SPECIFIC TECHNICAL REQUIREMENTS FOR TRANSMISSION LINE

- A.1.0 The design, routing and construction of transmission lines shall be in accordance with Chapter V, Part A of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2010, as amended from time to time.
- A.2.0 Selection of tower type shall be made as per CEA Regulations, however in case lattice type towers are used, the following shall also be applicable:
- A.2.1 Steel section of grade E 250 and/or grade E 350 as per IS 2062, only are permitted for use in towers, extensions, gantry structures and stub setting templates. For towers in snowbound areas, steel sections shall conform to Grade-C of IS-2062.
- A.2.2 Towers shall be designed as per IS-802:2015, however the drag coefficient of the tower shall be as follows:-

| Solidity Ratio | Drag Coefficient | |
|----------------|------------------|--|
| Upto 0.05 | 3.6 | |
| 0.1 | 3.4 | |
| 0.2 | 2.9 | |
| 0.3 | 2.5 | |
| 0.4 | 2.2 | |
| 0.5 and above | 2.0 | |

- A.3.0 Transmission Service Provider (TSP) shall adopt any additional loading/design criteria for ensuring reliability of the line, if so desired and /or deemed necessary.
- A.4.0 Transmission line shall be designed considering wind zones as specified in wind map given in National Building Code 2016, Vol.1. The developer shall also make his own assessment of local wind conditions and frequent occurrences of high intensity winds (HIW) due to thunderstorms, dust-storms, downburst etc. along the line route and wherever required, higher wind zone than that given in wind map shall be considered for tower design for ensuring reliability of line. Further, for transmission line sections passing within a distance of 50 km from the boundary of two wind zones, higher of the two wind zones shall be considered for design of towers located in such sections.
- A.5.0 The Transmission Line may encounter snowbound areas and may also pass through elevations of above 1000 m above mean sea level (MSL). Necessary correction factor for live metal clearance shall be considered as per clause no. 13.3.1 of IS-5613 (Part-2/Sec-1).
- A.6.0 For line in snowbound area, suitable ice loading on conductor & earth wire shall be considered.
- A.7.0 Triple and quadruple circuit towers and towers with more than two sub-conductors per phase up to 400 kV shall be designed for reliability level 2.
- A.8.0 A) For power line crossing of 400 kV or above voltage level, large angle & dead end towers (i.e. D/DD/QD) shall be used on either side of power line crossing.
 - B) For power line crossing of 132 kV and 220 kV voltage level, angle towers (B/C/D/DB/DC/DD/ QB/QC/QD) shall be used on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

- C) For power line crossing of 66 kV and below voltage level, suspension/tension towers shall be provided on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.
- D) For crossing of railways, national highways and state highways, Regulations of appropriate authorities shall be followed.

| Transmission line | ACSR Conductor specified | Equivalent minimum size of AAAC conductor based on 53.5% conductivity of Al Alloy | Equivalent minimum size of AL59 conductor based on 59% conductivity of AL Alloy | Sub- conducto r Spacing |
|---|--|--|--|-------------------------------|
| 400kV D/C (Quad Moose) transmission | Moose : Stranding 54/3.53mm-Al + 7/3.53 mm- Steel, | Stranding details: 61/3.55mm | Stranding details: 61/3.31 mm | |
| lines | 31.77 mm diameter | 31.95mm diameter; | 29.79mm diameter; | |
| | 528.5 sq mm, Aluminium area, | 604 sq. mm Aluminium alloy area | 525 sq. mm Aluminium alloy area | 457 mm |
| | Maximum DC Resistance at 20°C (Ω/km):0.05552 | Maximum DC Resistance at 20°C (Ω/km) : 0.05506 | Maximum DC Resistance at 20°C (Ω/km) : 0.0501 | |
| | Minimum UTS : 161.20 kN | Minimum UTS : 159.80 kN | Minimum UTS : 135.40 kN | |

A.9.0 The relevant conductor configuration shall be as follows: -

Note: The transmission lines shall have to be designed for a maximum operating conductor temperature of 85 deg C for ACSR as well as AAAC and AL59.

- A.10.0 The required phase to phase spacing and horizontal spacing for 400kV line shall be governed by the tower design as well as minimum live metal clearances for 400kV voltage level under different insulator swing angles. However, the phase to phase spacing for 400kV lines shall not be less than 8m.
- A.11.0 All electrical clearances including minimum live metal clearance, ground clearance and minimum mid span separation between earth wire and conductor shall be as per Central Electricity Authority (Measures Relating to Safety & Electric Supply) Regulations as amended from time to time and IS:5613.

a) Minimum live metal clearances for 400 kV line: (Elevations up to 1000 m above MSL).

(i) Under stationary conditions

From tower body: 3.05m

(ii) <u>Under swing conditions</u>

| Wind pressure Condition | Minimum electrical clearance |
|-----------------------------------|------------------------------|
| a) Swing angle (22 ^o) | 3.05 mtrs |

| b) Swing angle (44 ^o) | 1.86 mtrs |
|-----------------------------------|-----------|
|-----------------------------------|-----------|

- b) Minimum ground clearance: 8.84 m
- c) Minimum mid span separation between earthwire and conductor: 9.0 m
- A.12.0 Shielding angle shall not exceed 20 deg for 400kV D/C Line transmission line.
- A.13.0 The Fault current for design of line shall be 50kA for 1 sec for 400kV.
- A.14.0 Two no. earth wires shall be used by TSP if OPGW requirement is not mentioned in communication section. Earth wire shall be either of galvanized standard steel (GSS) or AACSR or any other suitable conductor type depending upon span length and other technical consideration.
- A.15.0 Each tower shall be earthed such that tower footing impedance does not exceed 10 ohms. Pipe type or Counterpoise type earthing shall be provided in accordance with relevant IS. Additional earthing shall be provided on every 7 to 8 kms distance at tension tower for direct earthing of both shield wires. If site condition demands, multiple earthing or use of earthing enhancement compound shall be used.
- A.16.0 Pile type foundation shall be used for towers located in river or creek bed or on bank of river having scourable strata or in areas where river flow or change in river course is anticipated, based on detailed soil investigation and previous years' maximum flood discharge of the river, maximum velocity of water, highest flood level, scour depth & anticipated change in course of river based on river morphology data of at least past 20 years to ensure availability and reliability of the transmission line.
- A.17.0 Transmission line route shall be finalized, in consultation with appropriate authorities so as to avoid the habitant zones of endangered species and other protected species. Bird diverters, wherever required, shall be provided on the line.
- A.18.0 The transmission lines shall be designed with porcelain disc insulators or porcelain long rod insulators / Composite Long rod Insulators/glass insulators with the specific creepage distance required as per Site Pollution Severity level in the concerned area.
- A.19.0 The raised chimney foundation is to be provided in areas prone to flooding/water stagnation like paddy field /agricultural field & undulated areas to avoid direct contact of water with steel part of tower. The top of the chimney of foundation should be at least above HFL (High Flood Level) or the historical water stagnation/ logging level (based on locally available data) or above High Tide Level or 500 mm above Natural Ground level (whichever is higher).

SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION

The proposed new 400/132kV substation at Kishtwar substation shall be Gas Insulated Switchgear (GIS) type generally conforming to the requirements of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2010, as amended from time to time.

The technical parameters indicated in this document are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor as per relevant standard shall be considered by the TSP.

B.1.0 Salient features of Substation Equipment and Facilities

The design and specification of substation equipment are to be governed by the following factors:

B.1.1 Insulation Coordination

| SI. No. | Description of parameters | 400kV Kishtwar (GIS) S/S | 132kV Kishtwar (GIS) S/S | |
|---------|---|----------------------------------|-------------------------------|--|
| 1. | System operating voltage | 400kV | 132kV | |
| 2. | Maximum voltage of the system (rms) | 420kV | 145kV | |
| 3. | Rated frequency | 50Hz | 50Hz | |
| 4. | No. of phase | 3 | 3 | |
| 5. | Rated Insulation levels | | | |
| i) | Impulse withstand voltage for (1.2/50 micro sec.) - Transformer and Reactors - for Other Equipment - for Insulator String | 1300kVp 1425kVp 1550kVp | 550kVp 650kVp 650kVp | |
| ii) | Switching impulse withstand voltage (250/2500 micro sec.) dry and wet | 1050kVp | - | |
| iii) | One minute power frequency dry withstand voltage (rms) | 630kV | 275kV | |
| iv) | One minute power frequency dry and wet withstand voltage (rms) | - | - | |
| 6. | Corona extinction voltage | 320kV | | |
| 7. | Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz | 1000 micro-volts at 266kV rms | 500 microvolts at 92kV rms | |
| 8. | Minimum creepage distance for insulator string/ longrod insulators/ outdoor bushings | 13020 mm (31mm/kV) | 4495 mm (31mm/kV) | |
| 9. | Minimum creepage distance for switchyard equipment | 10500mm (25mm/kV) | 3625 mm (25mm/kV) | |
| 10. | Max. fault current | 50kA | 40 kA | |
| 11. | Duration of fault | 1 Sec | 1 Sec | |

The system design parameters for substations/switchyards shall be as given below:

B.1.2 Switching Scheme

The switching schemes, as mentioned below, shall be adopted at various voltage levels of substation/switchyard:

| Substation | 400kV side | 132kV side |
|--------------------------|--------------------------|-------------------|
| 400kV Kishtwar (GIS) S/S | One & half breaker (GIS) | Double Main (GIS) |

Notes: -

- i) Each circuit of 400kV double circuit transmission line shall be terminated in different diameters.
- ii) Transformers and bus reactors of same HV rating shall be placed in different diameters (i.e transformers of same HV rating shall not be in the same diameter and similarly bus reactors of same HV rating shall also not be in the same diameter).
- iii) In case of GIS substation where the bus scheme is One & Half breaker scheme, the diameters (diameter is a set of 3 circuit breakers with associated isolators, earth switches, current transformers etc. for controlling of 2 numbers feeders) shall be complete with feeder/line side isolator to be used for any future line with switchable line reactor bay and GIS duct of the future bay shall be brought outside the GIS hall/building with extension/interface module suitably.
- iv) Bus scheme for future 765kV (GIS) system is envisaged as One & Half breaker scheme.

B.2.0 Substation Equipment and facilities:

The switchgear shall be designed and specified to withstand operating conditions and duty requirements. All equipment shall be designed considering the transmission line capacity.

| SI. No | Description of bay | 400kV Kishtwar (GIS) S/S | 132 kV Kishtwar (GIS) S/S |
|-----------|--------------------|--------------------------|---------------------------|
| | | 400kV | 132kV |
| 1. | Bus Bar | 6000A | 3000A |
| 2. | Line bay | 3150A | 1000A |
| 4. | Bus Reactor bay | 3150A | - |
| 5. | ICT bay | 3150A | 1000A |
| 6. | Bus Coupler Bay | - | 3000A |

B.2.1 200MVA, 400/132/33kV, 3-phase Autotransformer

Transformer shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website.

B.2.2 125MVAR, 420kV, 3-Phase, Shunt Reactor

Reactor shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website.

B.2.3 400kV & 132kV GIS Substation equipment

GIS (Gas Insulated Switchgear) shall be Indoor type in accordance to IEC: 62271-203. The switchgear shall be designed and specified to withstand operating conditions and duty requirements. All the switchgear such as Circuit Breaker, isolator, earth switch including CT, PT etc. shall be GIS type. The Surge Arrestor and Voltage Transformer shall be either GIS or outdoor AIS type.

The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF_6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. The layout of Gas Insulated Bus Ducts shall be properly planned to optimize the length of bus ducts and for easy accessibility for maintenance. The length of busbars, bus ducts, isolator sections shall be optimized considering effects of fast transient voltage due to isolator operations.

The bus bar modules including auxiliary bus modules (wherever applicable) shall be provided with suitable End Piece (Interface) module with the test link facility for future extension as per provisions of future requirement. The end piece module shall be designed in such a way so that future GIS module may be tested without extending test voltage to existing bus and vice-versa by removing the test link.

TSP shall make available the complete details for the design of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc. Further, adequate space for GIS busbar interface module shall be taken into account for future scope.

Each section shall have plug-in or easily removable connection pieces to allow for easy replacement of any component with the minimum disturbance to the remainder of the equipment. Inspection windows (View Ports) shall be provided for Disconnector Switches and both type of earth switches i.e. Maintenance and fast operating.

Local control cabinets (LCC) shall be provided as per requirement. The alarm & annunciation of GIS equipment shall be wired to SCADA System.

The material and thickness of the enclosures shall be such as to withstand an internal flash over without burns through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF_6 breakdown under arcing condition. This shall be validated with Type Test.

Service continuity requirement for GIS:

The GIS equipment with the given bus switching arrangement shall be divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartments may need to be degassed.

TSP shall meet following Service continuity conditions (to the extent possible) with ensuring equipment and operating personnel's safety:

- For One & half breaker bus switching scheme, during a fault in Circuit Breaker compartment, no bus bar and feeder is permitted out of service during maintenance and repair/replacement.
- For Double Main bus switching scheme, during a fault in Circuit Breaker compartment, no bus bar is permitted out of service during maintenance and repair/replacement.
- During a fault in GIS compartment other than Circuit Breaker compartment, maximum one bus bar and/or one feeder is permitted out of service during maintenance and repair/replacement.

UHF sensors in GIS for PD (Partial Discharge) detection:

Adequate number of UHF sensors shall be provided in the offered GIS along with suitable portable type PD measuring instrument for detection of Partial discharge (of 5 pC and above as per IEC 60270). The number and location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (Application Guide for sensitivity verification for UHF Partial discharge detection system for GIS).

B.2.3.1 Circuit Breakers (GIS)

GIS Circuit breakers shall in general be of C2-M2 class and comply with IEC-62271-100. The rated break time shall not exceed 40 ms for 400kV & 60 ms for 132kV. Circuit breakers shall be provided with single phase and three phase auto reclosing for 400kV. 145kV Circuit Breakers for 132kV Transformer bays and 132kV Bus Coupler bay shall be provided with 3-Ph auto-reclosing. Whereas, 145kV Circuit Breakers for 132kV line bays shall be suitable for 1-Ph as well as 3-Ph auto-reclosing. The Circuit breakers controlling 400kV lines wherever required shall be provided with pre-insertion closing resistor of about 400 ohms with 8 ms insertion time or Controlled Switching Device (CSD) for lines longer than 200 km. The short line fault capacity shall be same as the rated capacity and this is proposed to be achieved without use of opening resistors. Control switching device shall be provided in Circuit Breaker of switchable line reactor bay and in Main & Tie bay circuit breakers of line with non-switchable line reactors.

B.2.3.2 Isolators (GIS)

The isolators shall comply with IEC 62271-102 in general. Isolators shall be motor (DC powered) operated. Earth switches are provided at various locations to facilitate maintenance. Main blades and earth blades shall be interlocked and interlock shall be fail safe type. All isolators and earth switches shall be motor operated type.

Isolator shall be of extended mechanical endurance class-M2 and suitable for Bus Transfer Current Switching duty as per IEC standard. High speed earthing switches shall be provided for grounding purpose at overhead line terminations & cable terminations & cable terminations and shall have fault making capability as specified. Earth switch for line isolator shall be of earthing switch class E1 and shall be suitable for induced current switching duty as defined for Class-B as per relevant standard.

B.2.3.3 Current Transformers (GIS)

Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps only. Generally, Current Transformers (CT) shall have five cores (four for protection and one for metering) whereas; CT in Tie bays shall have six cores (four for protections & two for metering) suitably distributed on both sides of CB (for 400kV and above voltage class).

132kV Current Transformers shall have five cores (four for protection and one for metering). The burden and knee point voltage shall be in accordance with the requirements of the system including possible feeds for telemetry. Accuracy class for protection core shall be PX and for metering core it shall be 0.2S. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 20VA for metering core) for better sensitivity and accuracy.

The instrument security factor shall be less than 5 for CTs upto 400 kV voltage class.

B.2.3.4 Voltage Transformer (GIS)

The voltage transformers shall conform to IEC-61869. Voltage transformers shall be of electromagnetic type with SF_6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box. The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization. The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF₆ compartment, separated from other parts of installation. The voltage transformer shall be effectively shielded against high frequency electromagnetic transients. The voltage transformer shall have three secondary windings. The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens. The accuracy class for protection cores shall be 3P. The accuracy of 0.2 on metering core should be maintained throughout the entire burden range on all the three windings without any adjustments during operation. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 50VA for metering core) for better sensitivity and accuracy.

B.2.3.5 SF₆ to Air Bushing

Outdoor bushings, for the connection of conventional external conductors to the SF_6 metal enclosed switchgear, shall be provided. Bushings shall generally be in accordance with the requirements of IEC -60137. The creepage distance over the external surface of outdoor bushings shall not be less than 31 mm/kV. SF_6 to air Bushing shall be of Polymer / composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition. The electrical and mechanical characteristics of bushings shall be in accordance with IEC 60137. Polymer / composite insulator shall be seamless sheath of silicon rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicon composite insulators shall comply with the requirements of IEC 61462 and the relevant parts of IEC 62217.

B.2.4 400kV & 132kV AIS Substation equipment

B.2.4.1 Capacitor Voltage Transformers (AIS)

Capacitive Voltage transformers shall comply with IEC 61869 in general. These shall have three secondaries out of which two shall be used for protection and one for metering. Accuracy class for protection cores shall be 3P and for metering core it shall be 0.2. The Capacitive voltage transformers on lines shall be suitable for Carrier Coupling. The Capacitance of CVT for 400kV and 132 kV shall be of 4400/8800 pF depending on PLCC requirements. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 50VA for metering core) for better sensitivity and accuracy.

B.2.4.2 Surge Arresters (AIS)

336kV & 120kV Station High (SH) duty gapless type Surge arresters with thermal energy (Wth) of minimum 12 kJ/kV & 7 kJ/kV conforming to IEC 60099-4 in general shall be provided for 420kV &

132 kV system respectively. Other characteristics of Surge arrester shall be chosen in accordance with system requirements. Surge arresters shall be provided near line entrances, transformers & Reactor so as to achieve proper insulation coordination. Surge Arresters shall be provided with porcelain/ polymer housing fitted with pressure relief devices. A leakage current monitor with surge counter shall be provided with each surge arrester.

B.2.5 Protection Relaying & Control System

The protective relaying system proposed to be provided for transmission lines, auto-transformers, reactors and bus bars to minimize the damage to the equipment in the events of faults and abnormal conditions, is dealt in this section. All main protective relays shall be numerical type with IEC 61850 communication interface. All numerical relays shall have built in disturbance recording feature.

The protection circuits and relays of transformer and reactor shall be electrically and physically segregated into two groups each being independent and capable of providing uninterrupted protection even in the event of one of the protection groups failing, to obtain redundancy, and to take protection systems out for maintenance while the equipment remains in service.

a) Transmission Lines Protection

400kV lines shall have Main-I numerical three zone distance protection scheme with carrier aided inter-tripping feature. 400kV lines shall also have Main-II numerical distance protection scheme like Main-I but from different make that of Main-I. The Main-I and Main-II protection relays of same make may be provided only if they are of different hardware & manufacturing platform or different principle of operation.

However, Line Current Differential relay (with back up distance protection feature) as Main–I and Main-II shall be considered at both ends for short lines (line length below 30kM) having Fibre Optic communication link. Differential relay at remote end shall be provided by the TSP. Associated power & control cabling and integration with SAS at remote end shall be provided by respective bay owner.

For 400kV transmission lines, directional IDMT earth fault relay should be provided as standalone unit or in-built feature of Main-I and Main -II feature.

All 400kV lines shall also be provided with two stages over voltage protection. Over voltage protection & distance to fault locator may be provided as in-built feature of Main-I & Main-II protection relays.

The Main-I and Main-II protection relays shall be fed from separate DC sources and shall be mounted in separate panels.

132kV lines shall have Main numerical three zone distance protection scheme with carrier aided inter-tripping feature. However, Line Current Differential relay (with back up distance protection feature) as Main shall be considered at both ends for short lines having Fibre Optic communication link. 132kV lines shall also have independent back up over current & earth fault protection.

Further, all 400kV & 132kV lines shall be provided with single and three phase auto-reclosing facility to allow reclosing of circuit breakers in case of transient faults. These lines shall also be provided with distance to fault locators to identify the location of fault on transmission lines.

Auto reclose as built in function of Bay Control Unit (BCU) is also acceptable.

In case of loop in loop out of transmission lines, the existing protection scheme shall be studied and suitable up-gradation (if required) shall be carried out.

b) Auto Transformer Protection

These shall have the following protections:

- i) Numerical Differential protection
- ii) Numerical Restricted earth fault protection
- iii) Numerical Back-up Over-current and earth fault protection on HV & MV side
- iv) Numerical Over fluxing protection on HV & MV side
- v) Numerical Overload alarm
- vi) Numerical Back up Impedance protection (HV Side)

Further, Numerical Back-up Over-current and earth fault protection on HV & MV side of autotransformer shall not be combined with other protective functions (except back up Impedance protection) in the main relays and shall be independent relays. Besides these, power transformers shall also be provided with Buchholz relay, protection against high oil and winding temperature and pressure relief device etc.

Suitable monitoring, control (operation of associated circuit breaker & isolator) and protection for LT auxiliary transformer connected to tertiary winding of auto-transformer for the purpose of auxiliary supply shall be provided. The Over current and other necessary protection shall be provided for the auxiliary transformer. These protection and control may be provided as built in feature either in the bay controller to be provided for the auxiliary system or in the control & protection IEDs to be provided for autotransformer.

c) 400kV Reactor Protection

Reactor shall be provided with the following protections:

- i) Numerical Differential protection.
- ii) Numerical Restricted earth fault protection
- iii) Numerical Back-up impedance protection

Besides these, reactors shall also be provided with Buchholz relay, MOG with low oil level alarm, protection against oil and winding temperatures & pressure relief device, etc.

d) Bus bar Protection

The high speed low impedance type bus bar differential protection, which is essential to minimize the damage and maintain system stability at the time of bus bar faults, shall be provided for 400kV buses. Duplicated bus bar protection is envisaged for 400kV bus-bar protection. Single bus bar protection scheme is envisaged for 132 KV bus-bar protection. Bus bar protection scheme shall be such that it operates selectively for each bus and incorporate necessary features required for ensuring security. The scheme shall have complete bus bar protection for present as well as future bays envisaged i.e. input / output modules for future bays shall also be provided.

Bus Bar protection system for new substation shall be de-centralized (distributed) type.

In case, the bus section is provided, then each side of bus section shall have separate set of bus bar protection schemes.

For existing substations, the existing bus bar protection shall be augmented as per requirement.

e) Local Breaker Back up Protection

This shall be provided for each 400kV and 132kV circuit breakers and will be connected to deenergize the affected stuck breaker from both sides.

Notes:

- 1. LBB relay may also be provided as built-in protection function of distributed bus bar protection scheme; however in such case separate LBB relay shall be provided for tie bays (in case of One and Half breaker scheme).
- 2. Over fluxing & overload protection can be provided as built-in feature of differential relay.
- 3. In 400kV switchyard, if spare bay of half diameter is identified as future, Tie CB relay panel shall be with Auto-reclosure feature.

B.2.6 Substation Automation System

a) For all the new substations, state of art Substation Automation System (SAS) conforming to IEC-61850 shall be provided. The distributed architecture shall be used for Substation Automation system, where the controls shall be provided through Bay control units. The Bay control unit is to be provided bay wise for voltage level 132kV and above. All bay control units as well as protection units are normally connected through an Optical fibre high speed network. The control and monitoring of circuit breaker, dis-connector, re-setting of relays etc. can be done from Human Machine Interface (HMI) from the control room.

The functions of control, annunciation, disturbance recording, event logging and measurement of electrical parameters shall be integrated in Substation Automation System.

At new substations, the Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including proposed future bays/elements.

In existing substations with Substation automation system (SAS), augmentation of existing SAS shall be done for bays under present scope.

In existing Substations where Substation automation is not provided, control functions shall be done through control panels.

Necessary gateway & modems (as required) shall be provided to send data to RLDC/SLDC as per their requirement. Any augmentation work at RLDC/SLDC is excluded from TSP's scope. However, all the configuration work at substation end required to send data to RLDC/SLDC shall be in the scope of TSP.

b) Time synchronisation equipment

Time synchronization equipment complete in all respect including antenna, cable, processing equipment required to receive time signal through GPS or from National Physical Laboratory (NPL) through INSAT shall be provided at new substations. This equipment shall be used to synchronize SAS & IEDs etc.

B.3.0 Substation Support facilities

Certain facilities required for operation & maintenance of substations as described below shall be provided at new substation. In existing substation, these facilities have already been provided and would be extended/ augmented as per requirement.

B.3.1 AC & DC power supplies

For catering the requirements of three phase & single phase AC supply and DC supply for various substation equipment, the following arrangement is envisaged: -

(i) For LT Supply at each new Substation, two (2) nos. of LT Transformers (minimum 800kVA for substations with highest voltage rating as 765kV) shall be provided out of which one shall be connected with SEB/DISCOM supply and other one shall be connected to tertiary of Transformer.

Metering arrangement with Special Energy Meters (SEMs) shall be provided by TSP at 33kV tertiary of Transformer for drawing auxiliary supply at new substation. Such SEMs shall be provided by CTU at the cost of the TSP. Accounting of such energy drawn by the TSP shall be done by RLDC/RPC as part of Regional Energy Accounting.

Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of Transformer by local SEB/DISCOM for energy accounting.

- (ii) 2 sets of 220V battery banks for control & protection and 2 sets of 48V battery banks for PLCC/ communication equipment shall be provided at each new Substation. Each battery bank shall have a float-cum-boost charger. Battery shall be of VRLA type.
- (iii) Suitable AC & DC distribution boards and associated LT Switchgear shall be provided at new substation.

For new substation, following switch boards shall be considered with duplicate supply with bus coupler/ sectionalizer and duplicate outgoing feeders except for Emergency lighting distribution board which shall have only one incoming feeder:

- (a) 415V Main Switch board 1 nos.
- (b) AC distribution board 1 nos.
- (c) Main lighting distribution board 1 no.
- (d) Emergency lighting distribution board 1 no.
- (e) 220 Volt DC distribution board 2 nos.
- (f) 48 Volt DC distribution board 2 nos.

Sizing of LT Switchgear shall be suitable to cater the requirement for all present and future bays. AC & DC distribution boards shall have modules for all the feeders (including future as specified).

- (iv) At new Substation, one no. of DG set (minimum 500kVA for substations with highest voltage rating as 765kV) shall be provided for emergency applications.
- (v) At new substation, sizing of battery and battery charger shall be done based on the number of bays specified (including future bays).
- (vi) For substation extensions, existing facilities shall be augmented as required.

B.3.2 Fire Fighting System

Fire-fighting system for substation including transformer & reactor shall conform to CEA (Measures Relating to Safety & Electric Supply) Regulations.

Further, adequate water hydrants and portable fire extinguishers shall be provided in the substations. The main header of firefighting system shall be suitable for extension to bays covered under the future scope; necessary piping interface in this regard shall be provided.

Optical Beam type heat detection for GIS hall fire protection system shall be provided for all the GIS halls.

At existing substations, the fire-fighting systems as available shall be extended to meet the additional requirements.

B.3.3 Oil evacuating, filtering, testing & filling apparatus

To monitor the quality of oil for satisfactory performance of transformers, shunt reactors and for periodical maintenance necessary oil evacuating, filtering, testing and filling apparatus would be provided at new substations. Oil storage tanks of adequate capacities for storage of transformer oil would be provided.

B.3.4 Illumination

Normal & emergency AC & DC illumination shall be provided adequately in the control room & other buildings of the substation. The switchyard shall also be provided with adequate illumination.

Lighting of the entire control room building, fire-fighting pump house, other building (if any) and switchyard shall be done by LED based low power consumption luminaries.

B.3.5 Control Room

For new substation, substation control room shall be provided to house substation work stations for station level control (SAS) alongwith its peripheral and recording equipment, AC & DC distribution boards, DC batteries & associated battery chargers, Fire Protection panels, Telecommunication panels & other panels as per requirements. Air conditioning shall be provided in the building as functional requirements. Main cable trenches from the control room shall have adequate space provision for laying of cables from control room for all the future bays also.

At existing substations, the adequacy of size of control room shall be ascertained and the same shall be augmented as per requirement.

B.3.6 GIS hall

The Gas Insulated Switchgear (GIS) of each voltage alongwith other associated equipment shall be housed inside the GIS building separately. The panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, PLCC panels etc. are to be placed in a separate room in the GIS building. The size of the room shall be such that all the panels for the bays under present scope shall be accommodated. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers. Ventilation system of suitable capacity shall be provided for each GIS hall.

One EOT Crane of suitable capacity for erection & Maintenance of largest GIS component/assembly and all plant installed in the GIS switchgear room shall be provided in each GIS hall. The crane shall be capable of fulfilling all special requirements for erection & maintenance of GIS equipment. The capacity of the crane shall be sized to lift the heaviest GIS switchgear component.

For extension of existing GIS, existing facilities shall be suitably augmented/ extended for GIS equipment under present scope.

B.3.7 Control Concept

All the EHV circuit breakers in substation/switching stations shall be controlled and synchronized from the switchyard control room/remote control center. Each breaker would have two sets of trip circuits which would be connected to separate DC supplies for greater reliability. All the isolators shall have control from remote/local whereas the earth switches shall have local control only.

B.3.8 Visual monitoring system (VMS) for watch and ward of substation premises:

Visual monitoring system for effective watch and ward of substation premises shall cover all the transformers and reactors, all other major AIS Equipment (such as CB, isolators, CT, CVT, SA etc. as applicable), GIS bays, panel room, all the gates of switchyard and all entry and exit points of control room building and accordingly the location of cameras shall be decided. The camera shall be high definition color CCD camera with night vision feature. The VMS data partly/completely shall be recorded (minimum for 15 days) at least @25fps (or better) and stored on network video recorder. The system shall use video signals from various cameras installed at different locations, process them for viewing on workstations/monitors in the control room and simultaneously record all the cameras.

Mouse/keyboard controllers shall be used for pan, tilt, zoom and other functions of the desired camera. The Visual Monitoring System shall have provision of WAN connectivity for remote monitoring.

All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. The equipment should generally conform to Electromagnetic compatibility requirement for outdoor equipment in EHV substation.

At existing substations, the visual monitoring system if available shall be augmented as per existing or better specification as required.

B.4.0 General Facilities

- a) Line Gantry/Towers are envisaged for bays under present scope only. However, for adjacent future line bay, tower shall be designed for extension (considering Quad conductors for 400kV future lines and single conductor for 132kV future lines) wherever applicable.
- b) Bay extension works at existing substation shall be executed by TSP in accordance with the requirement/provisions mentioned above. However, interface points shall be considered keeping in view the existing design/arrangement at the substation.
- c) TSP has to arrange for construction power and water on its own.
- d) All outdoor steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m.
- e) In 400kV switchyard, if spare bay of half diameter is identified as future, all the equipment for Tie & Future bay shall be designed considering the current rating of line bay i.e. 3150A.
- f) Boundary wall shall be brick masonry wall with RCC frame or Stone masonry wall or Precast RCC wall under present scope along the property line of complete substation area (including future switchyard area) to prevent encroachment and unauthorized access with minimum height of 1.8 m from finished ground level (FGL) as per CEA Measures Relating to Safety and Electric Supply Regulations.

SPECIFIC TECHNICAL REQUIREMENTS FOR COMMUNICATION

In order to meet the requirement for grid management and operation of substations, Transmission Service Provider (TSP) shall conform to the following requirements.

C.1.0 Establishment of 400/132kV station at Kishtwar (GIS) along with 420kV, 125 MVAR Bus Reactor at Kishtwar Switching Station by LILO of one circuit of Kishenpur – Dulhasti 400kV D/C (Quad) line (Single Circuit Strung)

- i) TSP shall provide 2 no. FODP (96 F) with panel and Approach Cables (24/48F) with all associated hardware fittings (from gantry tower to Control Room) for all the incoming lines envisaged under the present scope.
- TSP shall provide STM-16 (FOTE) equipment with panel supporting minimum eight (8) MSP (Multiplex Section Protection) directions in combination of one no. of 5 MSP & one no. 3 MSP Equipment (including suitable STM-4 interfaces for Kishenpur & Dulhasti direction). Equipment shall be provided with suitable DC Power Supply & necessary interfaces to meet the voice and data communication requirement between Kishtwar GIS, Kishenpur S/s, Dulhasti S/s and upcoming 132kV lines.
- iii) FODP & FOTE equipment with panels shall be provided in Control Room of Kishtwar GIS, FOTE & FODP Eq can be accommodated in same panel to optimize space.
- iv) The integration work of new Communication equipment under present scope with existing regional level centralized NMS shall be responsibility of TSP. Configuration work in centralized NMS for integration of new Communication equipment is not in scope of TSP, however all necessary support to integrate new Communication equipment in the existing Centralized NMS shall be ensured by TSP.
- v) TSP shall install required no. of Phasor Measurement Units (PMUs) for all 400kV voltage line bays (under the scope of this project) at 400kV at Kishtwar GIS, these PMUs shall support latest IEEE C-37.118 protocols. These PMUs shall be provided with GPS clock and LAN switch and shall connect with LAN switch of control room with Fibre Optic cable. These PMUs shall be connected with the FOTE at Substation for onwards data transmission to the PDC (Phasor Data Concentrator) located at respective RLDC. However, configuration work in existing PDC at RLDC for new PMU integration is not in scope of TSP.
- vi) The maintenance of all the communication equipment including FOTE, FODP, approach cable, PMUs, DCPS alongwith suitable Battery Bank shall be the responsibility of TSP.

[#]Note: Location of Kishtwar pooling Station (GIS) is yet to be finalized.

C.2.0 <u>PLCC & PBAX:</u>

Power line carrier communication (PLCC) equipment complete for speech, tele-protection commands and data channels shall be provided on each transmission line. The protections for transmission line and the line compensating equipment shall have hundred percent back up communication channels i.e. two channels for tele- protection in addition to one channel for speech plus data for each direction. The PLCC equipment shall in brief include the following:

- Coupling device, line traps, carrier terminals, protection couplers, HF cables, PABX (if applicable) and maintenance and testing instruments.
- At new substation, a telephone exchange (PABX) of 24 lines shall be provided at as means of effective communication among various buildings of the substation, remote end substations and with control centres (RLDC/SLDC) etc.

- Coupling devices shall be suitable for phase to phase coupling for 765kV & 400kV Transmission lines. The pass band of coupling devices shall have sufficient margin for adding communication channel in future if required. Necessary protection devices for safety of personnel and low voltage part against power frequency voltages and transient over voltage shall also be provided.
- The line traps shall be broad band tuned suitable for blocking the complete range of carrier frequencies. Line Trap shall have necessary protective devices such as lightning arresters for the protection of tuning device. Decoupling network consisting of line traps and coupling capacitors may also be required at certain substation in case of extreme frequency congestion.
- The carrier terminals shall be of single side-band (SSB) amplitude modulation (AM) type and shall have 4 kHz band width. PLCC Carrier terminals and Protection couplers shall be considered for both ends of the line.
- PLCC equipment for all the transmission lines covered under the scheme (consisting of one set of analog PLCC channel along with circuit protection coupler and one set of Digital protection coupler for both ends) shall be provided by TSP. CVT & Wave trap for all the line bays under present scope shall be provided by TSP.
- TSP shall provide/ undertake necessary addition/ modification/ shifting/ recommissioning etc. of PLCC equipment due to LILO of transmission lines (wherever applicable).
- All other associated equipment like cabling, coupling device and HF cable shall also be provided by the TSP.

1.0 <u>Transmission Line:</u>

- 1.1 Please clarify that whether shutdowns for crossing of existing transmission lines of POWERGRID/STUs/ Power Evacuation Lines from Generation Plants/ Any other Transmission Licensee will be given to TSP on chargeable basis or free of cost.
 - **Reply:** Shutdowns for crossing of existing transmission lines of POWERGRID/ STUs/ Power Evacuation Lines from Generation Plants/ Any other Transmission Licensee will be given to TSP by the concerned owner of the lines as per their own terms & conditions. As far as shutdown of ISTS lines are concerned the same can be availed by approaching respective Regional Power Committee.
- 1.2 We understand that the suggested swing angle criteria are applicable for Suspension Insulator in Suspension Tower. Further, you are requested to provide similar swing angle and clearance criteria for Pilot Insulator with Jumper & Jumper.
 - **Reply:** It is clarified that the swing angle criteria (as mentioned in RFP) for transmission lines is applicable for Suspension Insulator in Suspension Tower. Further, as per Clause 3.0 of Specific Technical Requirements for transmission lines, Transmission service Provider (TSP) shall adopt any additional loading/design criteria for ensuring reliability of the line, if so desired and /or deemed necessary.
- 1.3 We request you to kindly allow that use of diamond configuration at Power line crossings and the existing owner of the lines may be directed to allow the same for the successful bidders.
 - **Reply:** Power line crossing including Diamond configuration is responsibility of the TSP. TSP shall formally submit the profile of the crossing section to the owner of the existing line suggesting proposed crossing alternatives. The crossing will have to be carried out as per approval of owner of the existing line.
- 1.4 It is requested you to kindly provide present status of Forest Clearances if any transmission line corridor area falling in wildlife forest / reserve forest/ mangroves.
 - **Reply:** Based on the preliminary route survey, the process of initiation of forest clearance for the forest stretches, if any, enroute the proposed line alignment will be initiated by way of writing letters to the concerned authority (ies).

However, it may be noted that it will be the responsibility of TSP for obtaining forest clearance for the forest stretches as provided in the survey report and also for any forest area encountered during detailed survey.

2.0 <u>Substation</u>

2.1 We understand that space for storage of O&M spare shall be provided by existing owner within the station boundary without any cost. Kindly confirm.

Reply: Space for storage of O&M spares shall be arranged by TSP on its own.

2.2 We presume that the O&M for the end Termination bays will be in the scope of the TSP and TSP shall not be liable for any payment towards O&M to the existing owner of the substation. Kindly confirm.

Reply: Operation and maintenance of the bays is solely responsibility of the TSP.

- 2.3 With reference to subject scheme of existing sub-station, we assumed following scope of work:
 - (a) We assumed internal road is available and need not to consider in the presentscope of work.
 - (b) Drainage is available and need not to consider in the present scope of work.
 - (c) Cable trench extension in adjacent to Main cable trench only under presentscope of work.
 - (d) Levelled area being provided by developer for bay extension.
 - **Reply:** Regarding requirement of internal road, drainage, cable trench, leveling of the bay extension area, bidder is advised to visit site and acquaint themselves with the provisions/facilities available at substation.
- 2.4 Kindly provide the soil investigation report of soil parameters of existing substation.

Reply: Bidder is advised to visit the substation site and ascertain the requisite parameters.

2.5 Kindly confirm, energy accounting of aux. power consumption. Whether it will be on chargeable basis or part of transmission loss.

Reply: It will be on chargeable basis.

2.6 We understand that VMS requirement is for unmanned stations only. For Manned stations VMS is not compulsory.

Reply: VMS shall be provided in line with requirements of RfP document.

2.7 It is understood that Construction water and power shall be provided free of cost to TSP by respective substation owner for construction of new bays.

Reply: Arrangement of construction power & water is in the scope of TSP.

2.8 It is understood that existing fire hydrant system shall be extended by the TSP for bay extension.

Reply: Existing fire hydrant system shall be extended from existing system (if required)

2.9 Please clarify that Status of land acquisition for Substations. Whether the lands havebeen acquired by BPC and will be transferred to TSP.

Reply: The acquisition of land for substation is in the scope of TSP.

2.10 We understood that no any dedicated metering CT & CVT required for

Line/feeders. Further, we understood that requisite Energy meters for various 765kV, 400kV & 220kV Feeders shall be provided & installed by CTU free of cost to TSP.

Reply: Dedicated metering CT and CVT are not required for line/feeders. Metering core of existing CT/CVT can be used provided accuracy class is matching with metering requirement. Requisite Special Energy Meters shall be provided and installed by CTU at the cost of TSP in C&P panel subject to space availability, else, in separate metering panel (to be provided by TSP atits cost).

3.0 <u>Communication</u>

- 3.1 What is the usage of OPGW, FOTE, PMU etc. under communication requirement of RFP?
 - **Reply**: User shall be responsible for providing compatible equipment along with appropriate interface for uninterrupted communication with the concerned control center and shall be responsible for successful integration with the communication system provided by CTU.

Communication systems e.g. OPGW, FOTE, PMU etc. are required for grid operation through RLDC/SLDC, speech communication, tele-protection andtele-metering.

- 3.2 Is space for installation of communication panels are provided to TSP in existing Substations incase new bays are in the scope of TSP?
 - **Reply**: The space replated issues are deliberated in the RFP itself. TSP to carry out survey of the existing substation for physical space requirement. In case space is not available in the existing substation then TSP shall accommodate

the same in the respective bay SPR (Switchyard Panel Room)/Bay Kiosk/ Relay panel room in case of GIS s/s. Further, TSP to connect and integrate the proposed FOTE with the existing FOTE in the control room.

In Case 132kV Substation TSP shall accommodate the said panels either by extension of existing control room or other arrangements.

- 3.3 How is the OPGW laying done in case of LILO lines?
 - **Reply**: In case LILO lines are on same towers (e.g. both Line in and Line Out portion are on same towers, generally done LILO of S/C lines). Then 2x24FOPGW shall be required to install by TSP on both earthwire peak on 400kV& 765kV lines where two E/W peaks are available. On 220 & 133kV lines where only one E/W peak is available TSP to install one no. 48F OPGW.

Incase LILO lines are on different towers (e.g. both Line In and Line Out portion are on different towers, generally done LILO of D/C lines). Then 1x24F OPGW shall be required to install by TSP on one earthwire peak, on both Line In and Line Out portions of 400kV & 765kV lines. On 220 &133kV lines where only one E/W peak is available TSP to install one no. 24F OPGW in place of conventional earthwire.

- 3.4 How is the OPGW laying done in case Multi circuit Towers?
 - **Reply**: In case two different lines are using common multi circuit portion for some distance (originating from different stations, may be terminating on same or on different stations). Two no. 24F OPGW to be installed on both E/Wpeaks for common M/C portion of 765kV & 400kV lines.

Incase 220/132kV lines using multi circuit portion where single E/W peak isavailable one no. 48F may be installed for common multi circuit portion.