried in ground (950mm below FGL). 20kV power cables originating from QSK, MTU & KTA generator units and routed to 20kV switchgears are laid on ladder type trays in trench inside the substation area & laid directly buried outside the substation fence.
	At Control Building :	All power and control cables from the switchyard and Diesel generators are entering the control room through two pull pits of 1500x1500x1000mm & 1000x1000x1000mm size. Cables in control room building are installed on cable trays in trenches.
3.	CABLE TRENCH DETAILS WITH CABLE TRAYS AND ACCESSORIES:	
	Within Switchyard :	<ul style="list-style-type: none"> - 800x600mm cable trench section having 2nos. of 600mm ladder type cable trays. - 500x300mm cable trench section having 1no. of 300mm ladder type cable tray. - 1000x1200mm cable trench section having 4nos. of 300mm ladder type cable trays. - 1400x900mm power cable trench having 2nos. of 300mm ladder type cable trays at both sides. - 1600x1200mm cable trench having 4nos. of 600mm ladder type cable trays at both sides.
	At 20kV Switchgear Container :	- 1000x1200mm cable trench section having

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		<p>4nos. of 300mm ladder type cable trays.</p> <ul style="list-style-type: none"> - 1400x1900mm cable trench section having 5nos. of 300mm ladder type cable trays on both sides. - 1400x2500mm cable trench section having 7nos. of 300mm ladder type cable trays on both sides. - 1700x2500mm cable trench section having 7nos. of 600mm ladder type cable trays at one side & same nos. of 300mm ladder type trays on another side.
	At Control Building :	<ul style="list-style-type: none"> - 800x600mm cable trench section having 2nos. of 600mm ladder type cable trays. - 500x600mm cable trench.
4.	GENERAL INFORMATION :	<p>Auxiliary power cables are laid in top tiers and control cables in bottom layers.</p> <p>All 50x50x6mm support angles are placed at every 1.5m interval along the trench length as shown in 042246-KDBK-E7506– Cable trench layout & details.</p> <p>For earthing of cable trays, the cable tray supports of 100x10x150mm MS Flat are earthed at both side and an interval of 30m by 1x95mm² Cu earthing rope through Cu cable lug as shown in Earthing detail D529.</p> <p>Cable trays are suitably supported with structure or hangers at an interval of 1.5m for LV power cable ladder trays and 1.0m for 24kv power cable trays to prevent excessive stressing and deflection of the trays as shown in 042246-KDBK-E7506– Cable trench layout & details.</p> <p>All trench cover for power cables are located with a gap of 10mm for air ventilation & heat exhaust, shown in 042246-KDBK-C7741 – Cable trench cover layout plan.</p> <p>Pipe filling ratio is 40% for three or more nos. of cable, mentioned in 042246-KDBK-E7510/01 – Cable fill ratio calculation</p>

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5.12. DIRECT STROKE LIGHTNING PROTECTION:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-E7500 – General arrangement layout
		042246-KDBK-E7501 – Sectional diagrams, Elevation
		042246-KDBK-P7403 – Lightning protection layout
		042246-KDBK-C7821 – Static calculation for lightning rod-1.
		042246-KDBK-C7822 – Static calculation for lightning rod-2.
2.	METHOD OF DESIGN :	All equipment, building and structures are protected from direct lightning strike by Rolling Sphere Method having 20m radius of the sphere as shown in 042246-KDBK-P7403 – Lightning protection layout
3.	LIGHTNING PROTECTION PHILOSOPHY :	
	For Switchyard Equipment Protection:	All the equipment of 123kV switchyard at BreshnaKot are protected by 95mm ² steel shield wire, mounted on 15.15mt long towers as shown in 042246-KDBK-P7403 – Lightning protection layout
	For Transformer Protection:	Four nos. of 20MVA Transformers are protected from lightning strike by :- Three nos. of 4m long lightning protection rod, located on top of the transformer firewalls of 6.5m height. Two nos. of 9.1m long lightning protection rod, located on top of two transformer foundation. ----- As shown in 042246-KDBK-P7403 – Lightning protection layout

5.13. LIGHTING WORKS:

SL.NO.	SALIENT FEATURES	DETAILS
1.	REFERENCE DRAWINGS :	042246-KDBK-E7300 – Lighting layout for switchyard
		042246-KDBK-E7301 – Switchyard lighting DB details
		042246-KDBK-C7831 – 12m single arm and double arm lighting pole details.
		042246-KDBK-E7302 – Lighting and power layout of control building.

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		042246-KDBK-E7302 – Lighting and power layout of control building-DB and fire alarm details.
		042246-KDBK-E7302/01 – Calculation for load detail.
		042246-KDBK-E7302/01 – Lighting and power load calculation.
		042246-KDBK-E7365 – Guard house lighting and power layout.
		042246-KDBK-E7306 – Lighting layout for the cable trench under the 20KV switchgear.
		042246-KDBK-E7012 – Lux level calculation for control building.
		042246-KDBK-E7327 – Lighting fixtures.
		042246-KDBK-E7328 – Receptacles
		042246-KDBK-E7358 – Distribution boards.
		042246-KDBK-E7359 – Conduits and accessories.
		042246-KDBK-E7360 – Exit sign and wall mounted incandescent light.
		Technical specification – Clause No. – 00753.4.7
2.	LIGHTING DESIGN :	
	2.1.Outdoor Switchyard Lighting :	The total switchyard is illuminated by 18 nos. of pole mounted 250W street lighting fixtures with 12 nos. of pole mounted 2x55W twin spot for emergency lighting purpose.
	a) Lux Levels :	Disconnect and earth switch switchblades – 12 lux. Substation bus area (general horizontal under bus and structures at ground level) – 22 lux. Outdoor equipment control cabinets – 50 lux. Fence and open areas within the substation at ground level – 3 lux. Roadways (between or along buildings) – 11 lux. Roadways (not bordered by buildings) – 5.5 lux.
	b) Fixture Details :	EAE - IP-65 class, sodium bulb 250W, Alum. Cover and frame polished alum. Reflector, street lighting fixture. – 18nos. These are mounted on 12.5m height of lighting poles EAE – IP 65 class, 2 x 55W self-charging Twin spot for emergency purpose. – 12nos. These are mounted on 4m height of lighting poles.
	c) Lighting Panel Details :	AC power of the wall mounted lighting panel (DB-2, 8 way TPN) is supplied from 400V AC distribution panel.

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		<p>Bus rating – 400V, 50A, 50Hz.</p> <p>Breaker rating – 1 no. of 50A, TPN MCCB , 12 nos. of 20A SP MCB, 2nos. of 20A TPN and 2nos. of 16A SP MCB.</p> <p>Load – 6.36KW.</p> <p>Earthing – 1C x 35mm² Cu wire.</p>
	d) Lighting Poles :	<p>11 Nos. of 12 meter long octagonal lighting poles and 4 number of 8 meter long octagonal poles have been used for switchyard lighting.</p> <p>3 nos of 8meter double arm lighting pole are used.</p> <p>1 no. of 8 meter with single arm lighting pole is used</p> <p>11 nos. of single arm lighting poles are used in the switchyard area shown in 042246-KDBK-C7831 & E7300, 12m and 8 m single arm and double arm lighting pole details.</p>
	e) Receptacles :	<p>6 nos. of receptacles are mounted on lighting poles at 1.2m height as shown in 042246-KDBK-E7301 – receptacle mounting details.</p>
	f) Junction Box :	<p>15 nos. for yard lamp holders and 12 nos. for emergency lamp socket.</p>
	g) Cabling :	<p>ACDP to DB-2 – 4C x 25 mm² Cu XLPE cable.</p> <p>DB-2 to Lighting JB – 4C x 16 mm² Cu XLPE cable.</p> <p>Lighting JB to Fixtures – 2C x 4 mm² Cu cable.</p>
	2.2.Control Building Lighting :	<p>Total control building is illuminated by 10 nos. of ceiling mounted lighting fixtures (VLX 2xTL554U) and 4 nos. of 1x100W wall mounted lighting fixtures.</p>
	a) Required Lux levels :	<p>Entrances – 110 lux.</p> <p>General areas – 110 lux.</p> <p>Floor – 150 lux.</p> <p>Vertical face of control & protection panels (1.225m above floor and front of panel) – 270 lux.</p>
	b) Achieved Lux Levels :	<p>The lux level is achieved as per requirement, mentioned in technical specification and has mentioned in 042246-KDBK-E7012 – Lux level calculation for control building.</p>
	c) Fixture Details :	<p>6 nos. of VLX 2xTL 554U – SP/PC 1x54W electronic ballast, polycarbon made with clips passing the housing and PC cover, polished Aluminium interior</p>

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		<p>reflex, bus bar surface armature.</p> <p>4 nos. of VLX 2xTL 554U – SP/PC – A3H 1x54W electronic ballast, polycarbon made with clips passing the housing and PC cover, polished Aluminium interior reflex, 3 hours lighting surface mass bus bar. (The supplier only adds small batteries of 3Ah inside the fixtures for these fixtures with the above rating).</p> <p>4 nos. of 1x100W wall mounted lighting fixture.</p>
	d) Lighting Panel Details :	<p>AC power of the wall mounted lighting panel (DB-1, 6 way TPN concealed type) is supplied from 400V AC distribution panel.</p> <p>Bus -bar rating – 400V, 50A, 50Hz.</p> <p>Breaker rating – 1 no. of 50A, TPN MCCB (for incoming feeder), 10 nos. of 20A, SP MCB (outgoing feeders for lighting circuits), 2 nos. of 20A, TP MCB and 2 nos. of 16A, SP MCB</p> <p>Load – 24.3KW.</p> <p>Earthing – 1C x 35mm² Cu wire.</p>
	e) Receptacles :	<p>Single phase socket with earth – 12 nos.</p> <p>Three phase socket with earth – 3 nos.</p> <p>These sockets are mounted on wall above 1.2m from FFL.</p> <p>Waterproof socket for AC – 2 nos.</p>
	f) Fan :	<p>1 no. of ceiling fan is mounted at 4m height in control room above operator’s table.</p> <p>1 no. of heavy duty exhaust fan is mounted in battery room.</p>
	g) Lighting Switch :	<p>5 nos. of one pole lighting switch are used and mounted on wall at 1.2m height from FFL as shown in Drawing No. 042246-KDBK-E7302.</p>
	h) Cabling :	<p>ACDP to DB-1 – 4C x 25 mm² Cu XLPE cable.</p> <p>DB-1 to Lighting circuits – 3C x 2.5 mm² Cu cable.</p> <p>DB-1 to Power sockets – 4C x 4 mm² Cu cable.</p> <p>DB-1 to AC circuits – 4C x 6 mm² Cu cable.</p>

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i) Conduit :	20mm diameter’s EMT conduit has used for wiring.
2.3.Guard House Lighting :	Guard house is illuminated by one set of 2 x 40W industrial type FTL lamp as shown in 042246-KDBK-E7365 – Guard house lighting and power layout.
a) Required Lux levels :	Entrances – 110 lux. General areas – 110 lux. Floor – 150 lux. Vertical face of control & protection panels (1.225m above floor and front of panel) – 270 lux.
b) Achieved Lux Levels :	The lux level is achieved as per requirement, mentioned in technical specification.
c) Fixture Details :	2 x 40W Industrial type FTL lamp. 1 x 150W wall mounted lighting fixture.
d) Other Items :	One wall mounted distribution board. One double pole lighting switch, mounted on wall above 1.2m from FFL. Two nos. of single phase socket mounted above 0.45m from FFL. One disconnecter switch of 220V, 50Hz, 20A is mounted at 1.2m above FFL. The diameter of conduit, used for wiring is 20mm.
e) Cabling :	DB to Lighting circuits – 3C x 2.5 mm ² Cu cable. DB to Power sockets – 4C x 4 mm ² Cu cable.
2.4.20kV Switchgear Room Trench Lighting :	13nos. of industrial type lighting fixture (2x18W FTL) have been used to maintain 110 lux in 20kV switchgear rooms. 4 nos. of two way lighting switch have mounted on wall as shown in 042246-KDBK-E7306 – Lighting layout for the cable trench under the 20KV switchgear.
2.5. 20kV Switchgear Container Lighting	
a) Lux levels	Controlled by Illuminance sensor
b) Fixture details	Indoor lighting - 2FLR-40, vapour tight fluorescent lighting fitting (VFL) with 2x40W lamps and electronic type ballasts External flood lighting - SHF 213, weather proof type outdoor wall mounted fixture, 1x150W HPSV,

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		IP55 Emergency lighting - EL-ST2H18W, efficient and secure 6V heavy duty emergency light including 10 years life maintenance free back up battery, works on either 120V or 277V AC.
	c) Panel details	Wall mounted type, Incomer – 1 x50AT MCCB, Outgoing – 12x20 AT ELCBs.
	d) Receptacles	250V, 50 Hz, 16A, 3 convenience receptacle.
	e) Switchboards	2 nos. 2-way tumbler switches near door.
	f) Ref. Drawings for 20kV Containers	<ul style="list-style-type: none"> a) Lighting layout plan for 20kV Switchgear building type A : E-100-01 of Hyundai b) Receptacle layout plan for 20kV Switchgear building type A : E-100-02 of Hyundai c) Fan & thermostat layout plan for 20kV Switchgear building type A : E-100-03 of Hyundai d) Emergency exit layout plan for 20kV Switchgear building type A : E-100-05 of Hyundai e) SLD of Lighting panel for 20kV Switchgear building type A : E-100-10 of Hyundai f) Lighting layout plan for 20kV Switchgear building type B : E-200-01 of Hyundai g) Receptacle layout plan for 20kV Switchgear building type B : E-200-02 of Hyundai h) Fan & thermostat layout plan for 20kV Switchgear building type B : E-200-03 of Hyundai i) Emergency exit layout plan for 20kV Switchgear building type B : E-200-05 of Hyundai j) SLD of Lighting panel for 20kV Switchgear building type B : E-200-10 of Hyundai

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5.14. FIRE DETECTION AND ALARM:

SL.NO.	SALIENT FEATURES	DETAILS
1.	FIRE DETECTION AND ALARM SYSTEM FOR CONTROL BUILDING :	
a.	REFERENCE DRAWINGS :	<p>042246-KDBK-E7361 – Specification for fire alarm materials.</p> <p>042246-KDBK-M7916 – Firefighting details-Control building and Guard house.</p> <p>042246-KDBK-E7302 – Lighting and Power layout of control building.</p> <p>042246-KDBK-E7302 – Lighting and Power layout of control building DB and fire alarm details.</p>
b.	GENERAL DESCRIPTION :	<p>For fire detection in control building, 8 nos. of smoke detectors are mounted at ceiling in such a way that these don't foul with the position of ceiling mounted lighting fixtures. 3 nos. of pull stations are mounted on wall near the gates of control building at height of 1.4m above FFL and 3 nos. of strobe fire alarms are mounted on wall at the height of 2.3m from FFL as shown in Drawing No. -042246-KDBK-E7302.</p>
c.	SYSTEM ACCESSORIES :	<p>Fire alarm cable – 1R#2Cx1.5mm².</p> <p>Fire/smoke detector – MG-9400 intelligent analogue addressable multi-sensor detector (photo electric smoke + heat).</p> <p>Sounder – MG-6600 symphony SY/C intelligent analogue addressable loop powered sounder. (VIP communication module included)</p> <p>MCP – MG-8130 addressable manual call point with isolator module, resettable.</p> <p>Fire alarm panel</p> <p>Fire extinguisher - FE-CO₂ 5LB, ABC dry chemical 4.5 LB.</p>
2.	FIRE DETECTION AND ALARM SYSTEM FOR 20KV SWITCHGEAR CONTAINERS :	
a.	REFERENCE DRAWINGS :	<p>a) Fire alarm layout plan for 20kV Switchgear building type A : E-100-04 of Hyundai</p> <p>b) Fire alarm layout plan for 20kV Switchgear building type B : E-200-04 of Hyundai</p>
b.	GENERAL DESCRIPTION :	<p>2 nos. smoke detectors, 1 no. manual pull station, 1 no. horn, 2 nos. fire extinguishers and 1 no. fire</p>

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		alarm panel have been used in each container.
c.	SYSTEM ACCESSORIES :	Smoke detector –photo electric smoke detector POTTER PS-24 with base type POTTER, SB-46 MPS – Die cast manual pull station, POTTER type RMS-1T-WP Fire alarm panel – Microprocessor based POTTER type PFC-5004E (4 zone expandable to 8 zones) Fire extinguisher –6kg, ABCE, Tyco

5.15. CIVIL WORKS:

The summary report intends to cover the summary of civil works in respect of BreshnaKot 110/20 kV Substation under Kandahar Helmand Power Project. General design & site data are as follows:

Seismic Zone - 4	Z=0.4
Velocity of Wind	41 m/sec
Allowable S.B.C	195 kN/m ²
φ for soil	25°
γ for soil	12.67 kN/m ³
Unit weight of structural steel	77 kN/m ³
Yield strength of structural steel	248 Mpa
Yield strength of reinforcement	60 ksi (420 Mpa)
Yield strength of concrete	4 ksi (28 Mpa)

DETAILED SUMMARY REPORT

SL. NO.	ITEM	GRADE OF P.C.C (FOR ROAD)	WIDTH OF ROAD	TYPE OF CEMENT	P.C.C. (FOR LEAN CONCRETE)	ROAD LAYERS
1	ROAD	Concrete (Fc') = 4.0 ksi with Portland cement (min. content of 348 kg/cu-m and max. free water cement ratio 0.45	2500,3000, 4000	PORLAND CEMENT	P.C.C. (F'c= 14Mpa) With Portland cement (min. content of 200 kg/cu-m)	125mm concrete surface finish, 150mm aggregate base course, 300mm compacted subgrade

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SL.NO.	ITEM	GRADE OF REINFORCEMENT	GRADE OF R.C.C.	DIA OF REINFORCEMENTΦ (mm)	TYPE OF CEMENT	CONCRETE COVER	THICKNESS OF LEAN CONCRETE (mm)	LEAN CONCRETE	FORMWORK	DIA OF P.V.C TUBE (mm)
1	TOWER-A	Yield of reinforcement =60 ksi (420 Mpa)	Concrete (Fc') =4.0 ksi with portland cement (min. content of 348 kg/cu-m and max. free water cement ratio 0.45	14,12,20	PORTLAND CEMENT	For Air = 40 mm For Soil = 75 mm	50	With portland cement (min. content of 200 kg/cu-m)	All visible surface to be fair faced with shuttering such as ply wood. All visible corner to be chamfered 15x15 mm	--
2	TOWER-B-F			14,12,20			50			--
3	TOWER-C			14,12,16,25			50			--
4	TOWER-D			12,16			50			--
5	TOWER-E-G			14,12,16,20			50			--
6	FOUNDATION (1)			10,12,14,20			50			--
7	FORMWORK FOUNDATION (2)			--			50			--
8	FORMWORK FOUNDATION (3)			10,12,14,20			50			--
9	FORMWORK FOUNDATION (4)			10,12,14,20			50			--
10	FORMWORK FOUNDATION (5)			10,12,14,20			50			--
11	FORMWORK FOUNDATION (6)			--			50			--
12	CABLE TRENCH AXIS D-F			6,10,12,16			50			100, 200
13	CABLE TRENCH AXIS 7/B-F			10,12,14,20			50			--
14	PULL PIT/ CABLE TRENCH AXIS 5-7/H-J			12,10			50			--
15	CABLE TRENCH AXIS B-D			6,10,12			50			100, 200
16	CABLE TRENCH COPING SLAB			10,12			--			--
17	STATION AUX. TRANSFORMER			14,12,16,20			50			--
18	POWER TRANSFORMER 1+2			8,14, 12, 10, 20, 25			50			200mm & Grating -3 cm
19	CONTAINER FOUNDATION			10,12,16,20, 14, 8			50			100,200
20	BOX CULVERT			12			50			Duct Bank
21	DRAINAGE SYSTEM			8,10,16			--			Grating - 5cm
22	DUCT BANK			12			--			200
23	LIGHTING POLE			8,12			--			--

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SL. NO.	ITEM	GRADE OF REINFORCEMENT	GRADE OF R.C.C	S.B.C	DIA OF REINFORCEMENT ϕ (mm)	TYPE OF CEMENT	CONCRETE COVER	THICKNESS OF LEAN CONCRETE (mm)	P.C.C	FORMWORK	PIPES	FINISHING ITEM
1	CONTROL ROOM	Yield strength of reinforcement (425 Mpa)	Concrete (F _c ') = 4.0 ksi with portland cement (min. content of 348 kg/cu-m and max. free water cement ratio 0.45)	218 KN/M ²	6,8,10,12, 16	PORLAND CEMENT	For Column, Beam= 40 mm, Slab= 20 mm For Footing = 75 mm	75	P.C.C (F _c '= 14 Mpa) With portland cement (min. content of 200 kg/cu-m)	500x1000 Metalic panel, 100x100 lumber joist, 100x50 lumber, 50 mm prop.	200mm dia P.V.C & 110 mm down spout pipe	Plaster = 15 mm, Roof mate= 40 mm, p.c.c = 50 mm, 4 mm water proofing membrane.

SL. NO.	ITEM	DIA OF PIPE	CHAIN LINK	TRUSS ROD	TENSION WIRE	TH. OF PLATE (mm)
1	CHAIN LINK FENCING	75, 63, 100, 50, 38	9 GAUGE	9.52mm	GALVANIZED 4.57mm	3, 5

5.16. STEEL STRUCTURAL WORKS:

The summary report intends to cover the summary of Structural works in respect of BreshnaKot110/20 kV Substation under Kandahar Helmand Power Project. General design & site data are as follows:

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SL. NO.	ITEM	QUALITY OF STRUCTURAL STEEL	CLASS OF BOLTS	GALVANIZING	ANGLE	TH. OF PLATE (mm)	BOLTS	NUTS & WASHER
1	TOWER -A	S 235 JR & S355 JR	8.8	For Angles & Plates with Thickness 3 to 6 mm = 500 gm/ m ² with Thickness > 6 mm = 610 gm/ m ²	L 100X8, L 90X6, L 90X8, L 50X4, L 40X4	30, 8, 6, 10, 2	M20, 16, 12	M20, 16, 12
2	TOWER -B				L 100X8, L 90X6, L 90X8, L 70X5, L 50X4, L 40X4, L80X8, L60X5	30, 8, 6, 10, 2	M20, 16, 12	M20, 16, 12
3	TOWER -C				L 150X12, L 130X12, L110X8, L120X10, L 90X6, L 50X4, L 40X4, L70X5	40, 12,8,10,18,4	M20, 16, 12	M20, 16, 12
4	TOWER -D				L 90X6, L 70X5, L 50X4, L 40X4, L80X8	20, 8, 6, 10, 18	M20, 16, 12	M20, 16, 12
5	TOWER -E				L120X10, L 100X8, L 90x6, L 70X6, L 40X4, L70X5, L60X5, L 100X10, L 90x8	30, 8, 6, 10, 18,2,12	M20, 16, 12	M20, 16, 12
6	TOWER -F				L 90X6, L 70X5, L 40X4, L80X8	20, 8, 6, 10, 18	M20, 16, 12	M20, 16, 12
7	TOWER -G				L120X10, L 100X8, L 90x6, L 70X6, L 40X4, L60X5, L 100X10, L 90x8	30, 8, 6, 10, 2, 12	M20, 16, 12	M20, 16, 12
8	BEAM -A				L 90X6, L 110X10, L 40X4, L80X8	8,10	M20, 16, 12	M20, 16, 12
9	BEAM -B				L 90X6, L 110X10, L 40X4, L80X8	8,10	M20, 16, 12	M20, 16, 12
10	BEAM -C				L 90X6, L 110X10, L 40X4, L80X8, L 50X4	8,10	M20, 16, 12	M20, 16, 12
11	BEAM -D				L 90X6, L 110X10, L 40X4, L80X8, L 50X4	8,10,6	M20, 16, 12	M20, 16, 12
12	BEAM -E				L 90X6, L 110X10, L 40X4, L80X8	8,10	M20, 16, 12	M20, 16, 12
13	24 KV DISCONNECTOR SUPPORT				L 60X6, L 120X12, L 40X4, L50X5, UNP 160	--	M12	M12
14	100 KV CT SUPPORT				L 60X6, L 120X12, L 40X4, UNP 120	--	M12	M12
15	100 KV CVT SUPPORT				L 60X6, L 120X12, L 40X4, UNP 120, UNP 160	--	M12	M12
16	110 KV DISCONNECTOR SUPPORT				L 130X14, L 150X12, L 40X4, UNP 140, UNP 80, L50X5, L60X6	12,10,6	M12, 16	M12, 16
17	110 KV PI SUPPORT				L 120X12, L 40X4, UNP 120, L60X5, L60X6, L 45X4	12,8	M12	M12
18	110 KV SA SUPPORT				L 120X12, L 40X4, L60X6, L 45X4	12	M12	M12
19	LIGHTING POLE				PWD 101.6 X 6.3, UNP 100, PWD 114X14	8,10,15,20, 25	M16	M16
20	TEMPLATE FOR TOWER -A	ST-37	58	:	L 40X4, , L60X5	--	M12	M12
21	TEMPLATE FOR TOWER -E & G				L60X6	6, 12	M12	M12
22	TEMPLATE FOR TOWER -F				L 40X4, , L60X5	--	M12	M12
23	TEMPLATE FOR E30,31,40,41,60,70, J20				L 40X4, , L60X5	4	M12	M12
24	TEMPLATE FOR E20,21,22				L 50X5, , L60X5	5	M12	M12
25	TEMPLATE FOR E71				L 40X4, , L60X5	--	M12	M12
26	TEMPLATE FOR E10				L 40X4, , L60X5	--	M12	M12

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SL. NO.	ITEM	QUALITY OF STRUCTURAL STEEL	CLASS OF BOLTS	GALVANIZING	MEMBER	TH. OF PLATE (mm)	BOLTS	NUTS & WASHER
1	110 kv steel poles	S 235 JR & S355 JR	8.8	For Angles & Plates with Thickness 3 to 6 mm = 500 gm/ m ² with Thickness > 6 mm = 610 gm/ m ²	UNP65, CB24, PWD60.3X2.3, CB32.6	8, 6, 20, 10, 12, 45, 16	M20, 16, 12	M20, 16, 12

5.17. HVAC SYSTEM:

SL.NO.	SALIENT FEATURES	DETAILS
1.	CONTROL BUILDING :	
a.	REFERENCE DRAWINGS :	042246-KDBK-M7915 – HVAC System. 042246-KDBK-E7302 – Lighting and Power layout of control building. 042246-KDBK-E7365 – Guard House Lighting and Power layout
b.	GENERAL DESCRIPTION :	Two nos. of direct expansion fan coil units with heat pump outdoor condensing units are being selected at control room. Capacity of each unit is --- cooling in summer is 18.9kW and heating in winter is 6.57kW. These two units are sufficient to control the temperature within range of 5°C to 25°C around the year and one air conditioner of 1200W with one 20A Disconnecter switch is used at guard house. One heavy duty exhaust fan (impeller diameter – 400mm) is used to exhaust the air from battery room.
2.	20kV SWITCHGEAR CONTAINERS :	
a.	REFERENCE DRAWINGS :	1. Fan and Thermostat layout plan for 20kV Switchgear Container, type-A: Drawing no. E-100-03 of Hyundai 2. Fan and Thermostat layout plan for 20kV Switchgear Container, type-B: Drawing no. E-200-03 of Hyundai
b.	GENERAL DESCRIPTION :	1 no. high pressure ventilator, 19CMM, 220V AC, DONGKUN type DUN-101 (brand name – Windy) with thermostat PT 100 ohm and room sensor

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6.0 - MATERIAL AND EQUIPMENT DATA

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6.0 MATERIAL AND EQUIPMENT DATA:

6.1. 110kV TRANSMISSION LINE CONDUCTOR:

Make	Patel Wire Industries	
Type	ACSR ELK	
Construction		
Centre	1 x 4.5 mm	Galvanized Steel Wire
1 st layer	6 x 4.5 mm	Galvanized Steel Wires
2 nd layer	12 x 4.50 mm	Aluminium Wires
3 rd layer	18.4.50mm	Aluminium Wires
Nominal Dimensions		
Core diameter	13.50 mm	
Overall diameter	31.50 mm	
Electrical Properties		
DC Resistance @ 20° C	0.0606 Ω / km	
Mechanical Properties		
Breaking Load	198.80 kN	
Modulus of Elasticity	80420 N / mm ²	
Coefficient of Linear Expansion	17.8 x 10 ⁻⁶ per °C	
Physical Properties		
Aluminium area	477.1 mm ²	
Steel area	111.30 mm ²	
Total area	588.4 mm ²	
Mass of Aluminium	1321 kg / km	
Mass of Steel	868 kg / km	
Total Mass (ungreased)	2189 kg / km	
Reference Document No.	042246-KDBK-E7362, Rev - B – 110kV Transmission Line ACSR Conductor	

6.2. 110kV TRANSMISSION LINE DISC INSULATOR:

Make	Aditya Birla Insulator
Type	Ball & Socket Type Disc Insulator (Type 'B')
Material	Porcelain
Nominal System Voltage	11 kV
Highest System Voltage	12 kV
Visible Discharge Test Voltage	18 kV
Dry 1 min. Power Frequency Withstand Voltage	72 kV
Wet 1 min. Power Frequency Withstand Voltage	42 kV
Power Frequency Puncture Withstand Voltage	125 kV

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Impulse (1.2/50 microsecond wave) Withstand Voltage	Positive – 115kVp Negative – 115kVp
Impulse (1.2/50 microsecond wave) flashover voltage	Positive – 125kVp Negative – 130kVp
Dry Power frequency flashover voltage	80 kV
Wet Power frequency flashover voltage	50 kV
Minimum Failing Load	160 kN
Creepage Distance (Min)	330 mm
Reference Drawing No.	JS – D573, R – 3
Reference Document No.	042246 – KDBK – E7363, Rev – 0 – Disc Insulators for 110kV Transmission Line

6.3. 110kV TRANSMISSION LINE DISC INSULATOR (OPTION – II):

Make	INSULATORS & ELECTRICALS COMPANY
Type of Insulator	Type “B”
Size and Designation of Ball & Socket	20mm
Outside diameter of the Disc	280 mm
Spacing	170 mm
Creepage Distance of the Single Disc	330 mm
Electro-mechanical strength of Single Disc	160kN
Withstand Voltage of Single Disc	
Power Frequency a) Dry b) Wet	80 kV (rms) 50kV (rms)
Impulse voltage 1.2/50 microsecond a) Positive b) Negative	140 kVp 140 kVp
Flashover Voltage for the Disc	
Power Frequency a) Dry b) Wet	85kV (rms) 55kV (rms)
Lightning Impulse Voltage – 1.2/50 microsecond a) Positive b) Negative	150kVp 150kVp
P.F Puncture Voltage	140 kV (rms)
Minimum Corona Extinction Voltage	18 kV (rms)
Maximum RIV with 10 kV (RMS) (micro volts)	50 μ V
Nominal System Voltage	11 kV
Highest System Voltage	12 kV
Specification Standard	IEC 60383
Weight of each Disc (approx.)	8.0kgs

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Reference Document No.	042246 – KDBK – E7373 – Disc Insulators for 110kV Transmission Line (Option-II)
Reference Drawing No.	CQ D 160 2 S 01, Rev– 0 – 11kV Disc Insulator (B/S Type) EMS – 160kN

6.4. 110kV TRANSMISSION LINE HARDWARES AND ACCESSORIES:

(i) Single Tension String	
Make	SHAHEEN
Type	ST – 02 – AF – 01
Rated Voltage	145 KV
Short Time Withstand Capacity	60 KA / 1 sec.
Breaking Load	120 kN
Reference Document No.	042246 – KDBK – E7372 – Transmission Line Hardware and Accessories
Reference Drawing No.	Aa 1245, Rev – A (Manufacturer’s Drawing)

(ii) Single Suspension String	
Make	SHAHEEN
Type	ST – 02 – AF – 02
Rated Voltage	145 kV
Short Time Withstand Capacity	60 kA / 1 sec.
Breaking Load	120 kN
Reference Document No.	042246 – KDBK – E7372 – Transmission Line Hardware and Accessories
Reference Drawing No.	Aa 1245, Rev – A (Manufacturer’s Drawing)

(iii) Stock Bridge Damper	
Make	SHAHEEN
Type	ST – 02 – AF – 05
Reference Document No.	042246 – KDBK – E7372 – Transmission Line Hardware and Accessories
Reference Drawing No.	Aa 1245, Rev – A (Manufacturer’s Drawing)

6.5. 110kV TRANSMISSION LINE SHIELD WIRE:

Make	ELSWEDY CABLES
Single galvanized steel wire specification	
Wire Diameter	2.50 (± 0.04) mm
Material Type	AISI 1060
Minimum Tensile Strength before Standing	1310N/mm ²
Minimum Weight of Zinc Coating	230gm/m ²
Minimum Elongation percentage	3.0%

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GSW Core Specifications	
Standard Steel Wires Conductor Acc. To	DIN48203-3
No. of Wires	19
Cross Section Area Conductor	95mm ²
Conductor Diameter	12.50mm
Minimum Breaking Load of Conductor	119 kN
Cutting Length (- 0 / + 2)%	1000 m
Lay Ratio/Direction Inner Layer	10-16/L.H
Lay Ratio/Direction Outer Layer	10-14/R.H
No. of Lengths Per One Wooden Drum	1
Net Weight Per One Wooden Drum	730 kg
Conductor Weight for Cutting Length	730 kg
Grease Application	No
Weight of Conductor for 1 km without grease, $\pm 2\%$	730kg/km
Reference Document No.	042246 – KDBK – P7404 – Earth Wire (Steel Wire)

6.6. 110kV TRANSMISSION POLE:

Pole Type	Steel Monopole Single Circuit
Material:	
a) Shaft and Flange	High Tensile Steel (S355JR)
b) All other members	Mild Steel (S235JR)
c) All Bolts	High Tensile Steel (ISO 898/90)
Construction	Polygonal type, 16 faces
Height	27.4m
Length	
a) Bottom Shaft	9.9m
b) Middle Shaft	9.925m
c) Top Shaft	11.73m
Thickness:	
a) Bottom Shaft	12mm
b) Middle Shaft	10mm
c) Top Shaft	8mm
Mounting	M42 Bolt Mounted
Number of Arms	3
Length of Arms:	
a) Bottom	3.91m
b) Middle	3.91m
c) Top	3.91m
Reference Standards	EN ISO 1461, DIN EN 22533
Reference Drawing No.	042246-KDBK-C7826-2

6.7. 110kV SURGE ARRESTER:

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Make	TRIDELTA Überspannungsableiter GmbH
Type	SB123 / 10.2 - 0
Rated Voltage, U_r	123 kV
Continuous Operating Voltage, V_c	98 kV
Temporary Overvoltage TOV	$U_{1s} - 141$ kV $U_{10s} - 134$ kV
Nominal Discharge Current	10kA
High Current Impulse (4/10)	100kA
Long Duration Current Impulse	500 A / 2000 us
Line Discharge Class	2
Rated Short-Circuit Current	40kA – 50kA
Specific Emergency Withstand	acc to IEC 60099 – 4 - 4.5 kJ / kU_{ur} Double Impulse 3000 us – 8.0 kJ / kV_{ur}
Reference Document No.	042246-KDBK-E7316 – Surge Arrester for Line 1001-Dr(E) (Manufacturer’s Drawing)
Reference Drawing No.	

6.8. 110kV CVT (for Q4-BU1 & Q4-BU5):

Make	ABB
Type	WN145N2
Highest System Voltage	145 kV
Rated Primary Voltage	110 / $\sqrt{3}$ kV
Rated Secondary Voltage	100 / $\sqrt{3}$ V
Rated Frequency	50 Hz
Rated Insulation Level	145/275/650 kV
Accuracy Class & Burden	0.2, 15 VA. 0.5 / 3P, 25 VA
Reference Document No.	042246-KDBK-E7313 – Capacitor Voltage Transformer
Reference Drawing No.	1HYT901711-008 (Manufacturer’s Drawing)

6.9. 110kV CVT (for WA1-B011, WA2-BU21, Q1-BU1, Q3-BU1, Q6-BU1):

Make	ABB
Type	WN145N2
Highest System Voltage	145 kV
Rated Primary Voltage	110 / $\sqrt{3}$ kV
Rated Secondary Voltage	100 / $\sqrt{3}$ V
Rated Frequency	50 Hz
Rated Insulation Level	145/275/650 kV
Accuracy Class & Burden	0.5 / 3P, 10 VA.

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	0.5 / 3P, 25 VA
Reference Document No.	042246-KDBK-E7313 – 110kV Capacitor Voltage Transformer
Reference Drawing No.	1HYT901711-008 (Manufacturer’s Drawing)

6.10. 110kV LINE TRAP:

Make	ABB
Type	DLTC1600A / 1.0
Rated Continuous Current	1600 A
Rated Voltage	170 kV
Rated Inductance Of 100 KHz	1.0 mH
Power Frequency	50 Hz
Shot Time Without Current	40 kA / 1 Sec.
Asymmetrical Peak Value	102 kA
Minimum Resistive Impedance	600 Ω
Lower Band limit Frequency	80 kHz
Upper Band limit Frequency	515 kHz
Reference Document No.	042246-KDBK-E7317 – 110kV Line Trap
Reference Drawing No.	1KHJ035301 (Manufacturer’s Drawing)

6.11. 110kV CT (LINE) {Q4-BI1 & Q5-BI1}:

Make	ABB
Type	IMB145
Highest System Voltage	145 kV
Rated Primary Normal Current	1600-800-400 A
Rated Secondary Current	1 A
Rated Frequency	50 Hz
Rated Insulation Level	145/275/650 kV
Rated Short Time Withstand Current	31.5 kA / 1 Sec.
Accuracy Class & Burden	Core - 1 – 5P20, 15 VA Core - 2 – 5P20, 15 VA Core - 3 – 5P20, 15 VA Core - 4 – 5P20, 15 VA
Reference Document No.	042246-KDBK-E7312 – 110kV C.T.
Reference Drawing No.	1HYT901711-002 (Manufacturer’s Drawing)

6.12. 110kV CT (TRANSFORMER) {Q1-BI1, Q2-BI1, Q3-BI1 & Q6-BI1}:

Make	ABB
Type	IMB145
Highest System Voltage	145 kV

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Rated Primary Normal Current	1600-800-400 A
Rated Secondary Current	1 A
Rated Frequency	50 Hz
Rated Insulation Level	145/275/650 kV
Accuracy Class & Burden	Core - 1 – 5P20, 15 VA Core - 2 – 5P20, 15 VA Core - 3 – 5P20, 15 VA Core - 4 – 5P20, 15 VA
Reference Document No.	042246-KDBK-E7312 – 110kV Current Transformer
Reference Drawing No.	1HYT901711-002

6.13. 110kV SF6 CIRCUIT BREAKER:

Make	Crompton Greaves Ltd., Nasik
Type	120-SFM-32B
Rated Voltage	145 kV
Rated Normal Current	1600 A
Rated Short Circuit Breaking Current	40 kA
Rated Short Time Withstand Current	40 KA for 1 second
Rated Lighting Impulse Withstand Voltage	650 kVp
Rated Coil Voltage	Closing 220V DC, Tripping 220V DC
Motor Voltage	220V DC
Auxiliary Switch Spare Contact	12 No + 12 No
Reference Drawing No.	SX-3856-01/02/03/04/05/06 (Manufacturer's dwg)

6.14. 110kV DISCONNECTOR SWITCH (WIH ONE EARTH SWITCH) – MOTOR OPERATED:

Make	ABB, VADODARA
Type	SGF123n100 + IE
Rated Voltage	123 kV
Insulation Level	550 kVp
Normal Current	1600 A
Short-Time Withstand Current	31.5 kA / 1 Sec.
Frequency	50 Hz
Motor	220 V DC
Motor Auxiliary Switch Connect	10 NO + 10 NC
Reference Document No.	042246-KDBK-E7314 – Disconnecter Switches 1HYD901238-301 (GA)
Reference Drawing No.	1HYD99161-157 (Motor Schematic Diagram)

6.15. 110kV DISCONNECTOR SWITCH (WITHOUT EARTH SWITCH) – MOTOR OPERATED:

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Make	ABB, VADODARA
Type	SGF123n100
Rated Voltage	123 kV
Insulation Level	550 kVp
Normal Current	1600 A
Short-Time Withstand Current	31.5 kA / 1 Sec.
Frequency	50 Hz
Motor	220 V DC
Motor Auxiliary Switch Connect	10 NO + 10 NC
Reference Document No.	042246-KDBK-E7314 – Disconnecter Switches 1HYD901238-302 (GA)
Reference Drawing No.	1HYD99161-157 (Motor Schematic Diagram)

6.16. 110kV DISCONNECTOR SWITCH (WITHOUT EARTH SWITCH) – MANUAL OPERATED:

Make	ABB, VADODARA
Type	SGF123n100
Rated Voltage	123 kV
Insulation Level	550 kVp
Normal Current	1600 A
Short-Time Withstand Current	31.5 kA / 1 Sec.
Frequency	50 Hz
Manual Auxiliary Switch Connect	10 NO + 10 NC
Reference Document No.	042246-KDBK-E7314 – Disconnecter Switches 1HYD901238-303 (GA)
Reference Drawing No.	1HYD99161-108 (Manual Schematic Diagram)

6.17. 24kV FUSE DISCONNECTOR:

Make	DriescherMoosburg
3 Pole Outdoor Disconnecter Type	FTr 24 – 400 – 25 - SU
Rated Voltage	24 kV
Rated Current	400 A
Rated Frequency	50 Hz
Rated Short time Withstand Current for 1 Sec	25 kA
Fuse Link H.v.h.b.c	10/24 kV
Rated Current	20 A
Rated Breaking Current	63 kA
Reference Document No.	042246-KDBK-E7315 – 24kV Fused Disconnecter 116707 – 001 – 02 (Manufacturer’s Drawing)
Reference Drawing No.	

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6.18. 12/16/20 MVA, 110/20kV POWER TRANSFORMER:

Make	Crompton Greaves Ltd., Mumbai
Rating MVA	12 16 20
Type of Cooling	ONAN ONAF1 ONAF2
Volts (No load)	HV-110000
Volts (No load)	LV-20000
Amperes	HV-105
	LV-577.4
Frequency	50 Hz
Connection Symbol	Dyn1
Highest Voltage (HV/LV)	123/24 kV
Impedance Voltage: 110/20 kV at principal tapping	9% (at 20MVA base)
Losses at principal tapping position:	
No load losses	18 kW(Max)
Load losses at ONAN cooling	91 kW (Max) @ 20 MVA base
Reference Drawing No.	T62B058596Q, Rev – 4 – Rating and Diagram Plate T61B09950F, Rev – 4 – Outline of 20MVA, 110/20kV Transformer

6.19. 0.4kV FUSE DISCONNECTOR:

Make	ABB
Model	XLP2-A60/120-B-below
Rated operational voltage	500 V (V_c)
Rated operational current (I_c)	400 A
Thermal current with fuse link (I_{th})	400 A
Rated insulation voltage (V_i)	1000 V
Rated impulse withstand voltage (V_{imp})	8 kV
Fuse protected short circuit making current	50 kA rms
Rated Making and Breaking Capacity	AC23B
Rated frequency	50 Hz
Power loss at I_{th} without fuse link/phase	13 W
Reference Document No.	042246-KDBK-E7371 – 0.4kV, 400A Disconnecter Switch
Reference Document No.	ABB-120003-I DS (Manufacturer's Drawing)

6.20. 20kV METAL CLAD SWITCHGEAR:

Make	Hyundai Heavy Industries Ltd.
Rated Voltage	24 kV

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Rated Busbar Current	1250 A
Rated Feeder Current	630 A
Rated Power Frequency Withstand Voltage	56 kV
Rated Lighting Impulse Withstand Voltage	125 kV Peak
Rate Current Interrupting Capacity	25 kA
Rated Short Time Withstand Current and Duration	25 kA for 1 Sec.
Rated Current Making Capacity	63 kA
AC Auxiliary Supply	230 V, 50 Hz, 1 PH
DC Control Supply	220 V DC
Spring Charging Motor Supply	220 V DC
Switchgear Insulation	AIR
Reference Drawing No.	11SH081L001 to 12 : Layout of Switchgear type A 11SH082L001 to 11 : Layout of Switchgear type B

6.21. 110kV SWITCHYARD CONDUCTORS:

(i) AAC	
(A) TECHNICAL PARTICULARS	
Make	ELSEWEDY CABLES
Type	Aluminium Conductor – AAC (H14)
Standard applied	BS EN 50182, IEC 60889
Nominal Cross-section of aluminum (H14)	626.2mm ²
Diameter of aluminum wire	2.96 ± 0.03mm
Number of aluminum wires	91
Approx. overall diameter of conductor	32.6mm
Conductor weight per Kilometer	1740 ± 2% kg / km
Length of conductor on drums	1000 ± 5% m
(B) PERFORMANCE	
Minimum ultimate tensile stress for wire after standing	16.46 kg / mm ²
Minimum D.C resistance of conductor at 20°C	0.0464 Ω / km
Rated strength	106.45kN
Density of aluminum wire material	2.703 kg / dm ³
Coefficient of liner expansion of aluminum wire	23 x 10 ⁻⁶ per °C
Constant-mass temperature coefficient of aluminum wire	0.00403 per °C

ii) ACSR	
(A) TECHNICAL PARTICULARS	
Make	ELSEWEDY CABLES
Type	ACSR

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Standard applied	BS EN 50182, IEC 60889, BS EN 50189
Cross-section of aluminum wire	653.5mm ²
Diameter of aluminum wire (H14)	4.3 ± 1%mm
Number of aluminum wire	45
Cross-section of steel wire	45.3mm ²
Diameter of steel wire	7
Overall diameter of conductor	34.4mm
Grease application (Y / N)	Y (all layers except outer layer)
Conductor weight including grease	2236 +2% kg / km 1000 +5% m
(B) PERFORMANCE	
Minimum ultimate tensile strength of aluminum wire after standing	15.49 kg / mm ²
Minimum ultimate tensile strength of steel wire after standing	130.7 kg / mm ²
Maximum D.C resistance of conductor at 20°C	0.0442 Ω / km
Density of aluminum wire material	2.703 kg / dm ³
Density of steel wire material	7.78 kg / dm ³
Coefficient of linear expansion of conductor	2.09E-051 / K
Final modules of elasticity	61 000N / mm ²
Minimum weight of zinc-coating of steel wire Class (A)	230Gm / m ²
Reference Document No.	042246-KDBK-E7304 – Wire Conductor

6.22. 110kV SOLIDCORE POST INSULATOR:

Make	Modern Insulators Ltd. ,India
Rated Voltage	123 kV
Rated Frequency	50Hz
Dry Power Frequency Withstand Voltage	280 kV
Wet Power Frequency Withstand Voltage	230 kV
Dry Power Frequency Flashover Voltage	305 kV
Wet Power Frequency Flashover Voltage	255 kV
Lightning Impulse withstand Voltage	550 kV _p
Impulse Flashover Voltage	
Tensile Strength	90 kN
Torsion Strength	4 kNm
Compression Strength	180 kN
Cantilever Strength	6 kN
Reference Document No.	042246-KDBK-E7303 – 110kV Post Insulator 211-C-1438 (Manufacturer’s Drawing)
Reference Drawing No.	

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6.23. 20kV SOLIDCORE POST INSULATOR:

Make	Modern Insulators Ltd. ,India
Rated Voltage	24 kV
Rated Frequency	50Hz
Dry Power Frequency Withstand Voltage	65 kV
Wet Power Frequency Withstand Voltage	50 kV
Dry Power Frequency Flashover Voltage	80 kV
Wet Power Frequency Flashover Voltage	65 kV
Lightning Impulse withstand Voltage	150 kV _p
Impulse Flashover Voltage	175 kV _p
Tensile Strength	100 kN
Torsion Strength	2 kNm
Compression Strength	200 kN
Cantilever Strength	6 kN
Reference Document No.	042246-KDBK-E7352 – 20kV Post Insulators 211-C-947 (Manufacturer’s Drawing)
Reference Drawing No.	

6.24. 110kV DISC INSULATOR (FOGTYPE):

Make	EMCO, Pakistan
Leakage Distance	445 mm
Wet Power Frequency Withstand Voltage	50 kV
Impulse withstand Voltage	125 kV
Puncture Voltage	130 kV
Electro mechanical failing load	120 kN
Radio Influence Voltage Data:	
Testing Voltage to ground	10 kV
Maximum RIV at 1000 KHz	50/μV
Reference Document No.	042246-KDBK-E7347 – 110kV Fog Type Disc Insulator
Reference Drawing No.	EM-1045-2 (Manufacturer’s Drawing)

6.25. 250 kVA, 20/0.4kV STATION SERVICE TRANSFORMER:

Make	KONČAR D & ST
Type	8TONO 250-24/A
Rated Power	250 kVA
Rated Voltage	HV - 20 kV; LV- 0.4 kV
Rated Frequency	50Hz
Power Frequency Withstand Voltage (HV/LV)	50/3 kV

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Lightning Impulse Withstand Voltage (HV/LV)	125 kV
Connection Symbol	Dyn5
Type of Cooling	ONAN
No load losses at rated voltage	650W
Load losses at normal ratio and 75°C	3250W
Impedance Voltage rated Voltage	4%
Reference Document No.	042246-KDBK-E7311 – 20/0.4kV, 250kVA Auxiliary Transformer
Reference Drawing No.	DT0724,268202,268264 (Manufacturer’s Dwg)

6.26. 400V AC DISTRIBUTION BOARD:

Make	Schiele AUH GmbH
Incomer I & II	400A MCCB, Motor Operated
Bus Sectionalizer	400A MCCB, Motor Operated
Bus Bar rating	600A, 400V, 15kA/1 Sec
Outgoing Feeders	16A-3 nos. in each Panel-1 & Panel-2
	25A-8 nos. in each Panel-1 & Panel-2
	40A-3 nos. in each Panel-1 & Panel-2
	63A-8 nos. in each Panel-1 & Panel-2
Reference Document No.	042246-KDBK-E7104 400/230 V AC Distribution
Reference Drawing No.	042246-KDBK-E7101, A 22 260-1

6.27. 220V DC DISTRIBUTION BOARD:

Make	Schiele AUH GmbH
Incomer I & II	100A MCCB, Motor Operated
Bus Sectionalizer	100A MCCB, Motor Operated
Bus Bar rating	100A,400V, 10kA/1 Sec
Outgoing Feeders	16A-4 nos. in each Panel-1 & Panel-2
	25A-16 nos. in each Panel-1 & Panel-2
	32A-4 nos. in each Panel-1 & Panel-2
Reference Document No.	042246-KDBK-E7105, 220V DC Distribution
Reference Drawing No.	042246-KDBK-E7102, A 22 260-2

6.28. 220V BATTERY:

Make	HOPPECKE
Type	4OPzS200
Total number of Blocks	106
Number of Packing Units	4

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Number of Drum Electrolyte	16
Number of Plate Electrolyte	3
Design of Positive Electrode	Tubular
Positive Electrode Material	Pb+<2%Sb
Design of Negative Electrode	Grid
Negative Electrode Material	Pb+<2%Sb
Electrode type	H ₂ SO ₄ , Liquid
Endurance	1500 cycles
Internal Resistance	0.92Ω/unit
Short Circuit Current	2166 A
Reference Document No.	042246-KDBK-E7320– 220V DC Battery & Battery Rack

6.29. 220V BATTERY CHARGER:

Make	ELTEK
Type	D 400 G 212 / 50 BWrug – V – MU
Mains Connection Voltage	400 V AC, 50 Hz, 3 Phase
Mains Connection Power	22.1 kVA
Mains Collection Current	31.6 A AC (Charging Part)
Nominal Output Voltage	212 V DC
Nominal Output Current	50 A DC
Trickle Charging Voltage	236.4 V +/- 1%
Electrical Boost Charging Voltage	254.4 V +/- 1%
Equalizing Charging Voltage	280.9 V +/- 1%
Battery	212 V, 106 Pb Cells, Low – Maintenance
Smoothing of Output Voltage	5% (Without Battery)
Form Factor approx	1.1
Reference Document No.	042246 – KDBK –E7321– Battery Charger

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6.30. POWER CABLES:
A) MV CABLES
I) 20kV, 1C-185 mm²COPPER CABLE:

Make	HES HACILAR ELECTRIK SAN VE TIC A.S.
Cable Code	N2XS2Y
Rated Voltage (V ₀ /V)	12/20 kV
Max Operating Voltage (V _m)	24 kV
Conductor Material	Annealed Electrolytic Copper
Cross Sectional Area	1x185 RM/25
Inner Semiconducting Screen Material	Semiconductive XLPE
Insulation Material	XLPE
Nominal Thickness	5.5 mm
Outer Semiconductive Screen Material	Semi conductive XLPE (Semiconductive Tape)
Metallic screen Material	Copper
Metallic screen Type	Wire & Tape (Polipropen Type)
Armouring type	Unarmoured
Outer sheath Material	MDPE
Nominal Thickness	2.1 mm
Power Frequency Test Voltage of 5 min duration	42 kV rms
Continuous Current Carrying Capacity	468A (Underground)
	535 A (Air)
	361 A (Duct)
Maximum Continuous Conductor Temperature	90°C
Maximum Temperature & Duration of Conductor at S.C condition	250°C/5 Sec
Short Time Withstand Current Capacity	26.5 kA/1 Sec
Effective AC resistance at 90°C	0.1268 Ω/km
Operating Capacitance	0.126 mF/km
Short Circuit Withstand Capacity for Screen	3.6 kA/1 Sec
Operating Inductance	0.61 mH/km
Overall Diameter of Cable	36 mm
Weight of Cable	2540 kg/km
Minimum Bending Radius	540 mm
Reference Document No.	042246-KDBK-E7353– Data Sheet for 20kV, 185mm ² Cable

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II) 20kV, 1C-300 mm² COPPER CABLE:

Make	HES HACILAR ELECTRIK SAN VE TIC A.S.
Cable Code	N2XSY
Rated Voltage (V ₀ /V)	12/20 kV
Max Operating Voltage (V _m)	24 kV
Conductor Material	Annealed Electrolytic Copper
Cross Sectional Area	1x300 RM/25
Inner Semiconducting Screen Material	Semiconductive XLPE
Insulation Material	XLPE
Nominal Thickness	5.5 mm
Outer Semiconductive Screen Material	Semi conductive XLPE (Semiconductive Tape)
Metallic screen Material	Copper
Metallic screen Type	Wire & Tape (Polipropen Type)
Armouring type	Unarmoured
Outer sheath Material	PVC
Nominal Thickness	2.2 mm
Power Frequency Test Voltage of 5 min duration	42 kV rms
Impulse Test Voltage	125 kVpeak
Continuous Current Carrying Capacity	589A (Underground)
	707 A (Air)
	454 A (Duct)
Maximum Continuous Conductor Temperature	90°C
Maximum Temperature & Duration of Conductor at S.C condition	250°C/5 sec
Short Time Withstand Current Capacity:	
Conductor-	42.9 kA/1 sec
Screen-	3.6 kA/1 sec
Reference Document No.	042246-KDBK-E7355 – 24kV Cable (1Cx300 mm ²)

B) LV CABLES
I) 4C-4 mm² COPPER CABLE:

Make	BayerischeKabelwerke AG
Type	(N)2XCY 4x4 RE/4, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulation Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6

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Outer Diameter	17mm
Weight of cable	460 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating	
Air-	43 A
Underground-	52 A
Short Circuit Current Capacity	0.57 kA/1 Sec
Reference Document No.	042246-KDBK-E7367– LV Cable N2XCY

II) 4C-6 mm²COPPER CABLE:

Make	BayerischeKabelwerke AG
Type	(N)2XCY 4x6 RE/6, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulation Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6
Outer Diameter	18mm
Weight of cable	590 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating	
Air-	64A
In ground-	53A
Short Circuit Current Capacity	0.86 kA/1 Sec
Reference Doc No.	042246-KDBK-E7367 – LV Cable N2XCY

III) 4C-10 mm²COPPER CABLE:

Make	BayerischeKabelwerke AG
Type	(N)2XCY 4x10 RE/10, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulation Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6
Outer Diameter	21mm
Weight of cable	830 kg/km

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Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating	
Air-	75A
In ground-	87A
Short Circuit Current Capacity	1.43 kA/1 Sec
Reference Doc No.	042246-KDBK-E7367 – LV Cable N2XCY

IV) 4C-25 mm² COPPER CABLE:

Make	Bayerische Kabelwerke AG
Type	(N)2XCY 4x25 RM/16, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulation Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6
Outer Diameter	28 mm
Weight of cable	1680 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating-	
Air-	136 A
In ground-	145 A
Short Circuit Current Carrying Capacity	3.58 A
Reference Doc No.	042246-KDBK-E7367 – LV Cable N2XCY

V) 1C-300 mm² COPPER CABLE:

Make	BayerischeKabelwerke AG
Type	N2XCY 1x300 RM/150, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulation Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor material	Cu Wire + Cu anti twist tape concentric lay stranding
Outer sheath material	PVC-DMV6
Outer Diameter	35 mm
Weight of cable	4420 kg/km
Temperature	

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a)In operation	90°C
b)In short circuit	250°C
Current rating-	
Air-	
In ground-	
Short Circuit Current Carrying Capacity	42.9 kA/1 Sec
Reference Doc No.	042246-KDBK-E7367 – LV Cable N2XCY

VI) 3C-25 mm²COPPER CABLE:

Make	DEMAŞ KABLO
Type	N2XH
Rated Voltage	0.6/1 kV
Cross Sectional Area	3Cx25 mm ²
Conductor Material	Electrolytic Copper
Insulation Material	XLPE
Bedding Material	Halogen free filter
Outer sheath material	EVA/PE
Outer Diameter	11.5 mm
Weight of cable	175 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current Carrying Capacity	
Air-	32 A
In ground-	40 A
Reference Document No.	

VII) 4C-4 mm²COPPER CABLE:

Make	DEMAŞ KABLO
Type	N2XH
Rated Voltage	0.6/1 kV
Cross Sectional Area	4Cx4 mm ²
Conductor Material	Electrolytic Copper
Insulation Material	XLPE
Bedding Material	Halogen free filter
Outer sheath material	EVA/PE
Outer Diameter	13.5 mm
Weight of cable	280 kg/km
Temperature	
a)In operation	90°C

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b)In short circuit	250°C
Current Carrying Capacity	
Air-	42 A
In ground-	52 A
Reference Document No.	

VIII) 4C-16 mm²COPPER CABLE:

Make	DEMAŞ KABLO
Type	N2XH
Rated Voltage	0.6/1 kV
Cross Sectional Area	4Cx16 mm ²
Conductor Material	Electrolytic Copper
Insulation Material	XLPE
Bedding Material	Halogen free filter
Outer sheath material	EVA/PE
Outer Diameter	20 mm
Weight of cable	800 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current Carrying Capacity	
Air-	96 A
In ground-	111 A
Reference Document No.	

6.31. 20kV CABLE TERMINATION KIT:

Make	TYCO ELECTRONICS
Type	Heat Shrinkable
Indoor –	IXSU-F 6141
Outdoor –	OXSU-F 6141
Reference Document No.	042246-KDBK-P7011, Rev – B – 20kV Cable Termination Kit

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6.32. CONTROL CABLES:
I) 7C-2.5 mm²COPPER CABLE:

Make	BayerischeKabelwerke AG
Type	N2XCY 7x2.5 RE/2.5, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulator Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor Material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6
Outer Diameter	17 mm
Weight of Cable	470 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating-	
Air-	21 A
In ground-	26 A
Short Circuit Current Carrying Capacity	0.36 kA/1 Sec
Reference Doc No.	042246-KDBK-E7368/01,- Control Cable N2XCY

II) 12C-2.5mm²COPPER CABLE:

Make	BayerischeKabelwerke AG
Type	N2XCY 12x2.5 RE/4, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulator Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor Material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6
Outer Diameter	21 mm
Weight of Cable	700 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating-	
Air-	17 A
In ground-	20 A
Short Circuit Current Carrying Capacity	0.36 kA/1 Sec
Reference Doc No.	042246-KDBK-E7368/01,- Control Cable N2XCY

III) 24C-2.5mm²COPPER CABLE:

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Make	BayerischeKabelwerke AG
Type	N2XCY 24x2.5 RE/10, 0.6/1 kV
Conductor Material	Electrolytic Copper, bare
Insulator Material	XLPE
Bedding Material	Extruded filling compound
Concentric Conductor Material	Electrolytic Copper, bare
Outer sheath material	PVC-DMV6
Outer Diameter	28 mm
Weight of Cable	1190 kg/km
Temperature	
a)In operation	90°C
b)In short circuit	250°C
Current rating-	
Air-	33 A
In ground-	40 A
Short Circuit Current Carrying Capacity	0.36 kA/1 Sec
Reference Doc No.	042246-KDBK-E7368,- Control Cable N2XCY

6.33. PLC COUPLING DEVICE (PLCC):

Make	ABB
Type	MCD80
High pass filter type-A9BS	
Impedance, equip side, unbalanced	75/125 Ω
Impedance line side	240/320 Ω
Nominal PEP at 50 KHz	<400 W
Nominal PEP at 100 KHz	<1000 W
Coupling Capacitance	1.5 to 20 nF
Composite Loss in band	<1.0 dB
Return Loss in band	>12 dB
Drain coil	
Inductance, adjustable	0.2 to 0.7 mH
Impedance at power frequency	<1.5 Ω
Earthing switch	
Rated Current	300 Amps
Lighting arrester	
Rated Voltage	660 V
Max 100% impulse Spark over voltage	3300 Peak
Reference doc	1KHA-000574-SEN
	SKED 120629

6.34. CONTROL AND PROTECTION CUBICLES:

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Cubicle Size	
Nominal Size	
Width	800 mm
Height	2200 mm
Depth	800 mm
Print Color	
Exterior	RAL 7035
Interior	
Gloss white	RAL 7035
Cubicle Wire	
Service	Minimum Wire Size, mm ²
Power Supplies and Packaged Control Systems	4 mm ²
Current Transformer Circuits	2.5 mm ²
Potential Transformer Circuits	1.5 mm ²
Control Wiring	1.5 mm ²
Annunciator Wiring	1.5 mm ²
Earth Bus	
Vertical Earth Bus for Cable Shield to Be Provided	No
Rated Supply Voltage	
AC	400/230V 50Hz
DC	220VDC
Reference Document No.	042246-KDBK-E7201 042246-KDBK-E7208 042246-KDBK-E7209 042246-KDBK-E7210 042246-KDBK-E7211 042246-KDBK-E7212 042246-KDBK-E7213 042246-KDBK-E7214 042246-KDBK-E7215

6.35. PROTECTIVE RELAYS:

Circuit Breaker and Bay Control, Circuit Breaker Protection	SEL451 – 5
Line Protection – Primary	SEL421 – 4
Line Protection – Back up	GE D60
Transformer Protection – Primary	SEL 787
Transformer Protection – Back up	SEL 3871A
Bus Protection – Primary	SEL 587Z
Bus Protection – Back up	SEL 587Z
IED/RTU Interface Switch	

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Annunciation	SACO64D4
Reference Document No.	042246-KDBK-E7354 – Data Sheet – Bay Level Devices

6.36. SCADA/RTU INTERFACE POINT LIST:

Binary Status Points	YES
Circuit Breaker (110kV)	YES
Normally open “a” contact	YES
Normally open “b” contact	YES
Remote control enabled	YES
Breaker Low Gas	YES
Breaker trouble (common status point for any remaining alarms)	YES
Disconnect Switches	
Normally open “a” contact	YES
Normally open “b” contact	YES
Remote control enabled	YES
Earthing Switches	
Normally open “a” contact	YES
Normally open “b” contact	YES
Power Transformers	
High Oil Temperature	YES
High winding temperature	YES
Sudden pressure alarm	YES
LTC high Oil temperature	YES
XFMR trouble (common status point for any remaining alarms)	YES
LTC in follower operation mode	YES
Relays Communication	
Communication trouble (one alarm for each transmission line communication scheme)	YES
Relays and GPS Equipment	
Relay failure alarm from each microprocessor based relay	YES
20kV Metal-Clad Switchgear	
Normally open	YES
Normally open “a” contact	YES
Normally open “b” contact	YES
Remote control enabled	YES
Trouble (common status point for any remaining alarms)	YES
Miscellaneous Status Points	
Reclose enabled for each transmission line with reclosing capability	YES

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Fire Alarm	YES
Intruder Alarm	YES
Dc Safety Switch open	YES
Dc low battery system for each battery system	YES
Battery Charger	YES
Earth detection	YES
On loss of primary ac station service source	YES
On loss of backup ac station service source	YES
Oil spill alarm	YES
20 kV metal-clad switchgear prefabricated metal building – high building temperature alarm	YES
20 kV metal-clad switchgear prefabricated metal building – low building temperature alarm	YES
20 kV metal-clad switchgear prefabricated metal building – fire alarm	YES
20 kV metal-clad switchgear prefabricated metal building – intruder alarm	YES
25 parts status inputs	YES
Control Points	
Circuit Breakers	
Trip/close pair	YES
Disconnect Switches	
Open/Close pair	YES
Earth Switches	
Open/Close pair	NO
Powers Transformers	
LTC raise/lower pair	YES
Analog Input	
Busbars	
3 – voltage for each busbar section	YES
1 – frequency for each busbar section	YES
Transmission Lines	
3 – Voltages	YES
3 – Currents	YES
MW	YES
MVar	YES
Power Transformers	
3 – Voltages	YES
3 – Currents	YES
MW	YES
Mvar	YES
Reference Document No.	042246-KDBK-E7207– SACADA/RTU Interface

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	Panel
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6.37. ANNUNCIATOR POINT LIST:

Circuit Breaker (110 kV)	
Common trouble	YES
Trip coil failure	YES
Power Transformer	
Abnormal condition	YES
Battery Chargers	
Common trouble	YES
AC Station Service Transfer Switch	
Switch connected to back-up source	YES
Line Relaying	
Primary relay trouble	YES
Backup relay trouble	YES
Loss of communication channel	YES
Transformer Relaying	
Primary relay trouble	YES
Backup relay trouble	YES
Lockout relay (86) tripped	YES
Circuit Breaker Relaying (110kV)	
Relay common trouble	YES
Breaker Failure Lockout Relay (86) tripped	YES
Switchgear Relaying	
Bus lockout relay (86) tripped	YES
Common relay trouble ²	YES
Bus Relaying	
Primary relay trouble	YES
Backup relay trouble	YES
Lockout (86) relay tripped	YES
Reference Document No.	042246-KDBK-E7207– SACADA/RTU Interface Panel (Annunciator Panel)

6.38. EARTHING MATERIAL:

(A) EARTHING SYSTEM DATA	
Main Earth Grid	1 x 120 mm ² copper conductor
Below Ground Earth Riser	1 x 120 mm ² copper conductor
Above Ground Earth Riser	2 x 95 mm ² copper bone conductor (for HV equipment & structure)
Above Ground Earth Riser	1 x 95 mm ² copper bone conductor (for panels, fence, other equipments and metallic post)
Earth flat around the Battery Room	30 x 5 mm ² bone copper bar

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Cable Tray Earthing	1 x 95 mm ² copper bone conductor
Ground Rod Type	J – 1534 –RR

(B) 1 X 120 mm² COPPER CONDUCTOR

Make	ELSWEDY CABLES
No. of Cores	1
Conductor Size	120mm ²
Number of wires	19
Wire diameter before compaction	3.05 mm
Conductor diameter after compaction	12.7 mm
Maximum Conductor DC Resistance at 20°C	0.153 Ohm / km

(C) 1 X 95 mm² COPPER CONDUCTOR

Make	ELSWEDY CABLES
No. of Cores	1
Conductor Size	95mm ²
Number of wires	19
Wire diameter before compaction	2.65 mm
Conductor diameter after compaction	11.3 mm
Maximum Conductor DC Resistance at 20°C	0.193 Ohm / km

(D) EARTHING CONNECTION TYPES
(i) Type – D500

Application	Earthing Connection used below ground, held type (suitable for 2no. 1 x 95 mm ²) set for Welding Connection
Mould Type	CC – DPH – 95 /95
Weld Granulate Type	C – 150
Hand Clamp Type	TSC – 80
Flint Gun Type	AI – FI
Sealer, Packing Type	Mastic
Mould Cleaner Type	R – 150

(ii) Type – D501

Application	'X' type earthing used below ground, weld type (suitable for 4 no. 1 x 120 mm ²) set for Welding Connection
Mould Type	CC – X – 120 /120
Weld Granulate Type	C – 200
Hand Clamp Type	TSC – 80
Flint Gun Type	AI – FI
Sealer, Packing Type	Mastic

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Mould Cleaner Type	R – 150
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(iii) Type – D502

Application	Cable Lug, press type for 1 x 95 mm ² copper conductor, 1 x Hole for M12, E-Cu, Tinned for earthing of fence, indoors and other metallic parts.
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(iv) Type – D503

Application	Cable Lug, press type for 2 x 95 mm ² copper conductor, 2 x Hole for M12, E-Cu, Tinned for HV equipments& structures.
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(v) Type – D504

Application	Cable Lug, press type for 2 x 95 mm ² copper conductor, 1 x Hole for M12, E-Cu, Tinned for marshalling box, panels.
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(vi) Type – D505

Application	Cable Lug, press type for 2 x 95 mm ² copper conductor, 1 x Hole for M12, E-Cu, Tinned.
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(vii) Type – D506

Application	Cable Lug, press type for 1 x 95 mm ² copper conductor, 1 x Hole for M12, E-Cu, tinned for earthing of metallic gate
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(viii) Type – D514

Application	Earthing connection of the Ground Rod with the Main Earth Grid.
Mould Type	CP – TS – 34 /120
Weld Granulate Type	C – 200
Hand Clamp Type	TSC – 80
Flint Gun Type	AI – FI
Sealer, Packing Type	Mastic
Mould Cleaner Type	R – 150

(ix) Type – D540

Application	'T' type earthing connection used below ground, weld type, for connecting 1 x 120 mm ² copper
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	conductor and 1 x 95 mm ² copper conductor.
Set for Welding Connection	
Mould Type	CP – TH – 120 /95
Weld Granulate Type	C – 150
Hand Clamp Type	TSC – 80
Flint Gun Type	AI – FI
Sealer, Packing Type	Mastic
Mould Cleaner Type	R – 150

(x) Type – D541	
Application	'T' type earthing connection used below ground, weld type, for connecting 2 nos. 1 x 120 mm ² copper conductors.
Set for Welding Connection	
Mould Type	CP – TH – 120 /120
Weld Granulate Type	C – 150
Handle Clamp Type	TSC – 80
Flint Gun Type	AI – FI
Sealer, Packing Type	Mastic
Mould Cleaner Type	R – 150

(xi) Type – D542	
Application	Cable Lug, Press Type, for NSGAF Öu 1 x 95 mm ² , 1 x Hole for M12, E-Cu, Tinned

Reference Drawing No.	042246-KDBK-E7400- Earth Mat Layout
Reference Document No.	042246-KDBK-P7401- Earthing Details 042246-KDBK-E7305– Copper Wire

6.39. FIRE DETECTION AND ALARM SYSTEM:

(a) Fire Alarm Cable	
Make	ERSE KABLO
Code NR	611 04 701
Cable	2C – 1.5 mm ²
Overall Diameter	8.4 mm
Conductor	Electrolytic Solid Copper
Insulation	HFFR Elastomer Compound
Stranding	Pair or layer
Screen	PES Type + Tinned Drain Wire + A1 PES Type
Sheath	HFFR Compound DIN VDE 0207 Part 24 HM ₂

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Conductor Resistance	23 Ω/km
Insulation Resistance	100 MΩ/km
Impedance	300 V
Manual Capacitance	100 nF/km
Test Voltage (50Hz)	1000 v
Bending Radios	10 x cable θ
Temperature range	Fixed :- -5°C to 50°C Flexible :- -30°C to 70°C
Reference Document No.	042246 – KDBK –E7361– Specification for Fire Alarm Materials

(b) Fire / Smoke Detector	
Make	MAXLOGIC & MAVIGARD
Type	MG 9400
Features	<ul style="list-style-type: none"> i) Intelligent analogue addressable multi sensor detector (photo electric smoke + heat) ii) Twin fire alarm indicators for 360° viewing. iii) ‘Soft’ addressable by use of address programmer. iv) Remote indicator output. v) Communication interrupts for fast fire alarm detection in 1.5 sec. vi) Protection from electromagnetic interface. vii) Microprocessor connected.
Analog Addressable System	MG 6600 Symphony SY/C intelligent analogue addressable loop powered sounder (VIP Communication Module included)
Manual Call Point	MG 8130 Addressable Manual Call Point with isolator module, resettable.
Reference Document No.	042246 – KDBK –E7361– Specification for Fire Alarm Materials

(c) Fire Alarm Panel	
Make	MAVILI ELEKTRONIK
Type	MC Series
Features	<ul style="list-style-type: none"> i) For each fire alarm zone, up to 32 units of fire detector and unlimited manual call points can be connected. ii) The desired zones of the panel can be set to disable and / or Test Mode so that the panel can be tested by a single person. iii) By using ‘Lamp Test’ button, it is easy to check whether all the LED’s are working properly or not. iv) 1 sounder output, 1 fire relay output.

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Reference Document No.	042246 – KDBK –E7361– Specification for Fire Alarm Materials
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(d) Fire Extinguishers	
Type	FE – CO ₂ 5LB ABC DRY CHEMICAL 4.5 LB

6.40. LIGHTING FIXTURES AND RECEPTACLES:

(a) Switchyard Normal Lighting	
Make	EAE AYDINLATMA
Type	EGS 1 * SON 250 – CD
Features	<ul style="list-style-type: none"> i) Lower Frame – Pressure die-cast aluminum. ii) Upper Frame – Pressure die-cast aluminum. iii) Reflector – 99.85% anodized aluminum. iv) Diffuser – Flat tempered glass of 4 mm. v) Cable Tray – Techno Polymer. vi) Lamp Type – SON-T
Reference Document No. Reference Drawing No.	042246 – KDBK –E7327 042246-KDBK-E7300 – Lighting Layout for Switchyard

(b) Switchyard Emergency Lighting	
Make	
Type	2 x 55 W Emergency Twin Spot Light
Features	<ul style="list-style-type: none"> i) Operating voltage – 230V AC / 50 Hz. ii) Battery Type – 12V maintenance free lead-acid battery. iii) Inbuilt fuse protection. iv) Protections against battery overcharge and overload. v) Self-Charging. vi) Led Indicator for Charge level and weak battery. vii) Separate switch for each lamp. viii) Test button
Reference Document No. Reference Drawing No.	042246 – KDBK – E7327 042246-KDBK-E7300– Lighting Layout for Switchyard

(c) Control Building	
Make	EAE AYDINLATMA
Type	VLX 2 * TL 554U – SP/PC
Features	<ul style="list-style-type: none"> i) Body – Injection moulded PC. ii) Cover – Injection moulded PC.

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	<ul style="list-style-type: none"> iii) Gear Tray – Pre-galvanized Sheet Steel. iv) Lamp – 1 x 54 W TL 5 Fluorescent Lamp. v) Ballast – EEI = A2 Warm Start Electronic.
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Make	EAE AYDINLATMA
Type	VLX 2 * TL 554U – SP/PC – A3H
Features	<ul style="list-style-type: none"> i) Body – Injection moulded PC. ii) Cover – Injection moulded PC. iii) Gear Tray – Pre-galvanized Sheet Steel. iv) Lamp – 1 x 54 W TL 5 Fluorescent Lamp. v) Ballast – EEI = A2 Warm Start Electronic.

Make	PELSAN
Type	Harman 27
Features	<ul style="list-style-type: none"> i) Lamp Type – Incandescent Lamp. ii) Power – 100 W. iii) Current – 0.43 A. iv) Body – Aluminum Injection. v) Diffuser – Frosted Glass.

Make	EAE AYDINLATMA
Luminaire Type	Acil Durum Yönlendirme Armatürleri
Product Name	EDT – K118 EXIT Kesintide 1 seat
Light Source	Type – T5 Watt – 8 W Volt – 230 V
Component	Ballast / Transformer – Elektronik Lamp Socket – G5
Reference Document No. Reference Drawing No.	042246 – KDBK – E7360 042246–KDBK–E7302– Lighting & Power Layout of Control Building

(d) 20 KV Switchgear Room	
Type	2 x 18 W Fluorescent Lamp
Reference Drawing No.	042246–KDBK–E7306– Lighting Layout for the Cable Trench under the 20kV Switchgear

(e) Guard House	
Make	
Type	1 x 150 W Light Fixture
Features	

Make	
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Type	2 x 40 W Fluorescent Lamp
Features	

Reference Drawing No.	042246–KDBK–E7365– Guard House Lighting and Power Layout
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6.41. LIGHTING DISTRIBUTION BOARDS:

(a) PANEL – 1 (Control Building)	
Description	Panel-1 is a LT 400/230V AC Distribution panel used for power supply to the lighting distribution of the control building.
Make	ELTE PANO
Feeder Details	Incomer - 50A MCCB Outgoing -1 PH, 6A, 3KA MCB – 3 nos. - 1 PH, 16A, 3KA MCB – 2 nos. - 1 PH, 20A, 3KA MCB – 10 nos. - 3 PH, 20A, 3KA MCB – 2 nos.

(b) PANEL – 2 (Switchyard)	
Description	Panel-2 is a LT 400/230V AC Distribution panel used for power supply to the lighting distribution of the Switchyard.
Make	ELTE PANO
Feeder Details	Incomer - 50A MCCB Outgoing -1 PH, 6A, 3KA MCB – 3 nos. - 1 PH, 16A, 3KA MCB – 2 nos. - 1 PH, 20A, 3KA MCB – 12 nos. - 3 PH, 20A, 3KA MCB – 2 nos.
Reference Drawing No.	ELT – S1212211600 (Manufacturer’s Drawing)
Reference Document No.	042246 – KDBK – E7358– Distribution Boards

6.42. BAY MARSHALLING KIOSK:

Make	ABB
Type	Outdoor
Rated Supply Voltage	400/230V AC,50 Hz
	220 V DC
Heating with integrated thermostat	55W
Heating Control	Thermostat Hygrostat
Cubicle Illumination	Flourescent,14 W

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AC Power outlet	1 Phase, 16 A, Type Schuko
Cable Duct	PVC
Wire Insulation	PVC 70°C
AC Auxiliary wiring	1.5 mm ² Cu wire
DC Power wiring	4 mm ² Cu wire
Control Circuit Wiring	1.5 mm ² Cu wire
VT Circuit	1.5 mm ² Cu wire
CT Circuit Wiring	2.5 mm ² Cu wire
Earthing	4mm ²
EMC earthing	16mm ²
Cable access	Bottom
Application	AC supply to field equipment. DC supply to field equipment. Control Input to control panel & relay panel.
Reference Drawing Nos.	Manufacturer's Drawing No. – IMCZZ10762-AFEO IMCZZ10762-AGEO IMCZZ10762-AHEO IMCZZ10762-AIEO IMCZZ10762-AJEO IMCZZ10762-AKEO
Reference Document Nos.	042246-KDBK-E7308 042246-KDBK-E7329 042246-KDBK-E7330 042246-KDBK-E7331 042246-KDBK-E7333 042246-KDBK-E7334

6.43. HV AC System:

The HV AC system consists of the following equipments:

- Heat Pump
- Direct Expansion Fan coil
- Motorized Fire/Smoke Dampers
- Duct Axial Fan

a) HEAT PUMP:

Make	Carrier
Type	38EYX060-X-9
Compressor	Scroll
Refrigerant	Puron (R410A)
Control	Piston
Condenser Fan	Propeller Type, Direct Drive
Air Discharge	Vertical

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Operating Voltage	400V AC
Operating Range-	
Cooling mode	13°C
Heating mode	34°C
Nominal Motor RPM (50Hz)	900 RPM
Connection(In/mm,1D)	
Vapour	7/8/22.23
Liquid	3/8
Refrigerant Tubes (In/mm,OD)-	
Rated vapour	1-1/8/28.58
Max liquid line	3/8
Capacity	5 Tons

b) DIRECT EXPANSION FAN COIL:

Make	Carrier
Type	FB4BSF060000
Operating voltage	230V AC
Nominal Capacity	5 Ton
Power	17.6 kW
Refrigerant	R-22/R-410 A
Refrigerant Control	Bypass AccuRater
Unit Arrangement	Upflow/Downflow/Horizontal (LH)
Fan	
Airflow/Normal	825 L/S
Motor Type	PSC
Nominal	0.56 KW
Indoor coil	Copper type/Aluminium fixed with lanced sine wave
Filter	Permanent Type/25 mm (1 inch) thick
Coil Connections	Sweat Type
Vapour (OD)	7/8 inch
Liquid (OD)	3/8 inch

c) MOTORIZED FIRE / SMOKE DAMPERS:

Make	BETEC CAD
Type	MFD-GB-21-A UL555
Fire Rating	1 ½ hours or 3 hours
Max Velocity	up to 2000 RPM (10.2 m/s)
Pressure	41 inch water gauge (1000 pa)
Temperature	250°F (121°C)

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Operating Voltage	230V AC
Actuator	Honeywell Actuator
Frame	Hat shaped, made of galvanized sheet steel
Blades	16 gauge (1.5mm) 3V type, made of galvanized steel
Jamb Seals	Stainless Steel
Bushes	Fire resistant Brass-Bronze bushes
Jack shaft	12mm ²
Blade Stop	18 gauge (1.2 mm) galvanized steel angle
Drive Shaft	Square shaft

d) DUCT AXIAL FAN:

Make	DYNAIR
Type	CC 404 B
Operating Voltage	230/400V AC
Frequency	50Hz
Specific wt.	1.225 kg/m ³
Impeller diameter	400 mm
No. of blades	6
Temperature	15°C
Rotation	1360 RPM
Motor	0.18 kW
Reference Document No.	042246-KDBK-M7915– HV AC System

6.44. OIL MONITORING SYSTEM:

Make	SEE WATER INC
Type	CP1008
Operating Voltage	1PH,220V AC
Frequency	50 Hz
Current	16 A
Panel Enclosure	Heavy Duty NEMA 4x Polycarbonate
Liquid Smart Enclosure	Type 3R High Impact Injected Plastic

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Features	<ul style="list-style-type: none"> i) System is designed to alarm maintenance personnel of a liquid in the Sump. If a liquid is present, the system is set up to only allow maintenance personnel to manually drain out the liquid. ii) Works in conjunction with normally closed solenoid valve. iii) Liquid Smart Alarm differentiates between oil and water. iv) Control visible Mounted Features- Value Toggle Hand off Auto switch, Green value open light. v) Alarm visible Mounted Features-High Red Beacon Alarm Light, Yellow light for oil, white light for water, Alarm Test and silence buttons. vi) High 85 Decibel Audible Alarm.
Reference Document no.	042246-KDBK-E7357– Oil Monitoring System

6.45. Hydrogen Detector

Make	Storage Battery System LLC
Type	SBS-H2
Location	Battery Room
Operating voltage	240 V AC
Frequency	50 HZ
No. of Sensors	02
Specification	<ul style="list-style-type: none"> 1. 1% hydrogen----Energizes a relay which activates exhaust fan. 2. 2% hydrogen----Sounds audible alarm and energizes relay. Annunciates alarm in the annunciator panel. This function is connected with the annunciator panel in the control room.

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7.0 - OPERATION AND MAINTENANCE MANUALS

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7.0 OPERATION AND MAINTENANCE MANUALS:

Proper maintenance of electrical systems helps in minimizing/preventing unwarranted breakdowns of equipment/ lines, thus improving the reliability and generating revenue. Periodical or preventive maintenance is normally followed to keep the equipment continuously in service with desired output. Condition based maintenance is the most accepted and adopted concept in maintenance now a days, which helps in providing advance information about the health of the equipment to take corrective action in advance.

As the electrical system is growing and dependability is increasing, it is getting more and more complex. Due to stringent regulations, the utility cannot afford to have breakdowns in the system resulting in interruption of power supply to the consumer. On the other hand equipment is getting older and is more prone to failure. Equipment overhaul and major maintenance are also expensive and need to be planned based on the condition of the equipment rather than on a periodic basis as a routine.

A detail “Operation and Maintenance Manual” has been developed for this substation describing the preventive and scheduled maintenance requirements. Kindly refer document no. 042246-KDBK-OMM-001 for this manual.

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**8.0 - INDEX OF ENGINEERING
DRAWINGS & DOCUMENTS**

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8.0 INDEX OF ENGINEERING DRAWINGS & DOCUMENTS :

SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
A.	ELECTRICAL :		
1	AEPC-DSWP/DD/E/001	Design Basis - Electrical	Final
2	042246-KDBK-E7000	Estimated Control & LV Cables	Final
3	042246-KDBK-E7000/01	Cable List	Final
4	042246-KDBK-E7000/02	Cable Connection List	Final
5	042246-KDBK-E7004	Battery and Charger Sizing Calculation	Final
6	042246-KDBK-E7005	CT/PT Sizing Calculation	Final
7	042246-KDBK-E7008	Short Circuit Force Calculation	Final
8	042246-KDBK-E7012	Lux Level Calculation for Control Building	Final
9	042246-KDBK-E7100	Single Line Diagram with Metering and Protection (Page 1 of 2)	Final
10	042246-KDBK-E7100	Single Line Diagram for 20KV System (Page 2 of 2)	Final
11	042246-KDBK-E7101	Single Diagram for 400 V AC Distribution	Final
12	042246-KDBK-E7102	Single Line Diagram for 220 V DC Distribution	Final
13	042246-KDBK-E7106	Overall SLD for 20 kV Cable Ampacity & Heat Load Calculations	Final
14	042246-KDBK-E7109	400V AC Three Line Overview Diagram	Final
15	042246-KDBK-E7110	220V DC Three Line Overview Diagram	Final
16	042246-KDBK-E7216	Calculation of Voltage Drop in Cables for Trip Coil	Final
17	042246-KDBK-E7300	Lighting Layout for Switchyard	Final
18	042246-KDBK-E7300/01	Lux Level Calculation for Switchyard	Final
19	042246-KDBK-E7301	Switchyard Lighting DB & 12M Octagonal Lighting Pole AD1 120/10 (Sheet 2 & 3)	Final
20	042246-KDBK-E7301/02	Emergency Lux Level Calculation for Switchyard	Final
21	042246-KDBK-E7302	Lighting & Power Layout of Control Building, Raceway Details, Earthing Connection Details and DB & Fire Alarm Details	Final
22	042246-KDBK-E7302	Lighting & Power Layout of Control Building & Fire Alarm Details - Sheet 4	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITILE	STATUS
23	042246-KDBK-E7302/01	Calculation Load Details	Final
24	042246-KDBK-E7306	Lighting Layout for the Cable Trench under the 20kV Switchgear	Final
25	042246-KDBK-E7309	Transformer Arrangement	Final
26	042246-KDBK-E7318	Cable Routing and Cable Routing - Sections (Sheet 1 & Sheet 2)	Final
27	042246-KDBK-E7323	Assembly Installation Drawings	Final
28	042246-KDBK-E7341	Label Fixation	Final
29	042246-KDBK-E7341/01	Cable Protection Fixation Details	Final
30	042246-KDBK-E7356	Cable Trench Details and Location	Final
31	042246-KDBK-E7365	Guard House Lighting and Power Layout	Final
32	042246-KDBK-E7365/01	Lux Level Calculation for Guard House	Final
33	042246-KDBK-E7500	123 KV Substation General Arrangement	Final
34	042246-KDBK-E7501	123 KV Substation Section	Final
35	042246-KDBK-E7502	Substation Isometric View	Final
36	042246-KDBK-E7504	Control Panel Arrangements Inside Control Room Building	Final
37	042246-KDBK-E7505	Cable Trench Layout inside Control Building	Final
38	042246-KDBK-E7506	Cable Trench Layout and Details	Final
39	042246-KDBK-E7506/01	Cable Ampacity and Heat Load Calculations for Cable Trench RW2	Final
40	042246-KDBK-E7506/01-01	Cable Ampacity and Heat Load Calculations for Duct Bank RW1	Final
41	042246-KDBK-E7506/01-02	Cable Ampacity and Heat Load Calculations for Direct Buried RW3	Final
42	042246-KDBK-E7507	General Site Layout	Final
43	042246-KDBK-E7508	Erection key diagram	Final
44	042246-KDBK-E7509	Erection key diagram - Sections	Final
45	042246-KDBK-E7510	20 KV Cable Routing for Outgoing Riser Poles (Sheet 1 & 2)	Final
46	042246-KDBK-E7510/01	Cable Fill Ratio Calculation	Final
47	042246-KDBK-E7510/03	Cable Ampacity Calculation for 20kV Outgoing Feeders	Final
48	042246-KDBK-E7511	Generator Cable Trench Layout	Final
49	042246-KDBK-P7400	Earth Mat Layout	Final
50	042246-KDBK-P7401	Earthing Details	Final
51	042246-KDBK-P7401/01	Fuel tank Earthing Detail	Final

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52	042246-KDBK-P7401/02	Gantry Tower Earthing Detail	Final
53	042246-KDBK-P7402	Earthing Design Calculation	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
54	042246-KDBK-P7403	Lightning Protection Layout	Final
B.	<u>CIVIL/ARCHITECTURAL & STRUCTURAL :</u>		
1	042246-KDBK-C0001	Control Building – Formwork Support Detail (Sheet 01 & 02)	Final
2	042246-KDBK-C0001/001	Load Calculation	Final
3	042246-KDBK-C0001/002	Staad Input	Final
4	042246-KDBK-C0001/003	Prop Reaction Summary	Final
5	042246-KDBK-C0001/004	Staad Prop Unity Check	Final
6	042246-KDBK-C0001/005	Staad Output	Final
7	042246-KDBK-C0001/006	Lumber Joist Design	Final
8	042246-KDBK-C7000	Control Building Architecture	Final
7	042246-KDBK-C7001	Architectural - Guard House	Final
8	042246-KDBK-C7602	Site Survey Plan / Existing Site Survey Plan	Final
9	042246-KDBK-C7603	Site Topography	Final
10	042246-KDBK-C7604	Site Topography & Demolition Plan	Final
11	042246-KDBK-C7606	Site Grading Plan / Preliminary Site Grading Plan	Final
		Final Site Grading Plan	Final
12	042246-KDBK-C7607	Site Grading Profiles / Preliminary Site Grading Profiles	Final
		Final Site Grading Profiles (4 Sheets - Rev. 1) / (5 Sheets)	Final
13	042246-KDBK-C7607/1	Earthwork Calculation	Final
14	042246-KDBK-C7608	Storm Drainage Layout (4 Sheets)	Final
		Storm Drainage Calculation	Final
15	042246-KDBK-C7609	Road Layout and Details (3 Sheets)	Final
16	042246-KDBK-C7609/01	Design Calculation for Concrete Pavement	Final
17	042246-KDBK-C7610	Site Fencing Layout and Details (3 Sheets)	Final
18	042246-KDBK-C7611	Emergency Egress Route Layout and Details	Final
19	042246-KDBK-C7700/01	Design Report Equipments Foundations	Final
20	042246-KDBK-C7701	Foundation Layout Plan	Final
21	042246-KDBK-C7701/01	Design Report for Lighting Pole Foundation	Final

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22	042246-KDBK-C7702	Foundation (1)	Final
23	042246-KDBK-C7703	Formwork Foundation 2 /Formwork & Reinforcement Foundation 2 (Sheet 1 & 2)	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITILE	STATUS
24	042246-KDBK-C7704	Form Work & Reinforcement Foundation 3	Final
25	042246-KDBK-C7705	Form Work & Reinforcement Foundation 4	Final
26	042246-KDBK-C7706	Form Work & Reinforcement Foundation 5	Final
27	042246-KDBK-C7707	Form Work Reinforcement Foundation 6 (Sheet 1 & 2)	Final
28	042246-KDBK-C7708	Formwork Transformer (1+2) &(3+4) (2 Sheets)	Final
29	042246-KDBK-C7708/01	Design Report for 20MVA Transformer	Final
30	042246-KDBK-C7709	Formwork Part 11 (Switchgear)/ Container Foundation Formwork Part 11	Final
31	042246-KDBK-C7709/01	Design Report Switchgear	Final
32	042246-KDBK-C7709/02	Design calculation for anchor bolts for tying switchgear foundation	Final
33	042246-KDBK-C7710	Cable Trench Axis (D-F) & (B-D) (2 Sheets)/ Cable Trench Axis (D-F)	Final
34	042246-KDBK-C7710/01	Design Report for Cable Trench	Final
35	042246-KDBK-C7711	Tower Type A (Formwork + Reinforcement)	Final
36	042246-KDBK-C7711/001	Design Report – Foundation Tower Type A	Final
37	042246-KDBK-C7712	Tower Type B (Formwork + Reinforcement)	Final
38	042246-KDBK-C7712/01	Design Report – Foundation Tower Type B	Final
39	042246-KDBK-C7713	Tower Type C (Formwork + Reinforcement)	Final
40	042246-KDBK-C7713/01	Design Report – Foundation Tower Type C	Final
41	042246-KDBK-C7714	Tower Type D (Formwork + Reinforcement)	Final
42	042246-KDBK-C7714/01	Design Report – Foundation Tower Type D	Final
43	042246-KDBK-C7713/01	Design Report – Foundation Tower	Final

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		Type C	
44	042246-KDBK-C7715	Tower Type E (Formwork + Reinforcement)	Final
45	042246-KDBK-C7715/01	Design Report – Foundation Tower Type E	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITILE	STATUS
46	042246-KDBK-C7716	Formwork Foundation / Cable Trench Axis 7/B-F	Final
47	042246-KDBK-C7717	Formwork (pull pit/ Cable trench – Axi 5-7/H-J)	Final
48	042246-KDBK-C7718	Container Foundation (11) Reinforcement Base Plate	Final
49	042246-KDBK-C7719	Container Foundation (11) Reinforcement Walls	Final
50	042246-KDBK-C7720	Container Foundation on Formwork Part 12	Final
51	042246-KDBK-C7721	Container Foundation (12) Reinforcement Base Plate	Final
52	042246-KDBK-C7722	Container Foundation (12) Reinforcement Walls	Final
53	042246-KDBK-C7723	Container Foundation (12) Reinforcement Slabs, Beams, Stairs	Final
54	042246-KDBK-C7724	Reinforcement Bottom Slab Transformer (1+2)	Final
55	042246-KDBK-C7725	Reinforcement Walls Transformer (1+2)	Final
56	042246-KDBK-C7726	Reinforcement Bottom Slab Transformer (3+4)	Final
57	042246-KDBK-C7727	Reinforcement Walls Transformer (3+4)	Final
58	042246-KDBK-C7728	Reinforcement Pull Pit/Cable Trench Axis 5-7/ H-J	Final
59	042246-KDBK-C7729	Reinforcement Foundation Cable Trench Axis 7/B-F	Final
60	042246-KDBK-C7732	Formwork Cable Trench Axis B-D	Final
61	042246-KDBK-C7733	Structural Section & Details of Duct Bank 1	Final
62	042246-KDBK-C7735	Reinforcement Cable Trench Axis D-F Part 1	Final
63	042246-KDBK-C7736	Reinforcement Cable Trench Axis D-F Part 2	Final
64	042246-KDBK-C7737	Reinforcement Cable Trench Axis B-D	Final
65	042246-KDBK-C7738	Structural Section & Details of Duct Bank 3	Final
66	042246-KDBK-C7738	Calculations to verify duct bank	Final

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		capacity for design vehicle loading	
67	042246-KDBK-C7739	Cable Trench – Coping Slabs	Final
68	042246-KDBK-C7739/01	Design Report Trench Cover Slab at Road Crossing	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
69	042246-KDBK-C7740	Foundation Auxiliary Transformer	Final
70	042246-KDBK-C7740/01	Design Report Auxiliary Transformer	Final
71	042246-KDBK-C7741	Cable Trench Cover Layout plan	Final
72	042246-KDBK-C7742	Foundation (11) Reinforcement Slabs, Beams, Stairs	Final
73	042246-KDBK-C7743	Structural Section and details of Duct Bank-4	Final
74	042246-KDBK-C7744	Structural Section and details of Duct Bank-5	Final
75	042246-KDBK-C7745	Box Culvert – 2 Formwork	Final
76	042246-KDBK-C7745/01	Design Report Box – Culvert -2	Final
77	042246-KDBK-C7746	Box Culvert – 2 Reinforcement	Final
78	042246-KDBK-C7747	Structural Section and details of Box Culvert – 1	Final
79	042246-KDBK-C7747/01	Design Report Box – Culvert – 1	Final
80	042246-KDBK-C7748	Transmission Line Pole Foundation Layout	Final
81	042246-KDBK-C7749	Transmission Line Pole Foundation FP1	Final
82	042246-KDBK-C7749/01	Design Report for Transmission Line Pole Foundation	Final
83		Design Report for Pole Foundation FP1	Final
84		Design Report for Pole Foundation FP1	Final
85	042246-KDBK-C7749/02	Design Report for Pole Foundation FP2	Final
86	042246-KDBK-C7750	Transmission Line Pole Foundation FP2	Final
87	042246-KDBK-C7750-01	Design Report for Pole Foundation FP2	Final
88	042246-KDBK-C7800	Control Building - Structural Drawing (3 Sheets) / (4 Sheets)	Final
89	042246-KDBK-C7800/01	Control Building - Structural Design Report	Final
90	042246-KDBK-C7801	Structural Guard House	Final
91	042246-KDBK-C7801/01	Guard House Structural Design Report	Final
92	042246-KDBK-C7802	Guard House Structural Design	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
		Report	
93	042246-KDBK-C7802/01	Design Report for Anchor Bolts Supports	Final
94	042246-KDBK-C7802/02	Steel Structures – Test Certificates	Final
95	042246-KDBK-C7802/03	Steel Structures - Fabrication Drawings	Final
96	042246-KDBK-C7805	Static Calculation for Disconnecter Switch (E20 & E21)	Final
97	042246-KDBK-C7806	Static Calculation for Disconnecter Switch (E22)	Final
98	042246-KDBK-C7807	Static Calculation for CT (E30/E31)	Final
99	042246-KDBK-C7808	Static Calculation for CVT (E40 & E40/L1)	Final
100	042246-KDBK-C7809	Static Calculation for SA (E60)	Final
101	042246-KDBK-C7810	Static Calculation for Post Insulator (E70 & E71)	Final
102	042246-KDBK-C7811	Gantry Layout	Final
103	042246-KDBK-C7812	Tower Type A,B,C,D,E,F,G (Page 1 to 7) & Beam Type A,B,C,D,E (Page 8 to 12)	Final
104	042246-KDBK-C7812/01	Template for Tower Type A-D	Final
105	042246-KDBK-C7812/02	Template for Tower Type E & G	Final
106	042246-KDBK-C7812/03	Template for Tower Type F	Final
107	042246-KDBK-C7813	Support Type E30-E31	Final
108	042246-KDBK-C7813/01	Template for E30, E31, E40, E41, E60, E70, J20	Final
109	042246-KDBK-C7814	Support Type E40-E41	Final
110	042246-KDBK-C7815	Support Type E60	Final
111	042246-KDBK-C7816	Support Type E70	Final
112	042246-KDBK-C7817	Support Type E20-E21	Final
113	042246-KDBK-C7817/01	Template for E20, E21, E22	Final
114	042246-KDBK-C7818	Support Type E22	Final
115	042246-KDBK-C7819	Support Type E71	Final
116	042246-KDBK-C7819/01	Template for E71	Final
117	042246-KDBK-C7819/02	Template for E10	Final
118	042246-KDBK-C7820	Static Calculation for Disconnecter (J20)	Final
119	042246-KDBK-C7821	Static Calculation for Lightning Rod-1	Final
120	042246-KDBK-C7822	Static Calculation for Lightning Rod-2	Final
121	042246-KDBK-C7823	Transmission pole route layout	Final
122	042246-KDBK-C7824	Transmission pole route profile	Final
123	042246-KDBK-C7825/01	SAG Tension Calculation/ SAG	Final

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		Tension Report	
126	042246-KDBK-C7825/02	Pole Static Calculation	Final
127	042246-KDBK-C7825/03	SAG Tension Report / Structure Loads Report	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
128	042246-KDBK-C7825/04	Survey Point Clearance Report / Terrain Clearances by Span Report	Final
129	042246-KDBK-C7825/05	Structure Clearance Report	Final
130	042246-KDBK-C7825/06	Swing Clearance Report / Wire Clearance Report	Final
131	042246-KDBK-C7826	110kV Single Circuit OHTL Steel Tension Poles (Transmission Pole Design Details) (C7826-01 to C7826-05)	Final
132		110kV Single Circuit OHTL Steel Tension Poles (Transmission Pole Design Details) (C7826-01)	Final
133	042246-KDBK-C7826-8	Breshnakot 110KV Single Circuit OHTL Steel Poles Anchor Cage Detail	Final
134	042246-KDBK-C7828	LR1 4MT Lighting Rod	Final
135	042246-KDBK-C7828	LR1 4MT Lighting Rod	Final
134	042246-KDBK-C7829	LR2 9.32 Lighting Rod	Final
135	042246-KDBK-C7830	Support Type J20	Final
136	042246-KDBK-C7831	12m Single Arm & Double Arm Lighting Pole Details	Final
137	042246-KDBK-C7831/01	Polygonal Steel Pole Design – LP1 12-100 12m Lighting Pole with Single Arm of 1.0m	Final
138	042246-KDBK-C7831/02	Steel Lighting Pole Design – LP1 12-200 12m Lighting Pole with Double Arm of 1.0m	Final
139	042246-KDBK-C7832	Structure Loading Diagram for 110kv Transmission Line Terminal Type Pole P1	Final
140	042246-KDBK-C7834	Structure Loading Diagram for 110kv Transmission Line Tension Type Pole P2	Final
141	042246-KDBK-C7835	Control Building Lintel Details	Final
142	042246-KDBK-C7835/01	Design Report for Control Building Lintel	Final
143	042246-KDBK-C7904	Area Use Plan	Final
144	042246-KDBK-C7905	Site Accommodation Facility – Architectural Drawing	Final
145	042246-KDBK-C7906	Site Accommodation Facility – Water Supply Layout	Final

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146	042246-KDBK-C7907	Site Accommodation Facility – Drainage Layout	Final
147	042246-KDBK-C7910	Demolition Plan	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITILE	STATUS
148	042246-KDBK-C7911	Architectural - Guard Tower	Final
149	042246-KDBK-C7912	Laydown Area Details	Final
150	042246-KDBK-C7913	Site Office Details	Final
151	042246-KDBK-C7914	Foundation Reference Levels	Final
152	042246-KDBK-C7915	Cabin Bunker	Final
153	AEPC-DSWP/DD/C/001	Design Basis- Civil	Final
154	AEPC-DSWP/DD/C/002	Design Data - Steel Structures 110 & 20 kV Gantries & Supports	Final
155	CP-001	Control Points	Final
156	SP-001	Survey Points	Final
C.	<u>MECHANICAL :</u>		
1	042246-KDBK-M7915	HVAC System	Final
2	042246-KDBK-M7916	Fire Fighting Detail for Control Building and Guard House	Final

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**9.0 - INDEX OF MANUFACTURER'S
DRAWINGS & DOCUMENTS**

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9.0 INDEX OF MANUFACTURER’S DRAWINGS & DOCUMENTS :

SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
1		Instruction Manuals for Control & Protection : AFR677 Switch Router ; D60 Line Distance Protection System; Meinberg – GPS; Nexus 1500; RTU 560 CMD 11 ;Protocol Converter; SACO64D4 Annunciator ; SEL387A; SEL 421; SEL 451-5; SEL 587Z; SEL 787; SEL 2522	Final
2		Overall Standard Test Instruction	Final
3		Protection Test Instruction	Final
4		Control Test Instruction	Final
5		Dielectric Test Instruction	Final
6		Inspection and Test Plan	Final
7		Overall Test Procedure	Final
8		FAT Program – Control Cubicles	Final
9		RFL 9785 : Programmable ON/OFF Powerline Carrier System - Technical Specification and Data sheet	Final
10		VLX Lighting Fixtures and Cables-Catalog	Final
11	042246-KDBK-E7007	Relay Setting Calculation	Final
12	042246-KDBK-E7007/01	Relay setting configuration and worksheet : Bay Control unit CCP1-A1	Final
13	042246-KDBK-E7007/02	Relay setting configuration and worksheet : Bay Control unit CCP1-A2	Final
14	042246-KDBK-E7007/03	Relay setting configuration and worksheet : Bay Control unit CCP3-A1	Final
15	042246-KDBK-E7007/04	Relay setting configuration and worksheet : Bay Control unit CCP3-A2	Final
16	042246-KDBK-E7007/05	Relay setting configuration and worksheet : Transformer CP11-FP1	Final
17	042246-KDBK-E7007/06	Relay setting configuration and worksheet : Transformer CP11-FP2	Final
18	042246-KDBK-E7007/07	Relay setting configuration and worksheet : Transformer CP13-FP1	Final
19	--	--	--

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
20	042246-KDBK-E7007/08	Relay setting configuration and worksheet : Transformer CP13-FP2	Final
21	042246-KDBK-E7007/09	Relay setting configuration and worksheet : Transformer CP36-FP1	Final
22	042246-KDBK-E7007/10	Relay setting configuration and worksheet : Transformer CP36-FP2	Final
23	042246-KDBK-E7007/11	Relay setting configuration and worksheet : Bus-bar CP1-FP11	Final
24	042246-KDBK-E7007/12	Relay setting configuration and worksheet : Bus-bar CP1-FP12	Final
25	042246-KDBK-E7007/13	Relay setting configuration and worksheet : Bus-bar CP2-FP21	Final
26	042246-KDBK-E7007/14	Relay setting configuration and worksheet : Bus-bar CP2-FP22	Final
27	042246-KDBK-E7007/15	Relay setting configuration and worksheet : Line Distance CP34-FP1	Final
28	042246-KDBK-E7007/16	Relay setting configuration and worksheet : Line Distance CP34-FP2	Final
29	042246-KDBK-E7007/17	Relay setting configuration and worksheet : Energy Meter E1+CM1-P1	Final
30	042246-KDBK-E7007/18	Relay setting configuration and worksheet : Remote Controller E1.Q1+CP11-A1	Final
31	042246-KDBK-E7007/19	Relay setting configuration and worksheet : Remote Controller E1.Q3+CP13-A1	Final
32	042246-KDBK-E7007/18	Relay setting configuration and worksheet : Remote Controller E1.Q6+CP36-A1	Final
33	042246-KDBK-E7011	String Details and Quantity	Final
34	042246-KDBK-E7104	400/230V AC Distribution	Final
35	042246-KDBK-E7104/01	400V AC Distribution Parts List	Final
36	042246-KDBK-E7104/02	400V AC Distribution Test Certificate	Final
37	042246-KDBK-E7105	220V DC Distribution	Final
38	042246-KDBK-E7105/01	220V DC Distribution Parts List	Final
39	042246-KDBK-E7105/02	220V DC Distribution Test Certificate	Final
40	042246-KDBK-E7107	Station Configuration Diagram	Final
41	042246-KDBK-E7108	Ring Circuit Diagram for AC/DC / Voltage Supply Diagram for AC/ DC	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
42	042246-KDBK-E7201	Bus-bar Protection (E1.WA2+CP2)	Final
43	042246-KDBK-E7201/01	Bus-bar Protection E1.WA2+CP2 – Test Certificate	Final
44	042246-KDBK-E7201/02	External Wiring Diagram- Bus-bar Protection E1.WA2+CP2	Final
45	042246-KDBK-E7207	SCADA/RTU Interface Panel (C1.CX2)	Final
46	042246-KDBK-E7207/01	SCADA/RTU Interface Panel (C1.CX2) – Test Certificate	Final
47	042246-KDBK-E7207/02	External Wiring Diagram - SCADA/RTU Interface Panel (C1.CX2)	Final
48	042246-KDBK-E7208	Control & Protection Cubicle (110kV Diameter Control - E1.CCP1)	Final
49	042246-KDBK-E7208/01	Diameter Control Panel E1.CCP1 – Test Certificate	Final
50	042246-KDBK-E7208/02	External Wiring Diagram Diameter Control Panel E1.CCP1	Final
51	042246-KDBK-E7209	Bus-bar Protection [110kV Bus-bar WA1 - E1.CP1 (WA1)]	Final
52	042246-KDBK-E7209/01	Bus-bar Protection E1.WA2+CP2 – Test Certificate	Final
53	042246-KDBK-E7209/02	External Wiring Diagram- Bus-bar Protection E1.CP1 (WA1)	Final
54	042246-KDBK-E7210	Control & Protection Cubicle (110kV Diameter Control - E1.CCP3)	Final
55	042246-KDBK-E7210/01	Diameter Control Panel E1.CCP3 – Test Certificate	Final
56	042246-KDBK-E7210/02	External Wiring Diagram Diameter Control Panel E1.CCP3	Final
57	042246-KDBK-E7211	Trafo. Protection Cubicle (110/20kV Transformer No.1 - E1.CP11)	Final
58	042246-KDBK-E7211/01	Trafo. Protection Cubicle E1.CP11 – Test Certificate	Final
59	042246-KDBK-E7211/02	External Wiring Diagram - Transformer Protection Cubicle E1.CP11	Final
60	042246-KDBK-E7212	Transformer Protection E1.Q3+CP13	Final
61	042246-KDBK-E7212/01	Transformer Protection Cubicle E1.Q3+CP13 – Test Certificate	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
62	042246-KDBK-E7212/02	External Wiring Diagram - Transformer Protection Cubicle E1.Q3+CP13	Final
63	042246-KDBK-E7213	Line Protection Cubicle [110kV Line Durai Junction S/S - E1.CP34 (Q4)]	Final
64	042246-KDBK-E7213/01	Line Protection Panel E1.CP34 – Test Certificate	Final
65	042246-KDBK-E7213/02	External Wiring Diagram - Line Protection Panel E1.CP34	Final
66	042246-KDBK-E7214	Transformer Protection E1.Q6+CP36	Final
67	042246-KDBK-E7214/01	Transformer Protection Cubicle E1.Q6+CP36– Test Certificate	Final
68	042246-KDBK-E7214/02	External Wiring Diagram - Transformer Protection Cubicle E1.Q6+CP36	Final
69	042246-KDBK-E7215	110kV Metering Panel (E1.CM1)	Final
70	042246-KDBK-E7215/01	110kV Metering Panel (E1. CM1) – Test Certificate	Final
71	042246-KDBK-E7215/02	External Wiring Diagram - 110kV Metering Panel (E1. CM1)	Final
72	042246-KDBK-E7303	110KV Post Insulators	Final
73	042246-KDBK-E7303/01	110kV Post Insulator – Test Certificate	Final
74	042246-KDBK-E7304	Wire Conductors (AAC& ACSR)	Final
75	042246-KDBK-E7304/01	Wire Conductors (AAC & ACSR) – Test Certificate	Final
76	042246-KDBK-E7305	Copper Wire (1x120 mm ² & 1x 95 mm ²)	Final
77	042246-KDBK-E7305/01	Copper Wire (1x120mm ² & 1x95mm ²) – Test Certificate	Final
78	042246-KDBK-E7307	List of Clamps and Connectors	Final
79	042246-KDBK-E7308	Marshalling Kiosk (E1.CS11(Q1))	Final
80	042246-KDBK-E7308/01	Marshalling Kiosk E1.CS11(Q1) - Test Certificate	Final
81	042246-KDBK-E7308/02	External Wiring Diagram Marshalling Kiosk E1.CS11(Q1)	Final
82	042246-KDBK-E7310	CVT Junction Box (E1.CA11 (Q1.BU1))	Final
83	042246-KDBK-E7310/01	110KV VT Box (E1.CA11 (Q1.BU1) – Test Certificate	Final
84	042246-KDBK-E7310/02	External Wiring Diagram - 110kV CVT Box (E1.CA11 (Q1.BU1))	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
85	042246-KDBK-E7311	20/0.4 kV, 250kVA Auxiliary Transformer : Outline and Dimensional Drawing ; Technical Data Sheet	Final
86	042246-KDBK-E7312	Current Transformer	Final
87	042246-KDBK-E7313	Capacitor Voltage Transformer	Final
88	042246-KDBK-E7314	Disconnecter Switches - Manufacturing drawings	Final
89	042246-KDBK-E7314/01	Manual/Motor Operating Mechanism (Disconnecter Switch	Final
90	042246-KDBK-E7314/01A	Information Record with regard to Operating Mechanism of Disconnecter Switches	Final
91	042246-KDBK-E7314/02	110 kV Disconnecter Switch Test Report	Final
92	042246-KDBK-E7315	24kV Fused Disconnecter	Final
93	042246-KDBK-E7315/01	24kV Fused Disconnecter - Inspection Certificate	Final
94	042246-KDBK-E7316	Surge Arrestor for Line : Outline and Dimensional Drawing; Technical Data Sheet	Final
95	042246-KDBK-E7317	110KV Line Trap	Final
96	042246-KDBK-E7317/01	110KV Line Trap – Routine Test Report	Final
97	042246-KDBK-E7317/02	Instruction Manual – Line Trap	Final
98	042246-KDBK-E7319	SCADA Interface Cubicle/ Annunciator Panel (C1.CX1)	Final
99	042246-KDBK-E7319/01	Annunciator Panel Data Sheet	Final
100	042246-KDBK-E7319/02	Annunciator Panel (C1.CX1) – Test Certificate	Final
101	042246-KDBK-E7319/03	External Wiring Diagram Annunciator Panel (C1.CX1)	Final
102	042246-KDBK-E7320	Battery, 220V DC & Battery Rack	Final
103	042246-KDBK-E7321	Battery Charger	Final
104	042246-KDBK-E7321/01	220VDC Battery & Charger Instruction Manual (OMI)	Final
105	042246-KDBK-E7321/02	Charger Test Protocol	Final
106	042246-KDBK-E7322	Battery Fuse Box	Final
107	042246-KDBK-E7325	Bay & Station - Interlocking Diagram	Final
108	042246-KDBK-E7327	Lighting Fixtures	Final
109	042246-KDBK-E7328	Receptacles	Final
110	042246-KDBK-E7329	Marshalling Kiosk E1.CS12(Q2)	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITLE	STATUS
111	042246-KDBK-E7329/01	Marshalling Kiosk E1.CS12(Q2) - Test Certificate	Final
112	042246-KDBK-E7329/02	External Wiring Diagram Marshalling Kiosk E1.CS12(Q2)	Final
113	042246-KDBK-E7330	Marshalling Kiosk E1.CS13(Q3)	Final
114	042246-KDBK-E7330/01	Marshalling Kiosk E1.CS13(Q3) - Test Certificate	Final
115	042246-KDBK-E7330/02	External Wiring Diagram Marshalling Kiosk E1.CS13(Q3)	Final
116	042246-KDBK-E7331	Marshalling Kiosk E1.CS34(Q4)	Final
117	042246-KDBK-E7331/01	Marshalling Kiosk E1.CS34(Q4) - Test Certificate	Final
118	042246-KDBK-E7331/02	External Wiring Diagram Marshalling Kiosk E1.CS34(Q4)	Final
119	042246-KDBK-E7332	Type test report for Disconnecter	Final
120	042246-KDBK-E7333	Marshalling Kiosk E1.CS35(Q5)	Final
121	042246-KDBK-E7333/01	Marshalling Kiosk E1.CS35(Q5) - Test Certificate	Final
122	042246-KDBK-E7333/02	External Wiring Diagram Marshalling Kiosk E1.CS35(Q5)	Final
123	042246-KDBK-E7334	Marshalling Kiosk E1.CS36(Q6)	Final
124	042246-KDBK-E7334/01	Marshalling Kiosk E1.CS36(Q6) - Test Certificate	Final
125	042246-KDBK-E7334/02	External Wiring Diagram Marshalling Kiosk E1.CS36(Q6)	Final
126	042246-KDBK-E7335	220V DC Battery and Charger Nameplates	Final
127	042246-KDBK-E7336	Type Test Report – Surge Arrestor	Final
128	042246-KDBK-E7336/01	Routine Test Report – Surge Arrestor	Final
129	042246-KDBK-E7337	110kV VT Box [E1.CA13(Q3.BU1)]	Final
130	042246-KDBK-E7337/01	110kV VT Box [E1.Q3+CA13] – Test Certificate	Final
131	042246-KDBK-E7337/02	External Wiring Diagram - 110kV CVT Box [E1.Q3+CA13]	Final
132	042246-KDBK-E7338	110kV VT Box [E1.Q4+CA31]	Final
133	042246-KDBK-E7338/01	110kV VT Box [E1.Q4+CA31] – Test Certificate	Final
134	042246-KDBK-E7338/02	External Wiring Diagram - 110kV CVT Box [E1.Q4+CA31]	Final
135	042246-KDBK-E7339	110kV VT Box [E1.CA33(Q6.BU1)]	Final
136	042246-KDBK-E7339/01	110kV VT Box [E1.CA33(Q6.BU1)]	Final

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SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITILE	STATUS
		– Test Certificate	
137	042246-KDBK-E7339/02	External Wiring Diagram - 110kV CVT Box [E1.CA33(Q6.BU1)]	Final
138	042246-KDBK-E7340	Labels	Final
139	042246-KDBK-E7341/01	Cable Protection Fixation Details	Final
140	042246-KDBK-E7342	FAT Instructions/ Procedures (Disconnecter Switches, CVT, Current Transformers)	Final
141	042246-KDBK-E7342/01	FAT test Procedure - Surge Arrestor	Final
142	042246-KDBK-E7344-01	O&M for Surge Arrestor	Final
143	042246-KDBK-E7345	110kV VT Box [E1.CA1(WA1.BU11)]	Final
144	042246-KDBK-E7345/01	110kV VT Box [E1.CA1(WA1.BU11)] – Test Certificate	Final
145	042246-KDBK-E7345/02	External Wiring Diagram - 110kV CVT Box [E1.CA1(WA1.BU11)]	Final
146	042246-KDBK-E7346	110kV VT Box [E1.CA2(WA2.BU21)]	Final
147	042246-KDBK-E7346/01	110kV VT Box [E1.CA2(WA2.BU21)] – Test Certificate	Final
148	042246-KDBK-E7346/02	External Wiring Diagram - 110kV CVT Box [E1.CA2(WA2.BU21)]	Final
149	042246-KDBK-E7347	110kv Fog Disc Insulator	Final
150	042246-KDBK-E7347/01	110kV Fog Type Disc Insulator – Test Reports	Final
151	042246-KDBK-E7348	Type Test Report – Current Transformer	Final
152	042246-KDBK-E7348/01	Routine Test Certificate for CT	Final
153	042246-KDBK-E7351	Type test report for CVT	Final
154	042246-KDBK-E7351/01	Data Sheet for 20kV, 185 mm ² Cables - N2XSY	Final
155	042246-KDBK-E7351/02	Routine Test Report for CVT	Final
156	042246-KDBK-E7352	20KV Post Insulators	Final
157	042246-KDBK-E7352/01	20kV Post Insulator – Test Certificate	Final
158	042246-KDBK-E7353	Data Sheet for 20kV, 185 mm ² Cables	Final
159	042246-KDBK-E7353/01	Data Sheet for 20kV, 185 mm ² Cables - N2XSY	Final
160	042246-KDBK-E7353	Data Sheet for 20kV, 185 mm ²	Final

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		Cables	
161	042246-KDBK-E7354	Bay Level Devices : Datasheets & Used Options	Final
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162	042246-KDBK-E7355	24KV Cable – 1Cx300 mm2	Final
163	042246-KDBK-E7357	Oil Monitoring System	Final
164	042246-KDBK-E7358	Distribution Boards	Final
165	042246-KDBK-E7359	Conduit & Accessories	Final
166	042246-KDBK-E7360	Exit Sign & Wall Mounted Incandescent	Final
167	042246-KDBK-E7361	Specification of Fire Alarm Materials	Final
168	042246-KDBK-E7362	110kV Transmission Line ACSR Conductors	Final
169	042246-KDBK-E7362/01	110kV Transmission Line ACSR Conductor - Test Certificates	Final
170	042246-KDBK-E7363	Disc Insulator for 110kV Transmission Line	Final
171	042246-KDBK-E7366	20KV CABLES (185mm2 & 300mm2) FAT REPORT	Final
172	042246-KDBK-E7367	LV Cable N2XCY	Final
173	042246-KDBK-E7368	Control Cable N2XCY	Final
174	042246-KDBK-E7368/01	Control Cable N2XCY (Technical Data)	Final
175	042246-KDBK-E7371	0.4kV, 400A Disconnecter Switch	Final
176	042246-KDBK-E732	Transmission line Hardware's and accessories	Final
177	042246-KDBK-E7373	110KV Disc Insulators - Option II	Final
178	042246-KDBK-E7373/01	Test Certificates - Disc Insulators for 110kV Transmission Line (Option II)	Final
179	042246-KDBK-E7401	Cable Trays	Final
180	042246-KDBK-P7011	20KV Cable Termination Kit	Final
181	042246-KDBK-P7011/01	20kV, 185mm2 Cable Lugs	Final
182	042246-KDBK-P7011/02	Type Test Report – 20 KV Cable	Final
183	042246-KDBK-P7203	20KV Control Panel (J1+CC1=J1.CC1)	Final
184	042246-KDBK-P7203	20KV Control Panel (J1+CC1=J1.CC1)	Final
185	042246-KDBK-P7203/01	20KV Control Panel (J1+CC1=J1.CC1) –Test Certificate	Final
186	042246-KDBK-P7203/02	External Wiring Diagram – 20kV Control Panel (J1+CC1=J1.CC1)	Final
187	042246-KDBK-P7204	20KV Control Panel (J1+CC2=J1.CC2)	Final

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188	042246-KDBK-P7204/01	20KV Control Panel (J1+CC2=J1.CC2) –Test Certificate	Final
SL NO.	DOCUMENT / DRAWING NO.	DOCUMENT / DRAWINGS TITILE	STATUS
189	042246-KDBK-P7204/02	External Wiring Diagram – 20kV Control Panel (J1+CC2=J1.CC2)	Final
190	042246-KDBK-P7205	20KV Control Panel (J1+CC3=J1.CC3)	Final
191	042246-KDBK-P7205/01	20KV Control Panel (J1+CC3=J1.CC3) –Test Certificate	Final
192	042246-KDBK-P7205/05	External Wiring Diagram – 20kV Control Panel (J1+CC3=J1.CC3)	Final
193	042246-KDBK-P7206	20KV Control Panel (J1+CC4=J1.CC4)	Final
194	042246-KDBK-P7206/01	20KV Control Panel (J1+CC4=J1.CC4) –Test Certificate	Final
195	042246-KDBK-P7206/06	External Wiring Diagram – 20kV Control Panel (J1+CC4=J1.CC4)	Final
196	042246-KDBK-P7300/01	PLC Cubicle (AH1.YA1)	Final
197	042246-KDBK-P7300/02	PLCC Cubicle (AH1.YA1) – Test Certificate	Final
198	042246-KDBK-P7300/03	External Wiring Diagram - PLCC Cubicle (AH1.YA1)	Final
199	042246-KDBK-P7301	PLCC Device Description (MCD80)	Final
200	042246-KDBK-P7301/01	PLCC Instruction Manual	Final
201	042246-KDBK-P7301/02	PLCC Technical Data Sheet	Final
202	042246-KDBK-P7404	Earth Wire (Grounding Wire) - Steel Wire	Final
203	042246-KDBK-P7404/01	Earth Wire / Steel Wire (19x2.5mm2) – Test Certificate	Final