HARYANA VIDYUT PRASARAN NIGAM LIMITED

(GOVERNMENT OF HARYANA)

MANUAL OF SPECIFICATIONS & STANDARDS

HVPNL 400 kV PPP-1 Transmission Project (Jhajjar Power)

LIST OF SYMBOLS & ABBREVIATIONS

AISC	American Institute of Steel Construction
ANSI	American National Standard Institute
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Standards
BS	British Standards
CBI&P	Central Board of Irrigation & Power
CCIR	Committee Consultatif International des Radio Communications
CCITT	Consultative Committee for International Telegraphy and Telephony
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CIGRE	Conseil International des Grands Réseaux Électriques
CISPR	Committee International Special des Perturbations Radio electro technique
CISTR	Control Inquiry System for Testing & Reporting
CPWD	Central Public Works Department
CSA	Canadian Standard Association
EIA	Electric Industries Association
GOI	Govt. of India
HERC	Haryana Electricity Regulatory Commission
IEA 1910	Indian Electricity Act – 1910
IEA 2003	Indian Electricity Act – 2003
IEC	International Electro technical Commission
IEEE	Institute of Electrical & Electronics Engineers
IEGC	Indian Electricity Grid Code
IER -1956	Indian Electricity Rules – 1956
IESA 1948	Indian Electricity (Supply) Act – 1948
IS	Indian Standards
ISO	International Organization for Standardization
ITA	Indian Telegraph Act, 1985
MOF	Ministry of Finance, GOI
MOP	Ministry of Power, GOI
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
PTC	Power Test Codes
SSPEC	Steel Structure Painting Council
TAC	Tariff Advisory Committee
USBR	United State Bureau of Reclamation
VDE	Verband der Elektrotechnik

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GENERAL TECHNICAL REQUIREMENTS

SECTION– 1: GENERAL TECHNICAL REQUIREMENTS

1.1 GENERAL

1.1.1 The System Capacity to be constructed under the Transmission System of HVPNL 400 kV Transmission Project (Jhajjar Power) and concurred by the Standing Committee on Transmission System Planning of Northern Region in its 26th meeting held on 13th October 2008 for connectivity with the Regional System, shall comprise of: (a) a 400 kV double circuit (D/C) Quad Moose ACSR transmission line from Jharli (Jhajjar) to Kabulpur (Rohtak); (b) a 400 kV D/C Quad Moose ACSR transmission line from Kabulpur (Rohtak) to Dipalpur (Sonipat); and (c) a 400 kV single circuit (S/C) Triple Snowbird ACSR Loop In Loop Out (LILO) at 400 kV substation Dipalpur of 400 kV D/C Abdullapur to Bawana transmission line and (d) two (2) 400 kV Substations with 2 X 315 MVA, 400 kV / 220 kV + 2 X 100 MVA, 220 kV / 132 kV transformers each at Kabulpur (Rohtak) and Dipalpur (Sonipat).

1.1.2 The Designed Notional Capacity based upon thermal loading limit of conductors shall, for the purpose of the Transmission Agreement be taken as 3300 MVA (2970 MW at 0.9 PF) both for 400 kV D/C Quad Moose ACSR Jharli – Kabulpur and Kabulpur – Dipalpur transmission lines and 1250 MVA (1125 MW at 0.9 PF) for Triple Snowbird ACSR S/C Loop In Loop Out (LILO) of 400 kV D/C Abdullapur - Bawana transmission line.

1.1.3 The System Capacity shall be constructed, completed, operated and maintained during the Concession Period by the Concessionaire as per the Specifications and Standards set forth herein and as per detailed description and technical requirements given in Schedule-B of the Agreement.

1.1.4 The Transmission System shall conform to the design requirements set out in this Manual which unless specified otherwise, are the minimum prescribed. The Concessionaire shall be solely responsible for undertaking all the surveys, investigations and detailed designs in accordance with Good Industry Practice and shall have no claim against the Authority for any loss, damage, risks, costs, liabilities or obligations arising out of or in relation to such surveys, investigations and designs.

1.1.5 All works, methods and workmanship shall be in accordance with this Manual of Standards & Specifications and Good Industry Practice for work of this nature.

1.1.6 All plant & equipment including replacements shall be new, unused, and of the most recent or current models unless provided for otherwise in the Transmission Agreement.

1.1.7 Concessionaire shall carry out residual life assessment and appropriate condition based maintenance in accordance with recommendations of “CBI&P Manuals on EHV Sub-station and Transmission Line Maintenance” and also carry out general maintenance as per the reviewed Maintenance Manual and Good Industry Practise so as to non-intrusively determine equipment health, arrest undue deterioration in performance, improve availability, regain lost capacity and extend useful life beyond normal standard life span.

1.1.8 The Concessionaire shall take all requisite measures for appropriate operation and maintenance as per relevant codes, standards and the Maintenance Manual and adopt requisite life extending procedures or replacement action to guard against undue capacity loss and de-rating of equipment as per Good Industry Practice.

1.2 CLIMATIC CONDITIONS & METEOROLOGICAL DATA

Equipment to be supplied and other services to be executed shall be suitable for satisfactory continuous operation under the following tropical conditions:

S. No.	Description	In the state of Haryana
1	Max. ambiant air temp. (^{o}C)	50
2	Min. ambiant air temp. (^{o}C)	-2.5
3	Daily average air temp. (^{o}C)	35
4	Everyday temperature as per IS: 802	32
5	Average number of thunder storm days per annum	45
6	Maximum relative humidity (%)	100
7	Minimum relative humidity (%)	26
8	Average annual rain fall (mm)	900
9	Max. wind pressure (kg / sq m)	195
10	Max. altitude above mean sea level (meters)	1000
11	Isocraunic level (days / year)	45
12	Seismic level (horizontal acceleration)	0.3 g
13	Average number of rainy days per annum	120

1.3 APPLICABLE ACTS, RULES, REGULATIONS, CODES AND STANDARDS

Concessionaire shall ensure minimum compliance with the following Acts, Rules, Regulations, Codes, Standards and Specifications:

1.	**Indian Electricity Act – 2003**	**2.**	**Indian Telegraph Act – 1885**
3.	**Indian Electricity Rules – 1956**		
4.	**CEA (Technical Specification for construction of Electric Plants and Electric Lines) Regulations 2009 (Draft)**		
5.	**CEA (Safety requirements for Construction, Operation & Maintenance of Electrical Plants & Electric Lines) Regulation 2009 (Draft)**		
6.	**CEA (Measures relating to Safety & Electricity Supply) Regulation-2007 (Draft)**		
7.	**CEA (Technical Standards for connectivity to the Grid) Regulation-2007**		
8.	**Haryana Grid Code (HGC) Regulations 2008**		
9.	**Indian Electricity Grid Code (IEGC) 2006**		
10.	**CEA (Grid Standards) Regulations 2006 (Draft)**		
11.	**Operating Procedures for Northern Region Sep – 2000**		
12.	**CBI&P Manual on Commissioning Procedure for Transmission Lines – Pub. No. 292**		
13.	**CBI&P Manual on Maintenance of EHV Substation Equipment**		
14.	**CBI&P Manual on Maintenance of Transmission Lines – Pub. No. 293**		

Notes:

In the event of conflict between standards and specifications prescribed in two or more of the aforesaid codes, the Concessionaire shall be at liberty to rely on one of the aforesaid codes and on Good Industry Practice, provided however, that in the event of any such conflict, the following codes shall have overriding priority in the order listed:

(i) Specifications and Standards set out in this Manual;

(ii) CEA (Technical Specification for construction of Electric Plants and Electric Lines) Regulations 2009 (Draft)

(iii) In the event of any conflict between the requirement of the international Standards or codes and the requirement of the BIS Standards or Codes, the latter shall prevail.

(iv) Where no standards exist, as in the case of patented or special materials; all such equipments & materials shall be of reputed make. Full details of the material and any quality control tests to which they may be subject shall be submitted to the Independent Engineer for approval.

(v) The latest version of the aforesaid codes, standards and specifications, which have been published at least 60 (sixty) days before the last date of bid submission shall be considered applicable.

1.4 ALTERNATIVE STANDARDS AND SPECIFICATIONS

The requirements listed in this Manual are the minimum. The Concessionaire may adopt alternative internationally recognised codes, standards and specifications if it can demonstrate to the Independent Engineer that such alternative is superior or more pertinent to the Project than the standards specified in this Manual.

1.5 TECHNICAL PARAMETERS OF THE TRANSMISSION SYSTEM

The following system parameters shall be met:

S.N.	System	400 kV	220 kV	132 kV	33 kV	11 KV	0.433 KV
1.	Nominal Voltage	400 kV	220 kV	132 kV	33 kV	11 kV	240 / 433 V
2.	Highest System Voltage	420 kV	245 kV	145 kV	36 kV	12 kV	……
3.	Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
4.	No. of Phases	3	3	3	3	3	3
5.	**Rated Insulation Levels:**						
i)	Full Wave Impulse Withstand Voltage (1.2 / 50 micro sec.)	1425 kVp for sub-station 1550 kVp for lines	1050 kVp	650 kVp	170 kVp	75 kVp	6 kVp
ii)	Switching Impulse Withstand Voltage (250 / 2500 ms)	1050 kVp	-	-	-	-	-
iii)	One minute Power Freq. withstand voltage (rms) dry & wet	630 kV for sub-station 680 kVp for lines	460 kV	275 kV	80 kV	28 kV	3 kV
6.	Corona Extinction Voltage	320 kV	156 kV	105 kV	-	-	-

S.N.	System	400 kV	220 kV	132 kV	33 kV	11 KV	0.433 KV
7.	Maximum Radio Interference Voltage (RIV) between 0.5 to 2.0 MHz at 267,156, & 105 kVrms for 400, 220, & 132kV	1000 micro volt	1000 micro volt	500 micro volt	-	-	-
8.	Minimum Creep Distance	31 mm / kV (13020 mm)	31 mm/kV (7595 mm)	31 mm/kV (4495 mm)	31 mm/kV (1116 mm)	31mm/kV (372 mm)	31mm/kV (75 mm)
9.	**Min. clearances:**						
i)	Phase to phase	4200 mm for Rod type Conductor / 4000 mm for Cond.- Cond. Configurations	2100 mm	1600 mm	350 mm	127 mm	19 mm
ii)	Phase to Earth (Sub-station)	3500 mm	2100 mm	1300 mm	320 mm	76.2 mm	15.8 mm
iii)	Sectional Clearances	6500 mm	5000 mm	4000 mm	3000 mm	Indoor	Indoor
iv)	Live Part to Tower Body under nil swing	3050 mm	2130 mm	1530 mm	-	-	-
10.	Rated Short Ckt. Current for 1 sec	40 kA	40 kA	31.5 kA	25 kA	25 kA	10 kA
11.	System Neutral Earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

1.6 INSULATION COORDINATION

Insulation levels of substation and line equipment including first tower of each line emanating / terminating at a sub-station shall be so designed as to meet the requirement of insulation coordination in accordance with guidelines contained in IS 2165-1977 (Specification for Insulation Coordination).

1.7 GALVANIZING AND PAINTING

1.7.1 Galvanizing: All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after completion of machining, drilling or welding etc. excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization. Grade of Zinc and its thickness on various components shall be as under:

i) Zinc shall conform to Grade Zn 98.5 of IS: 13229 - 1991 & Grade Zn 99.95 of IS: 209 - 1979.

ii) The minimum thickness / weight of the zinc coating:

- 85 microns/ 610 gm / sq. m for items thicker than 5 mm and used over ground or embedded in concrete.
- 210 microns/ 1500 gm/ sq. m for items thicker than 5 mm and directly embedded in soil.

- For items under 5 mm but over 2 mm, thickness of coating shall be - 65 microns /460 gm/ Sq. m
- For hardware fittings, bolts, nuts & tower accessories- Galvanization thickness shall be minimum 43 microns / 300 gm/ Sq. m

1.7.2 Painting: All sheet steel work not required to be galvanized shall be painted as per relevant standards / specifications to ensure long life.

i) The exterior color of the paint shall preferably be as per shade no: 697 (for outdoor) & 692 (for indoor) of IS-5 and inside shall be glossy white for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments.

ii) Coats of primer and finishing paint shall be of slightly different shade to enable inspection of the painting.

1.8 PROJECT MONITORING SYSTEM

The Concessionaire shall procure information technology based system for effective project monitoring. The IT system shall monitor status of engineering, design, ordering, testing, supplies and physical progress of site activities as well as O & M and help in identifying the bottlenecks in achieving the scheduled completion of works. The system shall be web based and have connectivity with major suppliers/contractors and the Authority.

1.9 QUALITY ASSURANCE

The Concessionaire shall develop and maintain a quality assurance system for design, installation and construction procedures and the interfaces between them. The quality plan shall also cover fully all quality assurance and quality management aspects of the operation and maintenance of the Transmission System.

1.10 REVIEW AND COMMENTS BY THE INDEPENDENT ENGINEER

In cases where the Concessionaire is required to send any drawings or documents to the Independent Engineer for review and comments, and in the event such comments are received by the Concessionaire, it shall duly consider such comments in accordance with the Transmission Agreement and Good Industry Practice for taking appropriate action thereon.

1.11 DEFINITIONS AND INTERPRETATION

1.11.1 All the obligations of the Concessionaire arising out of the provisions of this Manual shall be discharged in a manner that conforms to the provisions of the Transmission Agreement.

1.11.2 The rules of interpretation as specified in Clause 1.2, 1.3 and 1.4 of the Transmission Agreement shall apply *mutatis mutandis* to this Manual.

1.11.3 The definitions contained in the Transmission Agreement shall apply to the provisions of this Manual unless the context otherwise requires. Terms or words not defined in this Manual or the Transmission Agreement shall be governed by the definitions contained in the applicable Specifications and Standards.

SECTION – 2

SUB-STATION SPECIFICATION

SECTION – 2: SUB-STATION SPECIFICATION

2.1 MAIN DESIGN DATA

All the Substation equipments & systems shall be designed to meet the major technical parameters given in Section-1 of this specification and other project parameters given in the following clauses:

2.1.1 Switching Surge and Power Frequency Over Voltages: The 400 kV system switching surge over voltage and power frequency over voltage shall be limited to 2.5 p. u. and 1.5 p. u. respectively. The initial value of temporary over voltages could be 2.0 p. u. for 1-2 cycles.

2.1.2 Overall Fault Clearance Time: Overall fault clearing time may be designed preferably less than 100 m sec. for 400 kV, 120 m sec. for 220 kV and 160 m sec. for 132 kV levels under comparable conditions.

2.1.3 Duty Cycle of Circuit Breakers: The duty cycle of CBs installed in 420 / 245 / 145 kV System of the Concessionaire shall be "O-0.3 sec-CO-3 min-CO". The Surge Arrester shall be suitable for such circuit breaker duties in the system.

2.1.4 Degree of Protection: The degree of protection for enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. shall as under:

i) Installed Outdoor: IP- 55
ii) Installed Indoor in air conditioned area: IP-31
iii) Installed in covered area: IP-52
iv) Installed Indoor in non air conditioned area where possibility of entry of water is limited: IP-41.
v) For LT Switchgear (AC & DC distribution Boards) : IP-52

2.1.5 General Electrical Clearances: Inter equipment arrangement and distances – bay length, bay width etc. shall be maintained in accordance with the reviewed design of Single Line Diagram (SLD) and General Electrical Lay-Out (GELO) of the substation. A copy of indicative GELOs and SLDs of substations covered under the project are enclosed at Appendices-Ia to Id.

2.2 MAJOR EQUIPMENTS AND SUB-SYSTEMS

Brief particulars of major equipments, systems and sub-systems are given as follows:

2.2.1 Power Transformers:

i) 400 kV / 220 kV Transformers shall be auto-transformers of rating 315 MVA with 33 kV tertiary winding of 6.3 MVA active capacity and On Load Tap Changer (OLTC) with ± 10% range. Vector group shall be Yna0d11.

ii) 220 kV / 132 kV Transformers shall be auto-transformers of rating 100 MVA and On Load Tap Changer (OLTC) with - 5% to +15% range. Vector group shall be Yna0.

iii) 33 kV / 0.433 kV Auxiliary Transformers shall be of rating 630 kVA and Off Load Tap Changer with +/- 5% range. Vector group shall be Dyn11.

iv) Transformers with losses higher than specified below shall not be accepted:

Transformer Losses in KW

S. N.	Description	No Load losses	Load losses	Auxiliary losses	Total Losses
i)	400 / 220 kV 315 MVA	86	482	16	584
ii)	220 / 132 kV 100 MVA	28	233	11	272

v) The Normative Loss (sum of No Load & Load Loss) of 315 MVA, 400/220 kV and 100 MVA, 220/132 kV Transformers shall be 530 kW and 220 kW respectively...

2.2.2 Circuit Breakers: Interrupting medium of circuit breakers shall be SF6. Circuit breakers of 220 kV and 400 kV voltage class shall be suitable both for single phase and three phases auto-reclosing. Circuit breakers of 132kV voltage class shall be suitable for three-phase auto-reclosing. Each circuit breaker shall be provided with 2 nos. of trip coils. Two sets of trip circuits shall be connected to separate fuse or MCB controlled DC supplies for greater reliability. The circuit breaker shall have the provision for local manual trip which shall be at a position easily accessible to the operating person. Maximum rated break time in ms for circuit breakers shall be as given below:

400 kV	220 kV	132 kV
40	60	100

2.2.3 Disconnectors and Earthing Switches: Disconnectors for 132 kV, 220 kV and 400 kV rating shall have provision for remote and manual operation. Earthing switches shall be provided at appropriate locations to facilitate earthing of outgoing transmission lines to enable maintenance. Main blades and earth blades shall be interlocked with both electrical and mechanical means, which shall be fail-safe. Earthing switches shall be suitable for induced current switching duty as per relevant standard. Earthing switches shall be suitable for electrical and manual operation. Only local operation is recommended for earth switches.

2.2.4 Current Transformers: The rated currents and ratios, the number of secondary cores (protection or metering), accuracy class, burden, secondary winding resistance, knee point voltage and excitation current shall be in accordance with the requirements of the protection system. The accuracy class for metering core shall be equal to or better than the accuracy class of the meter specified in the Central Electricity Authority (Installation and operation of Meters) Regulations, 2006.

2.2.5 Capacitor Voltage Transformers: The number of secondary cores (protection or metering), accuracy class and burden shall be in accordance with the requirements of the protection system. The accuracy class for metering core shall be equal to or better than the accuracy class of the meter specified in the Central Electricity Authority (Installation and operation of Meters) Regulations, 2006. The capacitance of CVT shall be decided depending on PLCC requirements.

2.2.6 Surge Arresters: Station class, heavy duty, gapless metal oxide (ZnO) type surge arresters shall be provided. The rated voltage, Continuous Operating Voltage (COV), energy handling capability, nominal discharge current and other characteristics of a surge arrester shall be chosen in accordance with power system requirements. Surge arresters shall be provided at locations as per General Electrical Layout (GELO). These shall be fitted with pressure relief devices and diverting ports suitable for preventing shattering of porcelain housing providing path for the flow of rated currents in the event of failure of surge arrester. A leakage current monitor with surge counter shall be provided with each surge arrester.

2.2.7 Line Trap: A line trap, intended for insertion in a high voltage power transmission line between the point of connection of carrier frequency signals and adjacent power system elements such as bus bars, transformers etc., shall consist of a main coil in the form of an inductor, a tuning device and a protective device. The tuning device shall be so arranged as to permit replacement without removing the line trap. It shall be so designed that neither significant alteration in the line trap blocking requirements nor physical damage shall result from either temperature rise or the magnetic field of the main coil at rated continuous current or rated short time current. The protective device shall be so designed and arranged that neither a significant alteration in its protective function nor physical damage shall result either from temperature rise or the magnetic field of the main coil at rated continuous current or rated short time current.

2.3 AUXILIARY SUPPLY

i) AC and DC distribution system shall be so designed as to meet the requirement of the substation in accordance with Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.

ii) The sub-station auxiliary AC supply shall be obtained from the tertiary winding of the 400 / 220 / 33 kV ICT by installing one 33 / 0.433 – 0.250 kV transformers of 630 KVA or other suitable rating at each of the two ICTs. The normal characteristics of AC & DC auxiliary supply are given in the table below:

Normal Voltage connection	Variation in Voltage	Frequency in HZ	Phase / Wire	Neutral
415V AC	+/- 10%	50 +/- 5%	3 / 4 wire	Solidly earthed
240 V AC	+/- 10%	50 +/- 5%	1 /2 wire	Solidly earthed
220 V DC	190 V to 240 V	-	2 wire	Isolated 2 wire system
48 V DC	-	-	2 wire	2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to +/- 10% or as permitted under the IER-1956.

iii) For computation of capacity of battery in attended sub- station or switchyard, in general, the minimum durations assumed shall be as per Table given bellow:

	Where standby battery is provided	Where standby battery is not provided
Steady and continuous load	3 hours	6 hours
Emergency lighting loads	1 hour	2 hours

2.4 SUPPORT STRUCTURE / GROUND CLEARANCE

Support structures shall be galvanized as per design, drawings and recommendations of the equipment manufactures. Minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad, shall be 2.55 meters.

2.5 CLAMPS, TERMINALS AND CONNECTORS

All equipments shall be supplied with the necessary clamps and connectors, as required by the ultimate design of a particular installation. All clamps and connectors shall conform to IS: 5561 & NEMA CC-1.

2.6 BUS-BAR

i) Minimum Bus-Bar capacity (Ampacity) for 400 kV & 220 kV sides shall be 3200 Amps and that for 132 kV side 1600 Amps.

ii) The following switching schemes shall be adopted at different voltage levels:

132 kV Bus	Double bus scheme
220 kV Bus	Double bus scheme or double main and transfer bus scheme
400 kV Bus	Breaker and a half scheme

2.7 CONTROL CABINETS, JUNCTION, TERMINAL & MARSHALLING BOXES

All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039 / IS: 8623, IEC-439, as applicable. All Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be dust, water & vermin proof and made of sheet steel or aluminum enclosure properly braced to prevent wobbling. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life comparable with sheet steel of specified thickness.

2.8 AUXILIARY SWITCHES FOR ISOLATORS AND CIRCUIT BREAKERS

Auxiliary switches for Isolators and circuit Breakers shall be tested for electrical endurance for minimum of 2000 operation for 2A DC with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop / visual defects / temperature rise test and IR / HV test etc.

2.9 TERMINAL BLOCKS AND WIRING

i) The terminal blocks shall be of extendable design, 650 V category, rated to carry the maximum expected current on the terminals continuously, provided with test links and isolating facilities wherever required and suitable for connecting the designed size of conductors on each side

ii) Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All inter phase and external connections to equipment or to control cubicles will be made through terminal blocks having a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

2.10 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

2.10.1 Bushings: Bushings shall be manufactured & tested in accordance with IS: 2099 & IEC: 137.

2.10.2 Hollow Column Insulators & Support Insulators: Hollow column insulators shall be in accordance with IEC-233 / IS: 5621 and support insulators as per IS: 2544 / IEC-168, IEC-273 and IEC-815 as applicable. The Concessionaire may also use composite silicon insulators, conforming to IEC-1109.

2.10.3 Iron Parts: All iron parts of insulators and bushings shall be hot dip galvanized and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator / bushing design shall be such as to ensure a uniform compressive pressure on the joints.

2.11 SUBSTATION AUTOMATION SYSTEM (SAS)

The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from remote control centre (RCC) as well as from local control centre.

i) The SAS shall contain at least the following main functional parts:

- Bay control Intelligence Electronic Devices (IED s) for control and monitoring.
- Station Human Machine Interface (HMI)
- Redundant managed switched Ethernet
- Local Area Network communication infrastructure with hot standby.
- Peripheral equipment like printers, display units, key boards, Mouse etc.

ii) The SAS shall enable local station control via PC by means of HMI and control software package, which shall contain an extensive range of SCADA functions.

iii) The SAS shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. The communication gateway shall facilitate the information flow with remote control centers. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

2.12 POWER LINE COMMUNICATION AND PROTECTION OF TRANSMISSION SYSTEM

2.12.1 Power Line Tele-Communication and Tele-Protection Equipment

i) The power line tele-communication and protection equipment shall be Constructed by the Concessionaire at both ends of all the Transmission Lines Constructed by him under this Project. For the avoidance of doubt, the power line tele-communication and protection equipment at Jharli end of 400 kV Kabulpur–Jharli Line as well as at Abdallapur and/or Bawana ends of S/C LILO of 400 kV D/C Abdallapur-Bawana Line shall also be Constructed by the concessionaire.

ii) All equipments except that for tele-communication & tele-protection in respect of 400kV, 220kV, and 132kV bays for the transmission lines to be constructed by the Authority and terminating at 400kV Substations Kabulpur & Dipalpur (that is 2 No. 400KV, 6 No.220kV, 6 No.132kV line bays at Kabulpur and 6 No. 220kV, 6 No.132kV line bays at Dipalpur) shall be Constructed by the Concessionaire. For the avoidance of doubt, Construction of tele-communication and tele-protection equipment on these bays is not in the scope of Concessionaire. However; the Concessionaire shall associate in testing and commissioning and also carry out maintenance of all tele-communication & tele-protection equipments installed at Kabulpur and Dipalpur substations.

iii) The power line tele-communication and tele-protection on all new 400 kV lines Constructed under this project shall be provided through OPGW. The power line tele-communication and tele-protection on other lines to be terminated at the Substations shall be through OPGW or PLCC as may be compatible with the other end equipment.

2.12.2 Communication

2.12.2.1 **Frequency Planning:** For planning frequency and output power of carrier terminals the Concessionaire may plan for a minimum receive signal to noise ratio of 25 dB for the speech channels without companders as per standard practice. The noise power in 2.1 kHz band (300-2400 Hz) may be taken as -13 dBm referred to the coupling point of the H.T. line. The frequency plan will be referred to Wireless Adviser / DOT for clearance.

2.12.2.2 **Proposed Arrangement:** The power line tele-communication and tele-protection equipment shall provide primarily efficient, secure and reliable information link for speech communication, data transfer and distance protection as well as direct tripping of remote-end breakers. as the case may be. Minimum requirement of communication links is as below:

i) One protection channel for Main-I and another for Main-II distance protection schemes for 400 kV lines.

ii) One speech channel with a facility to superimpose telex and data signals.

iii) One main & one back-up protection channel for direct tripping of remote end breaker in respect of 400 kV lines.

iv) The time intervals between receipt of a trip command on the transmit side, its transmission over the communication link, reception at the far end and giving command to the trip relays at the distant end shall not exceed 20 ms for permissive inter tripping and 30 ms for direct inter-tripping even for the longest line section. The above timings are inclusive of operating time for auxiliary relays and interposing relays, if any, included in the communication equipment.

v) For reasons of security and reliability, where PLCC has to be used due to the other end co-ordination requirement, phase to phase coupling for 400 kV S/C as well as D/C lines shall be used.

vi) The Impedance of the High Frequency Cable (HFC) connecting the coupling device installed in the switchyard to the indoor PLC terminal shall be suitably balanced and matched with the impedance of the PLC terminal on one side and to that of the coupling device on the other, over the entire carrier frequency range of 40 - 500 kHz. Conductor resistance of the HF cable shall not exceed 16 ohms per Km at 20°C. The characteristic impedance of HF cable shall be 150 ohms (balanced) in line with existing practices in HVPNL.

2.12.3 Protection

2.12.3.1 **Protective Relaying System:** Adequately sectionalized and graded protective relaying system shall be provided for transmission lines, transformers and bus bars so as to automatically isolate the faulty equipment as per preset duty and, thus, minimize the damage to the equipment in the event of faults and abnormal conditions. All main protection relays shall be of numerical type and communication protocol shall be as per IEC-61850.

2.12.3.2 **Grouping of Protection:** The protection functions shall be subdivided into two groups each being independent and capable of providing uninterrupted protection even in the event of one of the protection groups failing. Grouping shall be done to the extent possible in such a way that each group can independently carry out protective functions with near equal redundancy. Interconnection between

these two groups shall not generally be attempted. However, if found absolutely necessary such interconnection shall be kept to the bare minimum.

2.12.3.3 The protection in respect of Transmission Lines, Power Transformers, Circuit Breakers, Bus-bars and other provisions shall be as per CEA (Technical Standards for Construction of Electrical Plants & Electric Lines) Regulation 2009 (Draft), meet the requirement of Haryana Grid Code and CBI&P guidelines on Protection.

2.12.3.4 **Bus Bar Protection and Local Breaker Backup Protection (Breaker Failure Protection):** Duplicate Bus bar protection for 400 kV, single bus-bar protection for 220 kV systems and local breaker backup protection for 400 kV and 220 kV shall be provided. The bus bar protection scheme shall have provision for future expansion.

2.12.3.5 **Disturbance Recorders, Event Loggers and Time Synchronization Equipment:** Each line shall be provided with facility for disturbance recording, distance to fault locator and Time Synchronizing Equipment (TSE). TSE complete with antenna, all cables, processing equipment etc., shall be provided to receive synchronizing pulse through GPS compatible for synchronization of event logger, disturbance recorder and SCADA/automation system of the sub- station or switchyard.

2.13 INTER UTILITY METERING SYSTEM

The Energy Metering System as specified in CEA (Installation & Operation of Meters) Regulation 2006 issued vide notification No. 502/70/CEA/DP&D dated 17.3.06 read with its amendment(s) dealing with installation & operation of meters including interface meters shall be used for tariff metering for Bulk Inter-utility power flows in the Concessionaire / HVPNL / Grid system. The metering system shall be installed on each circuit as a self contained device for recording & measurement of active energy & reactive energy in each successive 15-minute block and certain other functions as described in the CEA's Notification referred above.

2.14 SUB-STATION AND SWITCHYARD SUPPORT FACILITIES

2.14.1 Illumination and Lighting: The Concessionaire shall design, provide & maintain at all times a good lighting & illumination system in a substation both for normal and emergency situations and to facilitate operation and maintenance activities and ensure safety of the working personnel.

i) Lighting Systems: The illumination & lighting systems shall comprise of the following:

ii) AC Normal Lighting: AC lights shall be connected to Main Light Distribution Boards.

iii) AC Emergency Lighting: Emergency lighting system with about 50% points connected to auto start generators shall be available in Control room building, Fire fighting pump house, DG Set building & Switchyard. The emergency lighting system shall be kept normally 'ON'.

iv) D.C. Emergency Lighting: Strategically located lights in places like, Staircases, Corridors, Fire Control Rooms, Battery Room, DG Set building and Control Room building shall be connected to DC Emergency lighting system. These lights shall be kept normally 'OFF' and will be switched 'ON' automatically on AC failure.

v) Portable Lighting Fixtures: At least three (3) number battery powered portable lighting fixtures shall be kept at easily accessible points in the Control room building and one (1) each in DG Set Building

and Fire fighting pump house.

vi) **Illumination Levels:** Average illumination levels shall be as per CBIP manual on Substation Layout Publication No. 299.

2.14.2 Fire Protection System: Fire detection, Alarm and Protection system for Substation and Switchyard shall be provided as per CEA (Construction of Electrical Plants & Electric Lines) Regulation 2009 (Draft). Color scheme for Fire Protection & Air Conditioning systems shall be as given below:

S.No	Pipe line	Base Color	Band Color
	Fire Protection system		
1	Hydrant and Emulsifier system pipeline	Fire Red	-
2	Emulsifier system detection line- water	Fire Red	Sea Green
3	Emulsifier system detection line-Air	Fire Red	Sky Blue
4	Pylon support pipes	Fire Red	-

Direction of flow shall be marked by (arrow) in **black** color.

2.14.3 Air Conditioning System: Air Conditioning (AC) requirement shall be met using individual split AC units of 2TR each. AC units for control room building shall maintain **DBT 24.40^0 C +/- 2^0 C.** The following facilities, in addition to any other deemed necessary by the Concessionaire shall also be air conditioned:

a) Control room
b) S/ S Engineer's room
c) Battery room
d) Electronics test lab
e) Conference Room

Color scheme for Air Conditioning systems shall be as given below:

S.No	Pipe line	Base Color	Band Color
	Air Conditioning System		
1	Refrigerant gas pipeline - at compressor suction	Canary Yellow	-
2	Refrigerant gas pipeline - at compressor discharge	Canary Yellow	Red
3	Refrigerant liquid pipeline	Dark Admiralty Green	-
4	Chilled water pipeline	Sea Green	-
5	Condenser water pipeline	Sea Green	Dark Blue

Direction of flow shall be marked by (arrow) in **black** color.

2.14.4 Oil Evacuating, Filtering, Testing and Filling Apparatus: To monitor the quality of the oil for satisfactory performance of transformers and shunt reactors, and for periodical maintenance, necessary oil evacuating, filtering, testing and filling apparatus shall be provided at a new sub- station or new switchyard or for a cluster of sub- stations and switchyards. Oil tanks of adequate capacities for storage of pure and impure transformer oil shall be provided.

2.14.5 SF6 Filling, Evacuation, Filtering, Drying & Recycling Plant: SF6 filling, evacuation, filtering, drying and recycling plant with adequate storage capacity shall be provided at a new sub- station or new switchyard or for a cluster of sub-stations and switchyards along with trolley for filling or evacuation of SF6 circuit breaker or gas insulated switchgear (in case of GIS installation) and to monitor the purity, moisture content, decomposition product etc. of SF6 gas.

2.15 MANDATORY INITIAL SPARES, TOOLS & TACKLES

2.15.1 Mandatory Spares: The Concessionaire shall maintain mandatory spares as per the CERC / SERC guidelines and good industry practice. The inventory of spare parts shall at all times be maintained by replenishing in case any item of spare is utilized during construction & commissioning or operation & maintenance. Complete spares would be handed over to the Authority after the concession period.

2.15.2 Tools & Tackles: The bidder shall include in his proposal the deployment of all such special tools and tackles as required for erection testing, commissioning and maintenance of equipment. The Concessionaire shall hand over set of tools and tackles required for routine maintenance of the sub-station equipment at the time of transfer / handing back of the asset to the Authority.

SECTION – 3

TRANSMISSION LINE SPECIFICATION

SECTION – 3: TRANSMISSION LINE SPECIFICATION

3.1 MAIN DESIGN DATA

All Transmission Lines and Equipments shall be designed to meet the major technical parameters given in Part-1 of this specification and project parameters given in the following clauses:

3.2 MECHANICAL DESIGN

Concessionaire shall undertake detailed survey & investigation and work out designs of Transmission Lines and components (tower, hardware, conductor, ground wire and accessories, insulators, strings and hardware, etc.) based on the parameters given in the clauses that follow.

3.2.1 Wind Speed: Based on the wind speed map of India as per IS: 802 (Part I / Sec I) -1995, the project area in Haryana state (India) falls in wind zone-(4) with basic wind speed (47 m / sec.)

3.2.2 Maximum Operating Temperature of Conductor / Earth Wire: The maximum operating temperature of ACSR conductor shall be limited to 75°C and that for earth wire 53° C.

3.2.3 Section Length and Line Span: Maximum length of a section in plain terrain as per IS; 5613 Part-3 Section-2 shall be limited to fifteen (15) spans or five (5) Km. Normal span for 400 kV voltage transmission lines may be 400 m and weight spans for design of towers may generally be on the basis of maximum permissible weight spans given in the table below:

Terrain / tower type	Weight Span (m)			
	Normal condition		Broken wire condition	
	Max.	Min.	Max.	Min.
Plain Terrain (Cat-2)				
Suspension	600	200	360	100
Small / Medium Angle	600	0	360	-200
Large Angle /DE	600	0	360	-300

3.2.4 Tower Steel Sections: Steel Sections used for fabrication of towers, extensions and stub setting templates shall be in conformity to IS: 808-1989, and shall be of tested quality conforming to IS: 2062-1999 and IS: 8500 -1991 or latest version thereof.

3.2.5 Permissible Ultimate Stresses in Bolts (MPa): Estimated stresses in bolts shall not exceed the values given in IS: 802 (part I/Sec-2)-1992.

3.3 ELECTRICAL DESIGN

Concessionaire shall undertake work of Electrical design and selection of Transmission line components based on fixation of external insulation i.e., air clearance & insulator string length to cater to different electrical over voltages and other factors which affect electrical insulation; eg. climatic conditions, altitude, relative humidity, pollution levels etc.

3.3.1 Air Clearances: Air clearances applicable to transmission lines categorized as minimum ground clearance, phase to grounded metal clearance, phase to phase clearance, power conductor and ground wire mid span clearance, clearances between power lines crossing each other and crossing telecom lines, railway tracks, roads, rivers, water bodies etc. shall be as in the table below:

S. No.	DESCRIPTION	REFERENCE TO RULES & REGULATIONS
1	**Minimum Ground Clearance along / across road / street**	**Sub-rule 4 of rule 77 of IE rules 1956 + 150 mm as allowance for uneven ground profile and sagging error**
2	**Clearance with Power line Crossings**	**Sub-rule 3 of rule 87 of IE rules 1956**
3	**Clearances with Communication lines**	**Code of Practice for the protection of Telecom lines at crossings with overhead Power lines other than electric traction circuits (chapter VI of PTCC Manual 2009 issued by CEA)**
4	**Minimum clearance to Buildings**	**Rule 80 of IE rules 1956**
5	**Clearance at Railway tracks**	**Regulations for Power line crossing of Railway tracks issued by Railway Broad in 1987**
6	**Clearance between conductor & Ground wire at Tower and Mid Span**	**IS: 5613(Part 3/Section-I)**
7	**Clearance between live Conductor to earthed metal parts**	**IS 5613 (Part 3/Section-I)**
8	**Minimum clearance above highest flood level**	**6400 mm**

3.3.2 PTCC: The transmission lines shall be located far enough from a nearby tele-communication lines to meet following limits of interference:

(i)	Maximum value of induced electromagnetic voltage in volts for fault duration equal to or less than 200 ms	650
(ii)	Maximum value of induced noise in micro volts (noise-interference) shall be measured and taken cognizance, if the noise is persistent.	2000

3.3.3 Right of Way Requirement: The Right of way and minimum width of transmission line corridor for 400 kV transmission lines shall be 52 m as per Forest Conservation Act – 1980.

3.3.4 Other Design Constraints: Following constraints shall also be taken in to account while designing 400 kV and above transmission lines:

(i) Radio interference
(ii) TV Interference
(iii) Electrostatic field

3.4 MAJOR MATERIALS AND ACCESSORIES

Brief particulars of major materials, fittings, fixtures and accessories of Transmission Lines are given in the paragraphs that follow:

3.4.1 Insulators / Insulation: Insulator & insulator string ratings shall be selected such that:

i) Under ultimate design wind loading conditions, the load on insulator string shall not exceed 70 % of its selected rating.

ii) Under everyday temperature and no wind conditions, the load on insulator string shall not exceed 25% of its selected rating.

iii) The insulators shall consist of Anti Fog Disc Insulators or Long Rod Insulators having Electro-Mechanical strength of 120 KN for Suspension Strings & 160 KN for Tension Strings and minimum creep-age of 31 mm/kV.

3.4.2 Conductors: The Line conductors for 400 kV D/C Transmission Lines from Jharli to Kabulpur and Kabulpur to Dipalpur shall be Quad Moose ACSR and that for S/C LILO at Dipalpur of existing 400 kV D/C Abdallapur–Bawana Line shall be Triple Snowbird ACSR with the general electrical and mechanical properties described hereunder. For avoidance of doubt, the size, number and type of conductor required to be used in the lines covered under this project has been fixed as described in para 1.1.1 and no changes in the same shall be permitted.

Voltage Level	**400 KV**	
Code Name of Conductor	**ACSR "MOOSE"**	**ACSR "SNOWBIRD"**
No. of Conductors/Phase	**Four (Quad Bundle)**	**Three (Triple Bundle)**
Stranding / Wire Diameter	**54 / 3.53 mm AL + 7 / 3.53 mm steel**	**42 / 3.99 mm Al + 7 / 2.21 mm steel**
Total Sectional Area	**597 mm²**	**552 mm²**
Overall Diameter	**31.77 mm**	**30.56 mm**
Approx. Weight	**2004 kg/km**	**1657 kg/km**
Calculated D.C. resistance at 20 deg C	**0.05552 Ohm/km**	**0.05516 Ohm / km**
Min. UTS	**161.2 k N**	**118.0 k N**
Modulus of Elasticity	**7034 kg / mm²**	**6460 kg / mm²**
Co-efficient of Linear Expansion	**19.30×10^{-6} / ^{o}C**	**21.42×10^{-6} / ^{o}C**

3.4.3 Earth Wires: Two continuously run earth wires – one of 7/3.66 mm galvanized steel wire and another of 24-core OPGW earthed at every tower location shall be used.

3.4.4 Aviation Requirements and Warning Signals: Day and /or night visual aids and markers for denoting transmission lines or structures as per requirements of Directorate of Flight Safety or relevant IS or ICAO shall be provided.

3.4.5 Tower Accessories, Hardware & Fittings: Tower accessories and Conductor / earthwire, Hardware & fittings shall be as per IS 5613-(Part-III / Section-I) and any other International Standard applicable to OPGW.

3.5 CONDUCTOR FORMATION AND DESIGN & FABRICATION OF TOWERS

a) Conductor & Earthwire Formation: Bundled phase conductors of each circuit shall be vertical formation and the two earth wires in horizontal formation.

b) Design, Fabrication, Galvanizing, Testing & Dispatch of Towers: Towers shall be designed generally as per IS: 802 - Code of Practice for Transmission Line Towers, which follows the ultimate load concept except as specified below:

i) Suspension Towers shall be designed with 75% wind load under security loading condition (Broken wire case) .

ii) Tension Towers shall be designed with 100% wind load condition under security loading condition (Broken wore case).

3.5.1 Design Criteria: The following design factors shall apply:

i) If steel with minimum guaranteed yield strength is used for fabrication of tower, loads given in IS: 802 (part-1)-section-2 shall be increased by 1.02.

ii) If steel with less than minimum guaranteed yield strength is used, loads given in IS: 802 (part-1 section-2) shall be increased by a factor 1.05 in addition to that mentioned above.

3.5.1.1 Classification of Design Loads: Classification of loads for design of the towers as per IS: 802, part-1 / section-1-1995 shall be as follows:

i) Reliability Requirements - Reliability level-2 for 400 kV Towers corresponding to 150 years return period wind loads as per relevant IS shall be considered;

ii) Security Requirements - Ability of a transmission system to be protected from any major collapse such as cascading effect shall be considered;

iii) Safety Requirements - Protection and safety of workers so as to avoid accidents / injury during construction and Maintenance shall also be considered.

3.5.1.2 General Description of Type and Classification of Towers: The towers required for the project shall be Double-Circuit, self-supporting, lattice steel structures with bolted joints, designed to carry line conductors with necessary insulators, earth wire, fittings and fixtures under all loading conditions and classified as per Types indicated in table below:

Type of Tower	Deviation Limit	Typical Use As
DA	0-2 deg.	Suspension Tower
DB	0-15 deg. 0 deg.	1. Angle tower with tension insulator strings 2. With uplift forces under broken wire conditions 3. Under Anti Cascading Conditions Section Tower
DC	15-30 deg. 0 deg.	1. Angle tower with tension insulator strings 2. With uplift forces under broken wire conditions 3. Under Anti Cascading Conditions Transposition Tower with modifications
DD	30-60 deg. 0 deg.	1. Angle tower with tension insulator strings 2. With uplift forces under broken wire conditions 3. Dead end with 0–15 deg. deviation on S /Station side Complete Dead end
Special Location		As required as per site conditions
Extensions		3M, 6M, 9M, 12M, 15M, 18M & 25M extensions as required

3.5.1.3 Thickness of Members: The minimum thickness of angle sections used in the design of towers, unless otherwise specified elsewhere in this specification, shall not be less than the following:

i) Main corner leg members including the ground wire peak: 5 mm
ii) For all other members : 4 mm

3.5.1.4 Slenderness Ratio: Maximum limit of the slenderness ratio (Kl / r) for members computed in accordance with clause-6 of IS: 802 (Part-1/Sec-2) 1992 shall not exceed value specified here under:

a)	For main corner leg members including the corner members of earth wire peak and the lower horizontal members of the cross-arms in compression	120
b)	For other members carrying computed stresses	200
c)	For redundant members and those members carrying nominal stresses	250
d)	For members having tensile stress only	400

3.5.1.5 Erection Stresses: Where erection stresses combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified permissible working stress, such other provisions are to be made as may be necessary to bring the working stress within the specified permissible limit.

3.5.2 Fabrication, Galvanization, Testing, and Dispatch of Towers: Fabrication of all type of towers and tower materials shall be done in conformity with IS: 802 (Part-II) 1992 & CBIP publication No.-268 or relevant international standards.

3.5.2.1 Fabrication: All similar parts shall be made strictly inter-changeable.

i) Tower Members: Standard Structural Steel Angle Sections & Plates of tested quality as per IS: 2062 or any other equivalent international standards shall be used in fabrication of stubs, towers, extensions, stub setting templates etc.

ii) Grades of Steel: Not more than two (2) grades of steel shall be used.

iii) Max. Length of Members: No individual member shall be longer than 6000 mm.

iv) Fasteners: Full threaded hexagonal, chamfered, galvanized MS bolts & nuts of 16mm / 20 mm dia. conforming to IS: 6639-1972, IS: 1363-1967 / 1984 & IS: 12427-1988 of property class 5.6 as specified in IS: 1367 (part-III) 1979 and matching nuts of property class as specified in IS: 1367 (part-VI) 1980 shall be used. The high tensile steel bolts and nuts conforming to IS: 8500-1992 of property class 8.8 of IS: 3757:1985 and IS: 6623:1985 respectively could also be used; but all bolts & nuts of material similar to the material of the concerned tower member shall only be used.

v) Bolt Spacing: Minimum bolt spacing and rolled edge distance and sheared edge distance from the centers of the bolt holes shall be maintained as per IS: 802. Shearing stress and bearing stress for bolts shall be calculated as per clause 5.4 of IS: 802 Part-1/Sec-2 1992.

vi) Step Bolts & Ladders: Each tower shall be provided with step bolts capable of withstanding a vertical load not less than 1.5 KN and secured with two (2) nuts confirming to IS: 10238 of not less than 16 mm diameter and 175 mm long, spaced not more than 450 mm apart and extending from about 3.5 meters above the ground level to top of tower. The step bolts may be provided in only one of the main legs on in line towers and on two diagonally opposite legs in Section / Angle towers.

vii) Identification Mark: Each individual member shall have an erection mark conforming to the component number given to it in the fabrication drawings. The identification mark shall be made with marking dies of 16 mm size before galvanizing and shall be legible after galvanizing. The coding of identification mark shall be as follows:

A-BB-CC-DDD-H; where:

A = Authority's code assigned to the Concessionaire-Alphabet
BB = Concessionaire's Mark-Numerical
CC = Tower type-Alphabet
DDD = Number mark to be assigned by Concessionaire -Numerical.
H = Mark for HT steel members

3.5.2.2 Galvanization: Fully galvanized towers and stubs shall only be used for the lines. The galvanizing shall be done as specified in Part-1 of this specification after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanizing. Galvanizing of towers member shall conform to IS: 2629-1985 and IS: 4759-1968 and tests as per IS: 2633-1986. For fasteners the galvanizing shall conform to IS: 1367 (Part-13). Spring washers shall be electro-galvanized as per grade-4 of IS: 1573-1970.

3.5.2.3 Proto-Testing and Supply of Towers: One Galvanized standard tower of each type (DA, DB, DC and DD) with 6 meter extension shall be subjected to proto testing up to destruction as per IS:802 (Part III) in CPRI or another approved test bed. The Concessionaire may at his discretion also get towers with any extension over 6 meter tested similarly or alternatively prove their design through supporting calculations. Prefix 'T' shall be marked on all members of all test towers.

i) Test Loads: The tower shall be tested by first applying test loads for all the selected conditions considered for the design of tower. The tower shall withstand these tests without showing any sign of failure or permanent distortion in any part.

ii) Destruction Test: Thereafter the tower shall be subjected to destruction by increasing the loads further in an approved manner till it fails. In case of any premature failure even during waiting period, the tower is to be retested with rectified members. However, if the failures are major in nature and considerable portion of tower is to be re-erected, in such cases all the tests carried out earlier shall be re-conducted again.

iii) Disposal of Tower after Proto Test: No part of a tested tower shall be used on the line.

3.5.2.4 Supply as per Prototype: The Concessionaire shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the type & proto tests.

3.6 SURVEY & INVESTIGATION

Notwithstanding route alignment survey and other field investigations carried out earlier by the Authority, the Concessionaire shall conduct detailed survey and field investigation to gather, first hand, all data necessary to design, construct, operate and run the lines.

3.6.1 Survey of Line Route Alignments: Detailed survey shall be carried out by using GPS, Total Station Survey, long range scanners & Digital theodolites of reasonable accuracies. Wherever the route alignment has been carried out using satellite imageries of NRSA (PLAN & LISS-III merged product) and Survey of India topographical maps (scale 1:50,000), any changes; necessitated during execution stage in the route alignment, including the following activities shall be carried out by the Concessionaire using satellite imageries / topographical maps:

I) Digitized profiling along the selected route along with plan details;

II) Check survey including digitized contouring at undulated tower locations;

3.6.2 Soil, Geological and other Field Investigation: Concessionaire shall carry out complete soil and terrain Investigation to gather data necessary for design, construction and maintenance of the lines; such as, soil resistivity, bearing capacity, bore log data etc. along the routes of the lines.

3.7 LINE PLAN AND PROFILE

The line route plan with en-route details and level profile shall be plotted from the field book entries and prepared to a scale of 1:2000 horizontal & 1:200 vertical by using appropriate software or manually as per approved procedure.

3.8 CROSSINGS

All crossings of power lines - road crossings, railway crossings, river crossings, power line to power line and power line to tele-communication lines etc. - shall be done to satisfy requirements of Indian Electricity Rules – 1956, Applicable Codes, Standards, Specifications, the requirements of concerned authorities owning the en-route utility in respect of safety of its users and security of the Transmission System as per good industry practice. Necessary clearances, maximum permissible spans and requirements of mechanical and electrical parameters shall be observed in respect of all

3.9 CHECK SURVEY AND TOWER LOCATION

Check survey shall be conducted to locate and peg mark tower positions on ground conforming to the approved profile and tower schedule. Changes, if necessitated by site conditions, shall be carried out with the concurrence of the Independent Engineer and in line with statutory approvals.

3.10 TOWER EARTHING

All towers shall be effectively earthed. The footing resistance of all towers shall be measured by the Concessionaire in dry weather after completing tower erection; but before stringing of earth wire. Tower footing resistance shall not exceed 10 ohms.

3.11 TELE-COMMINICATION & TELE- PROTECTION

For the purpose of providing tele-communication and tele-protection (as dictated by the other end matching & marriage and on systems 400 kV) a composite 24 core Optical Fiber Ground Wire (OPGW) system with accessories shall be provided which shall include:

i) The OPGW / Optical Fiber Approach Cable (OFAC) system in totality;
ii) Fiber Optic Composite Ground Wire (OPGW) along with associated accessories & hardware;
iii) Shield wire jointing boxes suitable for splicing of OPGW– OPGW earth wires;
iv) Terminal jointing boxes suitable for splicing of OPGW earth wires and OFAC;
v) OFAC along with associated hardware suitable for direct burial;
vi) Distribution rack / termination box including pigtail cords etc. for connecting OFAC to the Optical Line Terminal Equipment (OLTE)

Co-ordination with the optical line terminal equipment, testing and commissioning of the composite fiber-optic communication & protection system comprising of OPGW / OFAC and line terminal and regenerator equipment shall be achieved.

3.12 TOWER FOUNDATIONS

Design of foundations shall be done by limit state method with minimum overload factor as 1.1. Minimum factor of safety for design of pile or well type foundations shall be 2.5. The Concessionaire shall, for safety assurance, get the designs counter checked and certified from a professional institute or an expert other than the one who has designed the same.

SECTION - 4:

CIVIL WORKS SPECIFICATION

SECTION - 4: CIVIL WORKS SPECIFICATION

4.1 GENERAL

All structures, buildings, foundations etc., layout & other details shall be designed and developed by the Concessionaire keeping in view the functional requirement of the line and sub-station facilities to meet the major technical parameters given in Part-1 of this specification and project parameters given in the following clauses:

4.2 LICENSED PREMISES (SUBSTATIONS SITES)

4.2.1 Formation Levels: Formation Level (FL) of substations shall be fixed minimum 600 mm higher than the surroundings on the basis of the drainage conditions and the Highest Flood Level in the area.

4.2.2 Site Preparation: Concessionaire shall carry out necessary earth cutting / filling (spreading), leveling, compaction and dressing to reach the desired formation level. Backfilled earth shall be free from harmful salts; viz, Sulphates, Chlorides and / or any Organic / Inorganic materials and compacted to minimum 95% of the Standard Proctor's Density (SPD) at Optimum Moisture Content (OMC). The sub-grade for the roads and embankment filling shall be compacted to minimum 97% of the SPD at OMC.

4.2.3 Site Surfacing in Switchyard Area: Concessionaire shall carry out site surfacing to provide a safe & hazard free high earth resistivity working area (switchyard) and to prevent growth of weeds & grass within the working area. The site surfacing will be restricted up to 2.0 m beyond the last structure / equipment foundation. A 100 mm thick base layer of lean concrete of 1:4:8 using coarse aggregate of 20 mm nominal size shall be provided in the areas with covering with M-20 concrete layer with minimum thickness of 50mm in the switchyard excluding roads, drains, cable trenches etc. 30-40 mm Stone / Gravel spreading shall be done in areas presently in the scope of the scheme. No stone spreading shall for the time being done in the areas (bays) kept for future expansion. To hold the stone (gravel) from spreading out of the surfaced / gravel filled area, a 115 mm thick and 300 mm deep toe wall 25 mm above top of gravel shall be provided. All visible portions of toe-wall shall be plastered & cement painted.

4.2.4 Outside Switchyard Area: Areas lying outside the switch yard shall be landscaped, developed and maintained in a clean and presentable fashion.

4.3 WATER SUPPLY, SEWERAGE & DRAINAGE SYSTEM

4.3.1 Water Supply & Sewerage: Concessionaire shall design water supply & sewerage system to meet the total water requirement of the substations, facilities and emergency reserve for complete performance of the works. The design and construction of septic tanks and soak pits shall be suitable for a minimum 100 users with a minimum 10 year span.

4.3.2 Design of Drainage: The concessionaire shall obtain rainfall data and design the storm water drainage system including culverts, drains etc. to accommodate the most intense rainfall that is likely to occur over the catchments area in one hour period on an average of once per ten years.

4.3.2.1 Slope of Drainage System: Invert level of drainage system at outfall point shall be decided in such a way that any water over flow from water harvesting recharge shafts can easily be discharged outside the substation boundary wall. For easy drainage of water, minimum slope of 1:1000 shall be provided from the ridge to the nearest drain. The above slope shall be provided at the top of base layer of cement concrete. The following minimum slopes & design parameters for drains shall be met:

i) Switchyard shall be sloped to prevent pounding of water and no area left un-drained;
ii) Pipe drains shall be constructed on both sides of roads and open trapezoidal drains along switchyard and as per requirement in other areas;
iii) Maximum spacing between two drains shall be less than 100 meter within the switchyard;
iv) Open trapezoidal drains shall have 300 mm bottom width and sides slope of 1:1.5;
v) Design of lined drain shall be as per IS: 10430 and cast-in-situ cement lining as per IS: 3873;
vi) Longitudinal slope shall range from 1:1000 to 1:2000 depending upon expected discharge;
vii) Side wall(s) of the drains shall be 25mm above the gravel level & covered with CI grating;
viii) RCC pipe of class NP-3 as per IS: 783 shall be used in normal pipe drains;
ix) RCC pipe of class NP-4 shall be used in culverts where heavy vehicle movement is expected;
x) Pipe drains shall be connected through manholes within intervals of maximum 30m;
xi) Two portable pumps of adequate discharge capacity shall be provided for drainage of water;
xii) In case the invert level of outfall point is above the last drain point, a sump pit of suitable capacity to hold water of at least 5 minutes discharge shall be constructed at a suitable point.

4.4 RAINWATER HARVESTING

The concessionaire shall make arrangement for rainwater harvesting in case the depth of water table is more than 8.0 m from finished ground level as per general guidelines given below:

4.4.1 Rainwater harvesting shall be done by providing two numbers recharge structures with bore wells suitably located within the sub-station with a suitable arrangement to connect the overflow from these structures with sump-pit.

4.4.2 The internal diameter of recharge shafts shall be minimum 4.5 m with 230 mm thick lining of brick work up to a depth of 2.0 meter from ground level and 345 mm thick brickwork to a depth below 2.0 m. The overall depth of shaft shall be 5.0 meter below invert level of drain. A 300 mm diameter bore well at least 5.0 m deeper than sub soil water table shall be drilled in the centre of the shaft. GI rungs of 20 mm diameter grouted at spacing of 300 mm shall be provided in the wall of shaft below the opening in the RCC slab to facilitate entry & cleaning of shaft. The shaft shall be covered with RCC slab for a live load of 300 kg per sq m. Two openings of size 0.7 x 0.7 meter shall be provided in the RCC cover slab. A CI cover made of 5 mm thick plate with lifting hooks shall be provided over the openings.

4.4.3 A 100 mm diameter medium duty GI pipe conforming to IS: 1161 shall be lowered in the bore well keeping bail plug towards bottom of bore well. The pipe shall have 1.58 mm holes for 4.0 meter length starting from 1.0 meter from bottom of bore well. Holes of 3.0 mm diameter shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and down wards. The overall length of pipe shall be equal to total depth of bore well plus depth of shaft.

4.4.4 Gravel of size 3mm to 6mm shall be filled around 100 diameter GI pipe in the bore well. The shaft shall be filled with 500mm thick layers each from the bottom of shaft with boulders of seize 50 mm to 150 mm, gravel of size 5 mm to 10 mm coarse sand having particle size 1.5 mm to 2.0 mm and boulders of size not less than 200 mm respectively.

4.5 ROADS, CULVERTS & PCC PAVEMENT / PARKING

All internal roads, culverts and PCC pavements / parking within the sub-station area and approach road from main PWD road to the sub-station main entry gate(s) shall be constructed as per Haryana PWD specifications and as per layout in the GELO / CLO of the sub-stations covered under the Project.

Finished top (crest) level of roads shall match with the levels fixed by the concessionaire for this purpose. All external / internal substation roads shall be constructed to permit transportation of heaviest of the substation equipment that can ever roll over the concerned road. The main road leading to control room / switch yard / colony shall have a minimum 6 m width with shoulder on either side.

4.5.1 Shoulders, Footpaths, & Side-walks: The shoulders / footpath / side-walk shall be provided with C.C. (M-15) pre-cast kerbs on either side of the road. The top edge of the kerbs shall be battered. The kerb stones with top 20 cm wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm from the road edge to allow for the drainage channel and shall project about 12.5 cm above the latter. Top of the shoulders / footpath / side-walk shall be provided with 20 mm thick precast checkered tiles made in ordinary grey cement without chips laid on bed of 100 mm coarse sand, PCC 1:8:16 (100mm thick) and 20mm thick bed of cement coarse sand mortar 1:3 with neat cement slurry between joints as per PWD specifications.

4.5.2 Road Drainage: Adequate provision shall be made for road drainage. The channel stones with top 30 cm wide shall be laid in position in camber with finished road surface and with sufficient slope towards the road gully chamber. The necessary drainage openings of specified sizes shall be made through the kerb as required for connecting to storm water drains. The rate of camber on a cement concrete surfacing shall be 1 in 72 unless otherwise provided.

4.5.3 Base Sub-Grade & Soling: Sub grade shall be compacted to achieve the density in accordance with IS: 2720 (Part-28). The base course shall be extended on either side to at least 15 cm (for switch yard roads) beyond the edge of the concrete pavement. The coarse aggregate used shall be crushed or broken stone or any naturally occurring aggregates; such as, kankar, laterites of standard quality conforming to the physical requirements as given below:

Maximum Los Angeles Abrasion value	50% (IS: 2386 (Part-IV))
Maximum Aggregate Impact Value	40% (IS: 2386 (Part-IV) or IS: 5640)
Maximum Flakiness Index	10% (IS: 2386 (Part-I)

4.5.4 Surfacing: The concrete to be placed shall conform to M-20 grade design mix using the approved materials & methods as per IS: 10262. For small works, nominal mix of 1:1½:3 may be used. The concrete shall be distributed to such depth that when consolidated and finished, the slab thickness obtained is as per site requirement; but not less than 50 mm and equal at all points.

4.5.5 Paving/ Parking: Cement concrete paving / parking shall be provided as per layout.

4.6 TRANSFORMER FOUNDATIONS

4.6.1 General Scope: The concessionaire shall design & construct RCC foundations & plinths having minimum Grade M-20 laid on base concrete (1:4:8) of minimum thickness 100 mm along with a pylon support system for supporting the fire fighting system for placing 315 MVA, 100MVA and 6.3 MVA Power Transformers compatible with the type of equipment & fire fighting systems and manufacturers' drawings and equipment parameters.

The foundations of transformers and circuit breakers shall be of block type. Minimum reinforcement shall be governed by IS: 2974 and IS: 456 suitable for equipment load requirements of transformer including impact load equivalent to 15% of total transformer load with oil etc. or total Jacking Load whichever is more. An RCC Rail cum Road system shall be provided duly integrated with the transformer foundation to enable installation of a new unit and the replacement of any failed unit. The rails shall be fresh, first

quality 52-kg / meter medium manganese steel as per Indian railway specification T-12-64 and laid to maintain the required rail gauge.

The plinth shall extend up to edge of road for perfect movement from trailer to plinth and vice-versa. Suitable arrangement for shifting the transformer from trailer like jacking etc. wherever required shall be made in plinth and in front of plinth on the road. If trench / drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with I.R.C. standard / relevant IS. The top of plinth i.e. top of rail level shall match with height of tractor-trailer used for transporting the transformer (minimum 750-mm from top of road). The space between the tract rails of the transformer plinth if any, shall be suitably filled with compacted sand and 50-mm thick PCC 1:2:4 laid on 75-mm thick base concrete (1:5:10) placed over compacted earth filling. The top of PCC shall be minimum 300-mm above the formation level of switchyard. Adequate drainage outlets shall be provided and necessary slopes given to drain off rain water/oil.

Suitable foundations shall be provided for all auxiliary equipment of the transformer like radiators, fan supports etc. as required and the transformer plinth foundation shall match the equipment drawings. If trench / drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with IRC standards / relevant IS.

4.6.2 Emergency Oil Evacuation System: Design & construction of Emergency Oil Evacuation System shall be suitable to the type of fire protection & emergency oil drainage system selected.

4.7 FIRE PROTECTION WALLS

4.7.1 General Scope: Fire protection walls in order to protect against the effects of radiant heat and flying debris from an adjacent fire for 315 MVA Transformers and 100 MVA Transformers shall be designed & provided in accordance with Tariff Advisory Committee (TAC) stipulations. The partitions meant to reduce the noise level of the transformers, shall have the same fire resistance if the partitions are also used as fire walls. A minimum of 2 meters clearance shall be provided between the equipments and fire walls. The building walls which act as fire walls shall extend at least 1 m above the roof in order to protect it.

4.8 CABLE & PIPE TRENCHES

4.8.1 General Scope: The layout & size of cable & pipe trenches shall be detailed in the GELO. The top of trenches shall be kept at least 25 mm above the gravel level so that rain water does not enter the trench. Trench walls shall not foul with the foundations and shall be designed for the following loads:

i) Dead load of 155 kg/m length of cable support +75 kg on one tier at outer edge of tier; and
ii) Earth pressure + uniform surcharge pressure of 2T / M^2.

Trenches shall be constructed in reinforced cement concrete of M-20 grade. Galvanized angle iron 50 x 50 x 6 mm welded with galvanized iron flat 50 x 6 mm – 75 mm long @1 meter c/c to hold the angle on top of the trench walls shall be provided for protection of the edges. All metal parts inside the trench shall be connected to the earthing system.

4.8.2 Outdoor Cable Trenches: RCC cable trenches shall be constructed in the switchyard and fibre glass/pre-cast RCC removable covers with lifting arrangement, edge protected with suitable galvanized angle iron designed to withstand self weight of top slab + concentrated load of 150 kg at center of span on each panel.

4.8.3 Indoor Cable Trenches: RCC indoor cable trenches shall be provided with 50X50X6 mm GI angles grouted on the top edge of the trench wall for holding minimum 7 mm thick mild steel checkered plate covers (600 mm in length except at ends & bends) with lifting arrangement. ISMC GI channels of 75x40 mm shall also be grouted at distances of 600 mm across the indoor cable trenches to support the checkered plates.

4.8.4 Trench Drainage: The trench bed shall have a slope of 1/500 along the run & 1/250 perpendicular to the run. In case straight length exceeds 30 m, suitable expansion joint shall be provided at appropriate distances. The expansion joint shall run through vertical wall and base of trench. All expansion joints shall be provided with approved quality PVC water stops of approx. 230x5 mm size. Man holes shall be provided at interval of not more than 30 meters.

Sumps, as necessary, shall be provided at suitable places and at the dead end of all trenches. Sumps shall be provided with drainage pumps of adequate discharge capacity with all accessories for pumping out water collected in the cable trenches. Cable trenches shall not be used as storm water drains.

4.8.5 Trench - Road Crossings: Suitable box culvert (Single span or multi spans) shall be provided for any road crossing. The box culvert shall extend 1.5 m on each side of road and shall have 230-mm wide, 500 mm high brick parapet wall at ends. If required, the bed of trench on both sides of culvert shall have to be lowered in slope, in 1.5 m length to meet the bed of culvert.

4.9 FOUNDATIONS FOR RCC COSTRUCTION WORKS

4.9.1 General: All the foundations except walls of switch house cum administrative and fire hydrant building shall be of Reinforced Cement Concrete. All properties of concrete regarding its strength under compression, tension, shear, punching and bond strength etc. as well as workmanship shall conform to IS: 456.

4.9.2 Design Standards & Procedure: The design and construction of foundations and other RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20 and M-25 for water retaining structures. Limit state method of design shall be adopted unless specified otherwise in the specification/IS Codes. For design and construction of steel-concrete composite beams ARE: 11384 shall be followed and for detailing of reinforcement, IS: 2502 and SP: 34 shall be followed. Two layers of reinforcement – one each on inner and outer side of wall and slabs having thickness of 150 mm and above shall be provided. The tower and equipment foundations shall be checked for a factor of safety of 2.2 for normal condition and 1.65 for short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor over loads in limit state design also. Foundations shall be proportioned so that the estimated total and differential movements of the foundations are lesser than the movements that the structure or equipment is designed to accommodate.

4.9.3 Sliding & Overturning Stability: All sub-structures shall be checked for sliding and overturning stability both during construction and operating conditions for various combinations of loads. Factor of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the specifications. For checking against overturning, the weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation shall also be considered, provided the site conditions such as presence of trench, drain etc, and render use of the same inappropriate.

4.9.4 Depth of Foundations: In case of overlapping of foundations in switchyard area, deeper foundation shall be constructed first. For the foundations resting on filled up soil, the fill material under

foundation / trenches shall be such that the maximum pressure from the footing transferred through fill material will not exceed the allowable soil bearing pressure of original undistributed soil. In case earth filling is involved due to high fixation of formation level, All foundations shall rest below virgin ground level and the minimum depth excluding lean concrete of all foundations below virgin ground level shall not be less than 500 mm.

4.9.5 Height of Foundations: The Switch Yard foundations shall be at least 100 mm above the finished ground level or as per the manufacturers' design. Excavation shall extend minimum 150 mm around foundation (from RCC portion and not from lean concrete). If the site is on a gradient / slope, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

4.9.6 Plinth Levels: The plinth level of the Control Room-cum-Administrative building shall be minimum 500 mm above the finished ground level. The plinth level of buildings shall be decided by the Concessionaire keeping in view the surroundings.

4.9.7 Pile Foundations: If pile foundations are adopted, the same shall be cast in-situ / driven / bored or pre-cast or under reamed as per relevant IS code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Necessary initial load test shall also be carried out to establish the piles design capacity. The spread or pile foundation may be required based on soil/sub-soil conditions and superimposed loads.

4.9.8 Reinforcement steel: Reinforcement steel (including TMT Bars) of the designed grade and manufactured by primary steel producers and conforming to IS: 1786 shall only be used.

4.9.9 Foundation Bolts: All the foundation bolts used for equipment foundations & for main gantry tower foundations shall be galvanized. The foundation bolts shall be embedded in concrete during concreting and no grout holes shall be left for this purpose.

4.9.10 Water Tanks: Minimum grade of concrete shall be M-25 for any water retaining structure or any member submerged in water. The RCC storage tank shall be designed for minimum O.65 million liter water storage capacities preferably in two compartments. The capacity shall, however, be increased depending on the detailed design and provisions of NBC, TAC or other relevant code. Water Tanks shall be constructed over head/ underground as per need of water supply and fire-fighting system adopted.

4.10 BUILDINGS

4.10.1 Design Criterion: The buildings shall be designed to withstand the earth quake pressure as per the requirements of the National Building Code of India.

4.10.2 Design Loads: Building structures shall be designed for the most critical combinations of dead loads, superimposed loads, equipment loads, crane loads, wind loads, seismic loads, short circuit loads and temperature loads. In addition, loads and forces developed due to differential settlement shall also be considered.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS: 1991. Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.

For crane loads an impact factor of 30% and lateral crane survey of 10% of (lifted weight + trolley weight) shall be considered in the analysis of frame according to provisions of IS: 875. The horizontal surge shall be 5% of the static wheel load. The wind loads and seismic forces shall be computed. Response spectrum method shall be used for the seismic analysis using at least first five modes of vibration. Wind and Seismic force shall not be considered to act simultaneously.

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for the purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Floors / slabs shall be designed to carry loads imposed by equipment, cables, piping, travel of maintenance trucks and equipment and other loads associated with the building. In general, floors shall be designed for live loads as per relevant IS and cable and piping loads of no less than 5kN / sq.m hanging from the underside.

For consideration of loads on structures, IS: 875, “Code of practice for structural safety of buildings” shall be followed. The following minimum superimposed live loads shall, however, be considered for the design:

i) Roof 150kg / m^2 for accessible roofs 75kg / m^2 for non-accessible roofs.
ii) RCC floors 500 kg / m^2 for offices and minimum 1000 kg/m^2 for equipment floors or actual, if higher than 1000 kg / m^2 based on equipment component weight and layout plans.
iii) Toilet Rooms 200 kg / m^2
iv) Walkways 300 kg / m^2

4.10.3 DG Building Cum Fire Fighting Pump House and RCC Water Storage Tank:

i) The DG and FF buildings designed to accommodate up to [two (2)] DG sets, motors / pumps as per fire fighting requirement and a permanent crane, hoist and service trucks mounted on suitable steel structure (I-section / RS joist) below the ceiling for servicing, lifting and maintenance of the heavy equipment shall be constructed adjacent to each other for convenience of maintenance of equipment.

ii) Arrangement shall be made to drain the spill oil from oil diesel operated equipment along the periphery for collection. Piping shall be provided for conveying oil from the storage tank (common for all diesel / engines) to individual fuel tank of engine. All the external features of the DG cum FF building shall be similar to CR building.

4.10.4 Storm Water Drainage for Buildings: The building drains shall be provided for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station. Cast iron / PVC rain water down comers (minimum 100mm diameter) with water tight joints shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work or cement concrete or cladding material. The number and size of down comers shall be governed by IS: 1742 and IS: 2527. All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be provided in place of steel grating. For all buildings, suitable arrangement for draining out water collected from equipment blow down, leakage, floor washings and fire fighting etc. shall be provided for each floor.

4.10.5 Brick Work: All brickwork shall strictly be done according to the Haryana P.W.D. specifications.

4.10.6 Damp Proof Course: On outer walls horizontal DPC shall be provided at level with plinth protection and on inner face vertical DPC 20 mm thick shall be provided. On all inner walls horizontal DPC shall be provided at floor/plinth level. Horizontal DPC shall consist of cement concrete (1:1.5:3) 50 mm thick. Edge of DPC shall be straight, even and vertical. It shall be cured for at least 7 days, after which it shall be allowed to dry. Vertical DPC shall consist of two layers of plaster (1:3) with total thickness of 20 mm. Hot bitumen shall be applied over dried up surface using bitumen of penetration 85/25 @ 1.7 Kg per Sq.m. in two coats. In earth quake resistant structures DPC may be substitute by 230mm x230mm thick M-20 RCC plinth beams,

4.10.7 Painting and Finishing: All paints & allied materials shall be of superior quality, conform to the relevant Indian Standards and of approved brands and shades.

4.11 FLOORING

The flooring of Control Room-cum-Administrative building except conference room, control room, reception hall & reception stairs shall be made of Kota stone. Pre-polished granite stone slabs, 19 mm thick (3/4") flooring shall be provided in reception hall, stairs of reception hall, control room and conference rooms. Anti-skid tiles 300 x 300 x 7.7 mm flooring in toilets and pantry. Anti skid floor tiles of reputed makes having minimum 300 x 300 mm nominal size and 7.7 mm thick preferably in Beige colour shall be provided in the toilets. In toilets, the skirting / dado shall be of tiles of 6.7mm thick 200x200 mm size and should go up to 2 m (6'-9") high from floor level. The tiles shall conform to relevant IS codes. The tiles & the colour scheme and style should match with the flooring.

Heavy duty ironite concrete floor hardener shall be provided in DG Building cum Fire Fighting Pump House. The cement ironite shall consist of well mixed dry composition containing one part ironite to four parts cement by weight. Water shall be added after mixing the aggregate. Placing of ironite cement mix, tamping, floating and trowelling shall be done in accordance with manufacturer's recommendations. Care shall be taken not to over trowel until the initial set has taken place.

Entire area around the Control Room-Cum-Administrative building, DG- cum-fire fighting building, Security Hut and the Driver's room shall be provided with PCC paving up to 1 meter from the outer edge of the buildings.

4.12 DOORS / WINDOWS

Aluminium frames / doors / windows / ventilators (single & double leaf) consisting frame work including vertical styles, top rails, lock (middle) rails and bottom rails with metal fastener & screws shall be fitted with nuts & bolts or using plastic plugs & screws. The Aluminum section to be used shall be of minimum 3 mm, anodized (15 micron) of reputed makes conforming to IS: 1968-1983. The Aluminium doors & windows shall be fitted with minimum 5.5 mm thick glass of reputed make with high-class rubber gaskets & beading complete so to make the glass airtight. The toilet doors shall, however, be fitted with pre-laminated board panels of appropriate size with Aluminium beading to make it airtight. The door / floor springs, locks, handles, tower bolts, stoppers with rubber cushion, screws etc. shall be of 1st quality bearing ISI quality certification mark.

4.13 ROLLING SHUTTERS

GI Rolling shutters with suitable operating arrangement according to size & weight shall be provided in buildings to facilitate handling and transportation of equipment.

4.14 TOILET & PANTRY SANITARY FITTINGS

All the water closets, wash basins, squatting pans etc. shall be of vitreous China clay in white color, (first quality) as per IS: 2556. The water closet in officer's toilet shall be European type with single / double siphon and low-level cistern. The toilets & pantry shall be provided with the best Indian make 20 mm diameter, 600 mm long towel rails and other normal fixtures, firmly fixed in position with plastic plugs and CP brass screws. All fixtures / fittings shall be chromium plated of good durable quality. The pantry shall be provided with reputed make white vitreous chinaware sink of size 600 x 450 x 250 mm or more with complete fittings including 40 mm CP brass waste and PVC pipe chromium plated brass tap etc. A granite slab 20-25 mm thickness shall be provided in the pantry. All water supply pipes shall be GI Pipes (minimum medium quality) conforming IS: 1239 ISI marked. All drainage pipes shall be HCI pipes ISI marked and embedded in walls, having concrete covering 1:2:4 around the horizontal pipes from outlet to first inspection chamber / gully trap. From Inspection chamber onwards to soak pit or to existing sewerage system, as the case may be, SW / PVC Pipes shall be used.

4.15 ROOFING AND ROOF TILING

On top of RCC slab of building, terracing shall be done with tile brick paving. The top surface of RCC slab when thoroughly dry shall be painted uniformly with bitumen of penetration 85 / 25, hot cut back bitumen, the quantity of bitumen shall be 1.7 kg per sq. m of roof surface. Clean & dry, coarse sand shall be evenly sprayed and leveled over the surface after the bitumen is still hot. The layer of bitumen shall be covered with good soil with optimum moisture content on the roof to a requisite thickness and slope. It shall be well compacted and shall be given a coat of mud plaster 25 mm thick and allowed to dry. Flat tile bricks shall be laid true to a slope of 1 in 48 over the mud plaster using a minimum amount of plain mud mortar as bedding. The tiles shall be laid close to each other & the width of joints shall not be less than 6 mm and more than 12 mm. The joints of tiles shall be grouted with cement mortar of mix 1:3 after tiles are well set & bedding mortar has dried, such that all the joints of tiles are completely filled with mortar. The joints shall be finished neatly by providing flush pointing in 1:3 cement mortars (cement & sand). The surface shall be cured by keeping it wet for at least 7 days.

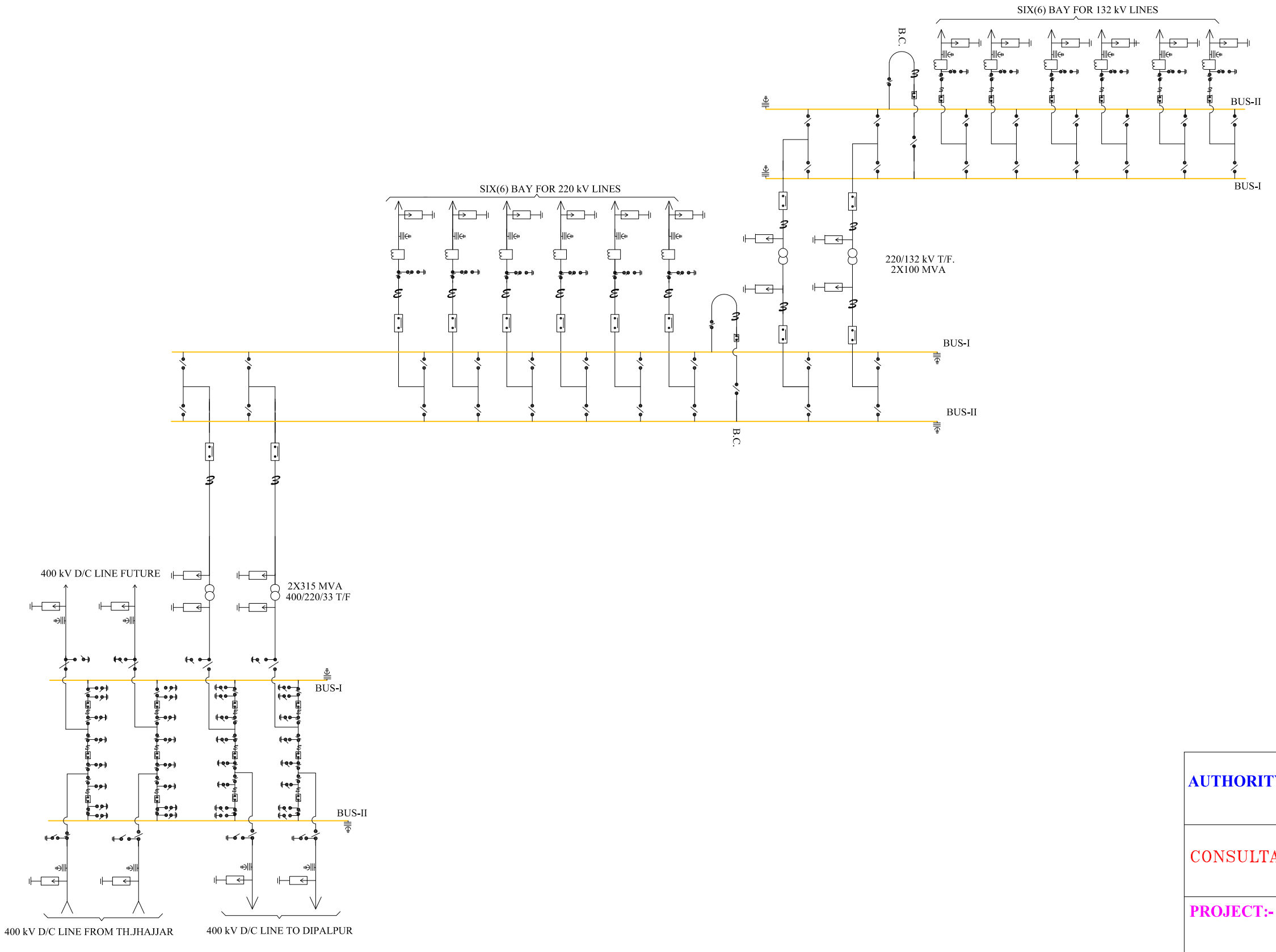
4.16 SWITCH - YARD FENCING AND GATES

Fencing & Gates shall be provided for Switchyard area as per General Electrical Layout Plan and any other specified area along the lines shown. Chain link fence fabric shall have size 75 mm; coated wire shall be of 3.15 mm diameter having zinc galvanizing after weaving. The barbed wire shall be of 12 SWG galvanized steel with its weight 155-186 gm/m length of wire. Maximum distance between two barbs shall be 75mm. The barbs shall carry four points and shall be formed by twisting two point wires, each two turn tightly round one line wire making altogether 4 complete turns. The barbs shall have a length of not less than 13 mm and not more than 18 mm. The points shall be sharp and well pointed and single strand galvanized steel wire conforming to requirements for fence fabric 4 mm diameter or single strand, high tensile, galvanized steel wire 4 mm diameter shall be used. Cast aluminum alloy or galvanized steel malleable iron D-Clamp drop forged with bolt, check nut, thimble and other clamps & material required shall be supplied and installed for stretching the Barbed wire complete in all respect.

4.17 BOUNDARY AND RETAINING WALLS

A Boundary wall shall be constructed all around the entire substation land. The front wall shall be 1.4 m high and in addition 0.600 m galvanized iron grill & the boundary wall on the other three sides shall be 1.8 m with 0.600 m U/C barbed wire fencing over the wall. All retaining walls and dual purpose boundary walls shall be designed to withstand sliding and over turning loads.

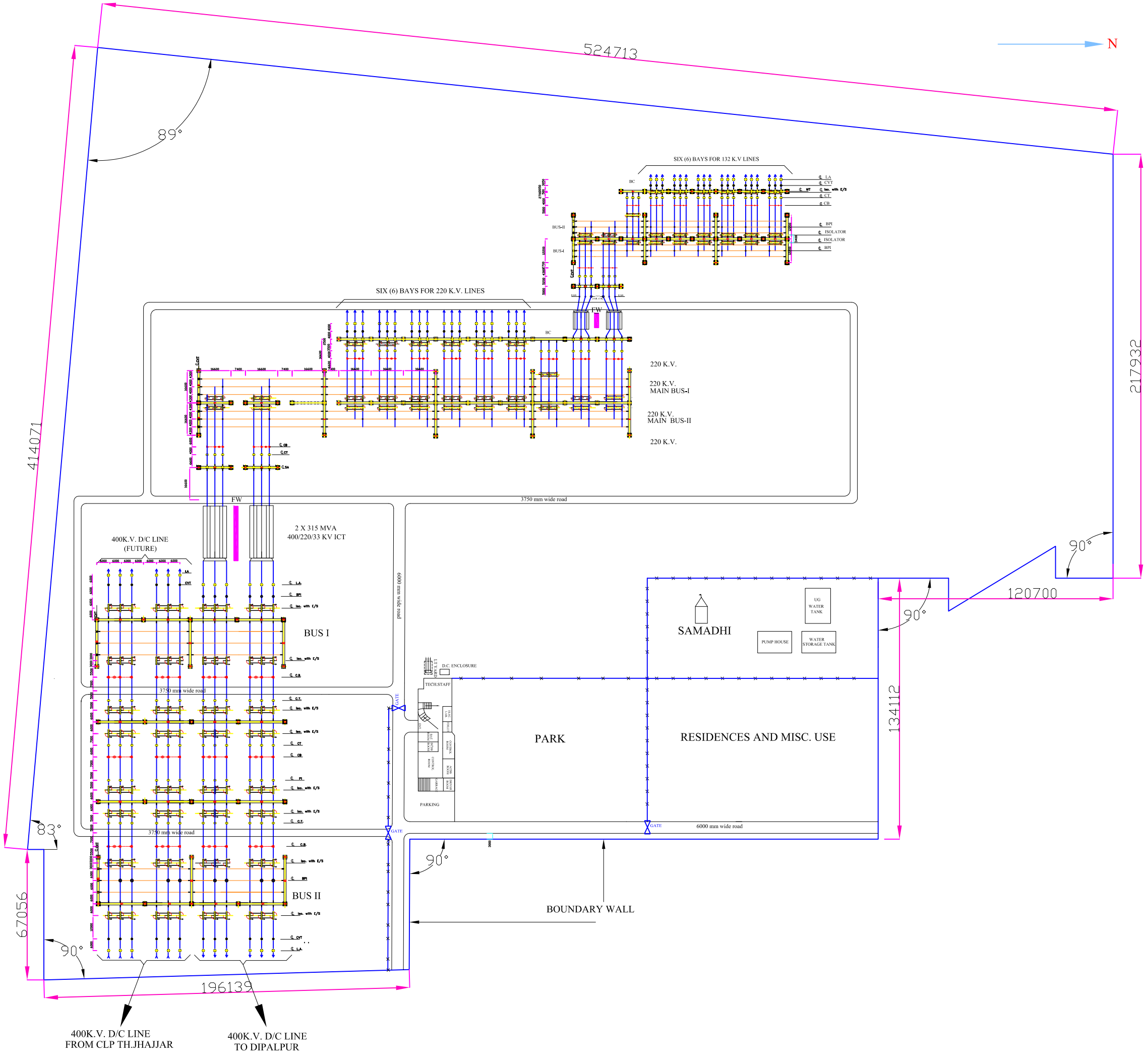
APPENDICES



SYMBOL

Sl.	SYM.	ITEMS–DESCRIPTION
1		Power Transformer
2		Circuit Breaker (CB)
3		Current Transformer (CT)
4		Captive Voltage Transformer (CVT)
5		Surge Arrestor (LA)
6		Isolator Double Break with one Earth Switch
7		Isolator Double Break with two Earth Switch
8		Isolator Double Break without Earth Switch
9		Wave Traps (WT)

AUTHORITY:-	HARYANA VIDYUT PARSARAN NIGAM LIMITED		
CONSULTANT:	SCOTT WILSON INDIA PVT.LTD. NEW DELHI		
PROJECT:-	400 KV HVPNL PPP–I TRANSMISSION PROJECTS FOR EVACUATION OF POWER FROM 2X660 MW TPP AT JHAJJAR		
TITLE:-	SINGAL LINE DIAGRAM FOR 400KV SUB–STATION KABULPUR (ROHTAK)		
DRG. NO:	SLD–1/KR	Date; 10.11.2009	N.T.S.



SYMBOLS

Sl.	SYM.	ITEMS–DESCRIPTION
1		Power Transformer (ICT / T/F)
2		Circuit Breaker (CB)
3		Current Transformer (CT)
4		Captive Voltage Transformer (CVT)
5		Surge Arrestor (SA)
6		Isolator Double Break with two Earth Switch
7		Isolator Double Break with one Earth Switch
8		Isolator Double Break without Earth Switch
9		Wave Trap (WT)
10		Fire Wall (FW)

NOTES:

1. EQUIPMENTS POSITION SHOWN IN THE LAYOUT ARE INDICATIVE ONLY. FINAL LOCATION WILL BE DECIDED ON FINAL FOUNDATION DRG. OF EQUIPMENTS.
2. PLINTH HEIGHT OF FOUNDATION WILL BE +300MM FROM THE FINISHED GROUND LEVEL. GRAVEL TOP LEVEL WILL BE +100MM FROM THE F.G.L.
3. UPPER FLOOR TO BE UTILIZED FOR ADM. BUILDING, SHIFT– IN CHARGE'S ROOM,CONFERENCE ROOM, ENGINEER'S ROOM AND LIBRARY CUM RECORD ROOM.

AUTHORITY:	HARYANA VIDYUT PARSARAN NIGAM LIMITED
CONSULTANT:	SCOTT WILSON INDIA PVT.LTD. NEW DELHI
PROJECT:	400 KV HVPNL PPP–I TRANSMISSION PROJECTS FOR EVACUATION OF POWER FROM 2X660 MW TPP AT JHAJJAR
TITLE:	GENERAL ELECTRICAL LAYOUT PLAN FOR 400KV SUB–STATION KABULPUR (ROHTAK)
DRG. NO: GELO–1/KR	Date; 10.11.2009 — N.T.S.

SYMBOL

Sl.	SYM.	ITEMS–DESCRIPTION
1		Power Transformer
2		Circuit Breaker (CB)
3		Current Transformer (CT)
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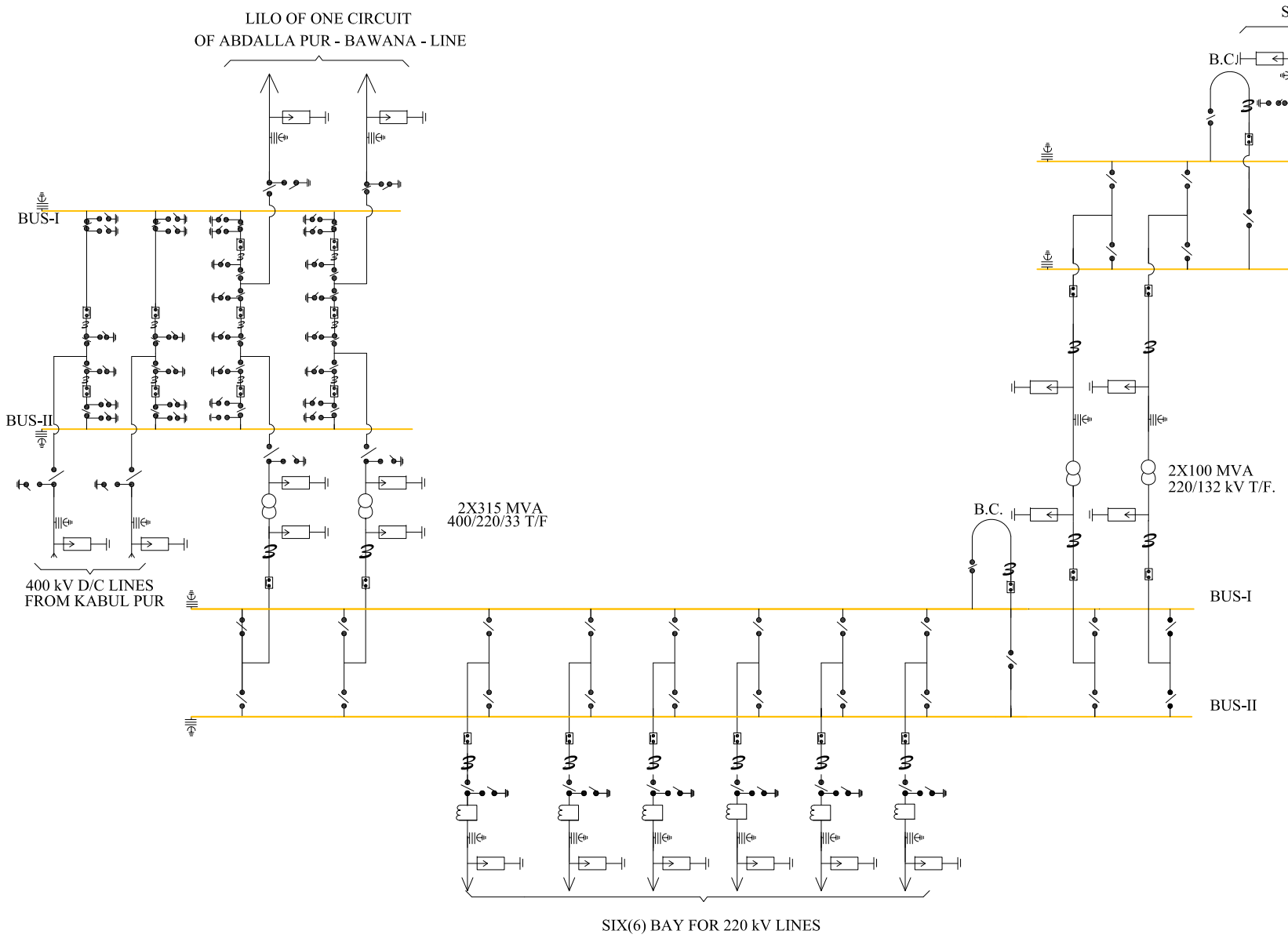

AUTHORITY:-	HARYANA VIDYUT PARSARAN NIGAM LIMITED		
CONSULTANT:	SCOTT WILSON INDIA PVT.LTD. NEW DELHI		
PROJECT:-	400 KV HVPNL PPP.II TRANSMISSION PROJECTS FOR EVACUATION OF POWER FROM 2X660 MW TPP AT JHAJJAR		
TITLE:-	SINGLE LINE DIAGRAM FOR 400KV SUB–STATION DIPALPUR (SONEPAT)		
DRG. NO:	SLD–1/DR	Date; 10.11.2009	N.T.S.

N

MATCH LINE - A

SYMBOLS

SL.	SYM.	ITEMS–DESCRIPTION
1		Power Transformer (ICT / T/F)
2		Circuit Breaker (CB)
3		Current Transformer (CT)
4		Captive Voltage Transformer (CVT)
5		Surge Arrestor (SA)
6		Isolator Double Break with two Earth Switch
7		Isolator Double Break with one Earth Switch
8		Isolator Double Break without Earth Switch
9		Wave Trap (WT)
10		Fire Wall (FW)

26176
43587
150°
175°
110374
145°
60350
268224
LILO OF ONE CIRCUIT
OF ABDULLA PUR - BAWANA - LINE
BOUNDARY WALL
60350
67056
241402
BUS I
BUS II
3750 mm wide road
MINIMUM 96 MTR.
400K.V. D/C LINE
FROM KABUL PUR
FW
2 X 315 MVA
400/220/33 KV ICT
SIX (6) BAYS FOR 132 KV LINES
SIX (6) BAYS FOR 220 KV LINES
BOUNDARY WALL
120701
110642
6000 mm wide road
WATER TANK
PUMP HOUSE
WATER STORAGE TANK
EV YARD
132 KV SWITCH YARD
GATE
PARKING
OFFICES & C/R
PARK
23470
RESIDENCES & MISC. USE
73914
281330
120701
50350
335432
MATCH LINE - A

NOTES:

1. EQUIPMENTS POSITION SHOWN IN THE LAYOUT ARE INDICATIVE ONLY. FINAL LOCATION WILL BE DECIDED ON FINAL FOUNDATION DRG. OF EQUIPMENTS.
2. PLINTH HEIGHT OF FOUNDATION WILL BE +300MM FROM THE FINISHED GROUND LEVEL. GRAVEL TOP LEVEL WILL BE +100MM FROM THE F.G.L.
3. UPPER FLOOR TO BE UTILIZED FOR ADM. BUILDING, SHIFT– IN CHARGE'S ROOM,CONFERENCE ROOM, ENGINEER'S ROOM AND LIBRARY CUM RECORD ROOM.

AUTHORITY:	HARYANA VIDYUT PARSARAN NIGAM LIMITED
CONSULTANT:	SCOTT WILSON INDIA PVT.LTD. NEW DELHI
PROJECT:	400 KV HVPNL PPP–I TRANSMISSION PROJECTS FOR EVACUATION OF POWER FROM 2X660 MW TPP AT JHAJJAR
TITLE:	GENERAL ELECTRICAL LAYOUT PLAN FOR 400KV SUB–STATION DIPALPUR (SONIPAT)
DRG. NO: GELO–1/DR	Date; 10.11.2009 N.T.S.