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ABBREVIATIONS

AC	Alternating Current
AM	Asset Management
CEA	Central electricity authority
CLR insulator	Composite Long Rod Insulator
CBIP	Central Board of Irrigation and Power
CERC	Central Electricity Regulatory Commission
CTUIL	Central Transmission Utility of India Limited
DC	Direct Current
D/C	Double Circuit
FS type Foundation	Fully submerged type foundation
GS	Ground Switch
IS	Indian standard
ICAO	International Civil aviation organization
MOEF	Ministry of Environment and Forest
M/C	Multi circuit
NTAMC	National Transmission Asset Management System
OPGW	Optical Fiber Ground wire
PTCC	Power and tele-communication coordination committee
ROW	Right of way
RTAMC	Regional Transmission Asset Management System
S/C	Single circuit

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DOCUMENT NO: D-2-01-70-01-03-Part A

DOCUMENT NAME: PRE-COMMISSIONING PROCEDURES FOR TRANSMISSION LINES

1.0 INTRODUCTION

This document includes overall procedure, safety rules, Statutory Requirements, dispatching procedure, switching sequences, inspection, testing & measurement, observations, acceptance criteria and documentation of test results for pre-commissioning procedures for transmission lines.

Different type of electrical clearances are tabulated as per CEA document (Measures relating to Safety and Electric Supply Regulations, 2010), CBIP manual for Transmission line in 2014, Forest conservation Act, 1980 & forest conservation Rules, 2003 & POWERGRID latest technical specifications for transmission lines. Different values indicated in this document is for reference purpose only; however, if there is any difference between the values indicated in this document & the values in the technical specifications/drawings; the values of technical specifications/drawings will prevail.

The detailed inspection and handing over documents are required to be checked for the entire length of transmission line before energization. Geo-tagged digital Photographs of all tower locations using high-resolution digital camera need to be handed over to taking over team and preserved as part of taking over record.

2.0 OVERALL PROCEDURE

First, it is to be ascertained that the transmission line to be energized is ready for operation and has been properly handed over (released) in writing. This will include all safety aspects, Electrical inspector clearance, PTCC clearance, statutory clearance, regulation/ system operator requirement and final inspection, if any.

Instructions for the work and supervision are given by the test leader (Line in charge). However, regular operators will execute all switching and operational activities.

Line charging instructions received from Engineering department & CTUIL should be clearly understood by the Line in charge and doubts, if any, are to be got clarified prior to the energization of the line.

Once, the line is handed over for charging, no work shall be permitted without a valid work permit.

Engineering department & CTUIL recommendations, system operator/ regulation requirements are to be followed before putting the system into continuous operation.

3.0 SAFETY PROCEDURES

Energization implies an abrupt and serious change of the working conditions in the line.

In order to avoid serious accidents, thorough information must be imparted to all personnel involved in the construction of transmission line. In-charge of the

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Transmission line must ensure that due publicity has been made to the public in all the villages/ areas along the line route cautioning them against climbing the towers etc. and that the line is proposed to be charged on notified date. It is also to be confirmed that all the agencies involved in construction activities shall not carry out any job on the said line without a valid work permit.

It shall be ensured that before charging all men, material, Tools & plants and any temporary earthing on any part of the entire length of line are removed.

It must be ensured that any power supply/ low voltage charging used as “anti-theft measure” must be disconnected and isolated to avoid accidental connection.

All equipment tests and pre-commissioning tests must have been completed, reconnected (in case cables were isolated for testing purpose) and documented as per prescribed format.

The system must be formally declared ready for Energization and handed over for operation in writing.

4.0 STATUTORY REQUIREMENT

4.1 The concerned authorities shall be informed before commissioning the line and their approval shall be obtained in accordance with latest Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations.

4.2 Before charging of the line, PTCC approval from concerned authority shall be obtained.

5.0 INSPECTION

Before the line is scheduled to be handed over for the pre-commissioning/ Energization, the same shall be inspected by representatives of POWERGRID and Construction Agency. Such inspection shall include:

- i) Right of way/ way leave/ electrical clearance
- ii) Jumper drops
- iii) Foundation and Revetments/ Protection Work
- iv) Tower and Tower accessories
- v) Earthing
- vi) Hardware fittings
- vii) Insulators
- viii) Conductors and Earth wire/OPGW
- ix) Accessories for conductor and Earth wires/OPGW
- x) Aviation Warning Signals (Lights/globules/painting)
- xi) Bird Diverter (if applicable)

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5.1 RIGHT OF WAY / WAY LEAVE / ELECTRICAL CLEARANCE

5.1.1 Right of way/ Way leave clearance

Maximum width of Right of way of transmission line in forest area and minimum electrical clearances between Conductor & trees shall be as per guidelines/clarifications issued by MOEF & climate changes in 2019 under Forest conservation Act,1980 & forest conservation rules,2003 for laying of transmission lines through forest area.

- (i) As per existing guidelines/clarifications issued by MOEF & climate changes in 2019 / POWERGRID specification, the maximum width of right of way for the transmission lines on forestland shall be as follows:

Transmission Voltage (KV)	Width of Right of Way (in meter)
66	18
132	27
220	35
+/-320 HVDC	44
400 S/C	52
400 D/C	46
765 S/C (Delta)	64
765 S/C (Horizontal)	85
765 D/C	67
+/-500 HVDC	52
+/-800 HVDC	69
1200 S/C	89

- (ii) Minimum electrical clearance between Conductor & Trees considering Maximum sag & swing of Conductor shall be as follows.

Voltage (KV)	Minimum clearance between conductors and trees (in meter)
66	3.4
132	4.0
220	4.6
400	5.5
765	9.0
+/-500 HVDC	7.4
+/-800 HVDC	10.7
1200	13

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5.1.2 Electrical Clearance

All statutory electrical clearance of transmission lines w.r.t. ground, building, Structures, Power line crossings, River crossing, Railway & Road crossings etc. as stipulated under latest version of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations & POWERGRID specification shall be ensured.

5.1.2.1 Minimum Ground clearance shall be as per clause 58.0 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 & POWERGRID specification under Sec-I & Sec-III of Vol-II.

The ground profile at the time of commissioning shall be checked with the profile approved at the time of check survey.

Sag in one of the span in each section shall be measured and it should be ensured that sag & tension of the section is in line with specification and sag & tension calculation chart approved by Engg.

Ground clearance of lowest conductors at critical points shall be checked in the field from any of the prevalent method and the values of ground clearance at these critical points including all power line, railway line and road crossings shall be recorded in the prescribed format.

In case of hilly Terrain and for building clearance, the side clearance from conductors and jumpers at critical points shall also be checked and recorded for all phases of conductor/ earth wire/ OPGW towards hill building side.

Transmission voltage (in kV)	66	132	220	± 320 HVDC	400	765	± 500 HVDC	± 800 HVDC	1200
Minimum Ground Clearance (in meter)	5.5	6.1	7.015	8.5	8.84	18	12.5	18	24

5.1.2.2 Clearance of earth wire/OPGW with Top conductor at mid span to Top conductor
Availability of required vertical clearances (as per design & POWERGRID Specification) between conductor and earth wire/OPGW shall be ensured through random checking. Minimum clearances between conductor and earth wire/OPGW at mid-span shall be as indicated below:

Voltage (kV)	66	132	220	+/- 320 HVDC	400	+/- 500 HVDC	765	+/- 800 HVDC	1200
Minimum mid span clearance (in meter)	3	6.1	8.5	8.5	9	9	9	12(pole) 6.1(DMR)	18

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Record of such random checks shall be the part of pre-commissioning records.

5.1.2.3 Clearance between line crossings each other, the minimum clearances between the Power line crossing each other shall be as per clause no 69.0, part-III, Sec-4 of CEA's Regulations 2010 (Measures relating to Safety and Electric Supply) and POWERGRID specifications under sec-III, Vol-II

Where an overhead line crosses another overhead line, clearances shall be as under: -
(Minimum clearances in meters between AC lines crossing each other)

Sl. No.	Nominal System Voltage (kV)	11-66	110-132	220	400	765	1200
1.	Low and Medium	2.44	3.05	4.58	5.49	7.94	10.44
2.	11-66	2.44	3.05	4.58	5.49	7.94	10.44
3.	110-132	3.05	3.05	4.58	5.49	7.94	10.44
4.	220	4.58	4.58	4.58	5.49	7.94	10.44
5.	400	5.49	5.49	5.49	5.49	7.94	10.44
6.	765	7.94	7.94	7.94	7.94	7.94	10.44
7.	1200	10.44	10.44	10.44	10.44	10.44	10.44

Where an overhead direct current (DC) line crosses another overhead line, clearances shall be as under: -

Minimum clearances in meters between AC and DC lines crossing each other

Sl. No.	System Voltage (AC/DC)	100 kV DC	200 kV DC	300 kV DC	400 kV DC	500 kV DC	600 kV DC	800 kV DC
1	Low and Medium AC	3.05	4.71	5.32	6.04	6.79	7.54	9.04
2	11-66 kV AC	3.05	4.71	5.32	6.04	6.79	7.54	9.04
3	110-132 kV AC	3.05	4.71	5.32	6.04	6.79	7.54	9.04
4	220 kV AC	4.58	4.71	5.32	6.04	6.79	7.54	9.04
5	200 kV DC	4.71	4.71	5.32	6.04	6.79	7.54	9.04
6	300 kV AC	5.32	5.32	5.32	6.04	6.79	7.54	9.04
7	400 kV AC	5.49	5.49	5.49	6.04	6.79	7.54	9.04
8	400 kV DC	6.04	6.04	6.04	6.04	6.79	7.54	9.04
9	500 kV DC	6.79	6.79	6.79	6.79	6.79	7.54	9.04
10	600 kV DC	7.54	7.54	7.54	7.54	7.54	7.54	9.04
11	765 kV AC	7.94	7.94	7.94	7.94	7.94	7.94	9.04
12	800 kV DC	9.04	9.04	9.04	9.04	9.04	9.04	9.04
13	1200 kV AC	10.44	10.44	10.44	10.44	10.44	10.44	10.44

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Provided that no guarding are required when line of voltage exceeding 33 kV crosses over another line of 250 V and above voltage or a road or a tram subject to the condition that adequate clearances are provided between the lowest conductor of the line of voltage exceeding 33 kV and the top most conductor of the overhead line crossing underneath the line of voltage exceeding 33 kV and the clearances as stipulated in regulation 58 from the topmost surface of the road maintained

5.1.2.4 Electrical clearance from railway tracks shall be as stipulated under Sec-III, Vol-II of Technical Specification of POWERGRID.

(i) Vertical clearance for OHE (other than high rise OHE):

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line crossing or crossing planned for alteration
1	Above 66 kV & up to 132 kV	15.56 m
2	Above 132 kV & up to 220 kV	16.46 m
3	Above 220 kV & up to 400 kV	18.26 m
4	Above 400 kV & up to 500 kV	19.16 m
5	Above 500 kV & up to 800 kV	21.86 m

(ii) Vertical clearance for high-rise OHE*:

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line crossing or crossing planned for alteration
1	Above 66 kV & up to 132 kV	17.56 m
2	Above 132 kV & up to 220 kV	18.46 m
3	Above 220 kV & up to 400 kV	20.26 m
4	Above 400 kV & up to 500 kV	21.16 m
5	Above 500 kV & up to 800 kV	23.86 m

(iii) Clearance between highest traction conductor & lowest crossing conductor

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line crossing or crossing planned for alteration
1	Above 66 kV & up to 132 kV	3.05
2	Above 132 kV & up to 220 kV	4.58
3	Above 220 kV & up to 400 kV	5.49
4	Above 400 kV & up to 500 kV	7.94
5	Above 500 kV & up to 800 kV	7.94

***Applicable only for electrification of routes where double stack container having maximum height of 6809 mm is plying**

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5.1.2.5 Clearances from buildings of Lines

Electrical clearances (Horizontal as well as vertical clearances) from building/structures shall be as per clause 61.0 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010.

- (1) An overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line.
- (2) Where an overhead line of voltage, exceeding 650 V passes above or adjacent to any building or part of a building, it shall have on the basis of maximum sag a **vertical clearance above the highest part of the building** immediately under such line, of not less than clearance mentioned as per below table for respective voltage level

Voltage (kV)	66	132	220	400	765	1200
Minimum clearance (mm)	4000	4600	5500	7300	10600	14500

- (3) **The horizontal clearance** between the nearest conductor and any part of such building shall, on the basis of maximum deflection due to wind pressure, be not less than clearance mentioned as per below table for respective voltage level

Voltage (kV)	66	132	220	400	765	1200
Minimum clearance (mm)	2300	2900	3800	5600	8900	12800

Note: Clearance are calculated as per norms specified in clause no 61 of CEA safety regulation 2010

- (4) For High Voltage Direct Current (HVDC) systems, vertical clearance and horizontal clearance, on the basis of maximum deflection due to wind pressure, from buildings shall be maintained as below:

Sl. No	DC Voltage (kV)	Vertical Clearance (in mm)	Horizontal Clearance (in mm)
1.	100 kV	4600	2900
2.	200 kV	5800	4100
3.	300 kV	7000	5300
4.	400 kV	7900	6200
5.	500 kV	9100	7400
6.	600 kV	10300	8600
7.	800 kV	12400	10700

Vertical and horizontal clearances shall be as specified in schedule-X of **CEA safety regulation 2010**

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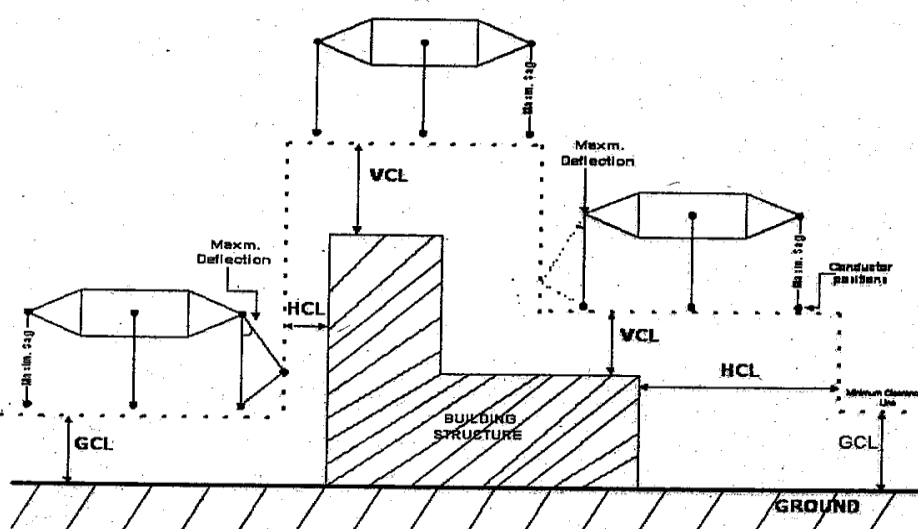
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Explanation: - For the purpose of this regulation the expression “building” shall be deemed to include any structure, whether permanent or temporary.

Schedule-X

Ground, Vertical and Horizontal clearances
[See sub-regulation (6) of regulation 58, sub-regulation (5) of regulation (60) and sub-regulation (5) of regulation 61]



GCL: Clearances as per Regulation 59

VCL: Clearances as per Regulation 60 & 61

HCL: Clearances as per Regulation 60 & 61

5.1.2.6 Minimum Clearance in air above ground and across road surface of Highways or roads for lowest conductor of an AC overhead lines, including service lines of nominal system voltage

As per sub regulation (1) of regulation (58) of CEA draft safety regulation 2021

Nominal system Voltage(in kV)	Clearance above ground			Clearance between conductor & road surface across high way(in meter)
	Across street (in meter)	Along street (in meter)	Elsewhere) (in meter)	
66	6.5	6.1	5.5	11.6 or U/G cable
132	6.5	6.1	6.1	11.6
220	7.02	7.02	7.02	12.52
400	8.84	8.84	8.84	14.0
765	18*	18*	18*	18.8
1200	24*	24*	24*	30

**Higher clearance predominantly induction effects and time varying electric field (ICNIRP limit:10 kV/m for occupational exposure) at voltage exceeding 400 kV*

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5.1.2.7 Minimum Clearance in air above ground and across road surface of Highways or roads for lowest conductor of an DC overhead lines,

As per sub regulation (1) of regulation (58) of CEA draft safety regulation 2021

Nominal system Voltage (in kV)	Clearance above ground	Clearance between conductor & road surface across high way (in meter)
+/- 500 kV HVDC	12.5	17.25
+/- 800 kV HVDC	18	22.75

Highway clearance required 4.75 meter higher than ground clearances (considering the vehicle height 4.75 meter as mentioned in the Indian road congress documents, 1983)

5.1.2.8 Power line/cable crossing with waterway:

Minimum Clearance of Power Conductor over the Highest Flood Level in case of navigable/non navigable rivers (As per clause no 4.5.1 of CBIP manual on Transmission line, 2014)

a) AC system

AC Voltage Level in kV (Nominal voltage)	Minimum Clearance above H.F.L (mm)	
	Navigable River	Non-navigable river
66	19000	3650
110	19000	4300
132	19220	4300
220	20100	5100
400	21900	6400
765	25550	9400
1200	29900	11000

b) DC system

DC Voltage in kV	Minimum Clearance above H.F.L (mm)	
	Navigable River	Non-navigable river
+/- 500	24030	6750
+/- 800	27700	11000

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FOUNDATION AND REVETMENTS/ PROTECTION WORK

5.2.1 FOUNDATION:

There shall not be any damage/ uneven settlement of foundations. For this, tolerances in levels of all four stubs should not exceed the criteria provided in the Annexure - C of IS -5613 (Part -3/Section 2) latest revision.

It is to be ensured that back filling of foundation is properly done. Soil shall be filled over all legs up to ground level.

Extra surface earth after foundation back filling shall be removed from legs of the tower.

Any crack or break in chimney, if found, shall be repaired/rectified with approval of site In-charge.

5.2.2 REVETMENTS / PROTECTION:

Cracks/ damages to revetments shall be repaired/ rectified with approval of site In-charge.

Wherever revetments are provided, weep holes shall have slope such as to flush out the deposited water away from tower platform.

In case of hilly terrain, the benching area should be leveled properly. The area around tower shall have proper slope for drainage of rainwater.

5.3 TOWER AND TOWER ACCESSORIES

5.3.1 Normal Tower

After completion of a transmission line, all the towers shall be thoroughly checked before charging the line. Special attention shall be given to the following points:

Deformed/ Buckled/ Missing/ Rusted Members and Nuts and Bolts

It is to be ensured that no members are bent, deformed or rusted in towers and if so, the same shall be replaced.

If any member is found missing, a new member shall be fixed as per structural drawing of the Tower.

Nuts shall be sufficiently tightened for the required Torque. Minimum 2/ 3 complete threads shall be projected outside the nut. All bolts shall have their nuts facing outside of the tower for Horizontal connection and downwards for Vertical connections.

Bolts shall be punched as per the specification and nuts shall be properly tack welded. It shall be ensured that the circular length of each welding shall be at least 10 mm. Proper zinc rich paint (90% zinc content) shall be applied on welded portion.

It shall be ensured that all tower members are fixed and tightened properly. All extra blank holes on tower members are filled with correct size of nuts & bolts. Geotagged Digital Photographs (from different angles) of such conformance of all towers are to be handed over to taking over team and preserved with taking over

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records.

5.3.2 Special Towers

In addition to the above checks for towers, ladders and platforms provided in special towers shall be properly tightened and no foreign material shall be left out on such platforms.

5.3.3 Earthing of Towers

Ensure that proper earthing (Pipe type earthing in one of tower leg/ Counterpoise Earthing) of tower has been done and earthing strip is neither damaged nor broken and is properly fixed to the stub.

Ensure that Additional earthing is provided on every 7 to 8 kms distance at tension tower for direct earthing of both shield wires (Earth wire/ OPGW).

Ensure that Additional Rod type earthing is provided in one of foundation pit (Diagonally opposite to pipe type earthing) of all the transmission line towers in normal soil (i.e., Dry, Wet cultivated, Wet, PS, FS & Black cotton soil) in addition to pipe type earthing.

In case of counter poise earthing, it is to be ensured that earth wire is sufficiently buried in the ground to avoid digging out during cultivation. The length of counterpoise shall be as per technical specification. The same shall be laid uniformly and stacking/ coiling of counter poise wire is not allowed.

Before charging of the line, ensure that tower footing Impedance at each tower is below 10 ohms. If tower footing impedance of any tower (before stringing) has been recorded higher than 10 ohms, additional counterpoise type earthing/ Chemical earthing shall be provided to bring the tower footing impedance value below 10 ohms.

Earthing of special towers shall be verified as per approved drawings applicable for special towers/ special foundation.

5.3.4 Tower accessories

All danger plates, number plates, circuit plates and phase plates shall be in position as per the specification and properly tightened.

All phase plates shall be fixed in correct phase sequence. Special care may be taken at transposition towers for indicating the correct phase sequence.

It shall be ensured that the anti-climbing device (ACD) is provided at the suitable height of tower. In case of barbed wire type ACD, barbed wire shall be tightly fixed.

It shall be ensured that the step bolts (for normal towers) are provided up to the peak of the tower. Any missing step bolts shall be replaced.

Fixing of bird-guards shall be ensured at all towers to prevent birds perching on suspension insulator strings.

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5.4 HARDWARE FITTINGS

Tightening of all bolts and nuts are to be checked up to specified torque. Check fixing of all security clips (W/R type clips).

Surface condition of corona control rings should be smooth. Distance/ alignment between tower side arcing horn (wherever applicable) and line side arcing horn/ corona control ring should be as per approved drawings.

Jumpers in the tension tower shall be properly bolted with the tension clamp and form a parabolic shape in order to achieve adequate clearance from steel super structure.

Provision of Suitable counter weight shall be ensured on Pilot string insulator (CLR type) as per approved drawings to restrain swing towards the tower.

Provision of Counter weight shall also be ensured on pilot insulator string (for both disc type/CLR pilot string) in case of transposition tower.

5.5 INSULATORS

All damaged/ broken porcelain/ glass insulator discs/ composite long rod/ porcelain long rod insulator units shall be replaced.

Unusual deflection in suspension strings, if observed, shall be rectified.

It is to be ensured before charging those insulators are clean. IR value of individual porcelain disc insulators shall be checked on random basis by 5/ 10 kV Insulation Tester and it shall not be less than 2000 Mega Ohm per disc.

5.6 CONDUCTORS & EARTH WIRES/OPGW

5.6.1 Conductor

Surface of the conductors shall be free from scratches/rubs.

Ensure that conductor strands are not cut and opened up. Wherever strands are found cut/ damaged/ scratched, they must be repaired with repair sleeves/ repair protective rods in case the no. of damaged strands are within specified limits (normally up to 1/6th nos of strands in the outer layer) for lines up to 220 kV and maximum 2 strands in case of 400 kV and higher voltage level.

5.6.2 Earth wire/OPGW

Ensure that strands of earth wire/OPGW have no cuts.

5.7 ACCESSORIES FOR CONDUCTOR AND EARTH WIRES/OPGW

5.7.1 Joints

All joints on conductor/ earth wires shall be away from the tower at a distance of at least 30 meters or as provided in the technical specification (TS).

Ensure that not more than one joint in a sub-conductor is provided in one span.

Ensure that no mid span joint is provided in major crossings like SH/NH/ Expressway, railway crossing, 132 kV & above voltage level power lines and major

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rivers etc. or as per the provision of technical specification.

Ensure that all mid span joints on conductors/ earth wire and repair sleeves of compression type are free from sharp edges, rust and dust. Wherever grease is specified the same shall be applied in the joints.

5.7.2 Clamping

Ensure that conductor is not over tightened in the suspension clamps.

5.7.3 Spacers, vibration dampers and copper bonds

Placement and number of spacers/ spacer-dampers on the bundle conductors on each phase shall be verified as per spacer/ spacer damper placement chart. Damaged/ missing spacers/ spacer-dampers shall be replaced and loose/ displaced spacers/ spacer-dampers shall be tightened/ relocated.

In case of tension towers, one additional spacer/ spacer damper shall be placed within 10 meters of dead-end clamp.

Spacing of Vibration dampers from the tower and spacing between damper to damper shall be verified as per the damper placement chart. All loose/ displaced VD shall be properly tightened/ relocated and missing VDs shall be provided.

It is to be ensured that no copper/ aluminum bond is loose/ missing.

5.7.4 Jumpers

Verify Jumper drop (i.e., distance between cross-arm and null point of jumper) as per drawing. All jumpers shall be checked for proper tightening and missing bolts. In case, jumpers (Conductor/ Earth wire) are found loose, it shall be tightened properly before line charging.

Geotagged Digital Photographs of such conformance for all jumper connections are to be handed over to taking over team and photographs are to be preserved by taking over team for record.

Jumper drop need to be measured for all tension tower locations and to be handed over to RHQ-AM. RHQ-AM will cross check 5% of measurement value on sample basis. If any abnormality is found in readings, additional 5% sample checking to be done. The sample checking process to be repeated till all abnormality related to jumper drop are resolved.

Transmission voltage kV)	66	132	220	400	765	± 500 HVDC	± 800 HVDC
Jumper Drop (In meter)	1.3	1.8	2.4	3.6	6.1	4	7.8(Pole) 2.6(DMR)

5.7.5 Foreign material

Ensure that all foreign materials like ropes, dead bird, fallen tree branches; bird nests etc. on conductors, earth wires/OPGW, jumper, insulator string, cross arms are removed.

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5.7.6 Others

It shall be ensured that all temporary/ local earthing, guys, T & P (Tools and Plants), foreign material, Pilot rope used in OPGW stringing and other loose material, which were used during stringing/ tower erection, have been removed.

If, there is any change in the ground profile before commissioning of line from the approved profile, the extra earth/ obstruction/ temporary sheds/ any other construction shall be removed.

5.8 AVIATION WARNING OBSTRUCTION SIGNALS (LIGHTS/ GLOBULES/ PAINTING)

It shall be ensured that following measures have been taken in the line/ Towers falling within obstruction zone of civil aviation and defense establishments as per IS-5613(latest revision), ICAO Guidelines and POWERGRID specification.

5.8.1 Day markers

5.8.1.1 Structure marking: The structure portion excluding cross arms above 45-meter height shall be painted in alternate bands of international orange and white color as per IS-5613(latest revision) & ICAO Guidelines.

5.8.1.2 Line markers may be provided as per the technical specification.

5.8.2 Night markers

It shall be ensured that proper aviation lights at the peak level/ at specified heights of towers have been provided along with Solar panels/ Battery banks/ Control cubicles and other accessories as per specification. The functioning of lights with simulation shall be checked/ verified.

5.9 BIRD DIVERTERS

Bird diverters shall be placed in identified stretches as per conditions stipulated by forest authority to avoid the chance of collision of birds with transmission line.

6.0 TESTING AND MEASUREMENT

6.1 Tower footing Impedance Measurement

Tower footing impedance measurement is to be carried out using tower footing impedance tester. The value of impedance should be below 10 ohms. If impedance value is higher than 10 ohms, additional counterpoise type earthing/ chemical earthing shall be provided to bring the tower footing impedance value below 10 ohms. These measurements may preferably be carried out during dry climate.

Tower footing impedance need to be measured for all tower location and the values need to be recorded for future reference and document will be handed over to RHQ-AM. RHQ-AM will carry out impedance measurement at 5% locations on sample basis. Corrective action will be taken if impedance values are higher than 10 ohms.

6.2 Before commissioning of the lines following tests may be carried out:

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6.2.1 Conductor Continuity test:

6.2.1.1 Objective of this test is to verify that each conductor of the overhead line is properly connected.

A simple method of continuity test is illustrated below. Once the insulation test is completed and the results confirm no short circuit, carryout the following testing using 5kV/ 10 kV Insulation Tester

Sending End	Receiving End	Results (Ohms)
CLOSE R- Ph ground switch OPEN Y- Ph ground switch OPEN B- Ph ground switch	Test IR for R-Ph	Zero/ Low
	Test IR for Y-Ph	High
	Test IR for B-Ph	High
OPEN R- Ph ground switch CLOSE Y- Ph ground switch OPEN B- Ph ground switch	Test IR for R-Ph	High
	Test IR for Y-Ph	Zero/ Low
	Test IR for B-Ph	High
OPEN R- Ph ground switch OPEN Y- Ph ground switch CLOSE B- Ph ground switch	Test IR for R-Ph	High
	Test IR for Y-Ph	High
	Test IR for B-Ph	Zero/ Low

(All Ground Switch in open condition)

If the above test results are satisfactory, it confirms the continuity of the line.

6.2.1.2 The continuity Test of the line with proper phase indication or phase marking can be checked by continuity test as described below:

Sending End	Receiving End IR value in between	Results (Ohms)
Connect R & Y phase. B-phase & all GS open	R & Y Phase	Zero Or Low
	Y & B Phase	High
	B & R Phase	High
Connect R & B phase. Y-phase & all GS open	R & Y Phase	High
	Y & B Phase	High
	B & R Phase	Zero Or Low
Connect Y & B phase R-phase & all GS open	R & Y Phase	High
	Y & B Phase	Zero Or Low
	B & R Phase	High

If the test results are satisfactory, it confirms that marking of the phases are in order.

6.2.2 Insulation Resistance Test of Line

This test may be carried out using 5 kV or 10 kV Insulation Tester preferably power driven to ascertain the insulation condition of the line. If, 5 kV Insulation Tester is used for insulation resistance measurement, it shall be ensured that the induced voltage (CVT reading) is less than the instrument withstanding capacity to avoid the possibility of damage of instrument.

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6.2.3 Transmission Line parameters (Z_1 , Z_0 , Z_n) measurement

The Transmission line parameters measurement to be done by Substation commissioning team and the measured line parameters need to be incorporated in the relay setting. This is to improve the accuracy of fault locators and the distance relays.

6.2.4 Offline Signature Analysis

Offline signature shall be taken before commissioning to ensure healthiness of transmission line before charging. If any abnormality is found in signature, same need to be analyzed and defects must be attended before line charging. This will be preserved for future reference if any.

6.2.5 Phase Sequence checking/validation (After energization)

Once, the line is charged from one end, without closing the Breaker at the other end, the Phase sequence is to be checked from the CVT output using Phase Sequence Meter. If other charged feeders are available, Phase sequence to be RECHECKED by the measurement of secondary voltage of both the Feeders (New line & available charged line).

Let the secondary Voltage of CVT is 110 volts (Phase to Phase) for both the Circuit. In case of correct Phase sequence the voltage reading shall be as follows:

New Circuit	Old Circuit	Voltage (in Volts)
R – Phase	R – Phase	0
R – Phase	Y – Phase	110
R – Phase	B – Phase	110
Y- Phase	R – Phase	110
Y- Phase	Y – Phase	0
Y- Phase	B – Phase	110
B- Phase	R – Phase	110
B- Phase	Y – Phase	110
B- Phase	B – Phase	0

In case the results are not matching the phase sequence is to be re-checked and reconfirmed before closing the breaker.

7.0 PROTECTIVE SYSTEM

Before energization, it must be ascertained that all protective systems for the line to be energized are operative.

This includes confirmation that the protections have been properly tested and tests have been documented as per Pre-Commissioning Procedure laid down by the utility for S/S Bay Equipment.

It also includes verification by inspection or otherwise, if necessary, by repetition of

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trip test, that the protections are actually functionally enabled. This verification serves to prevent that energization takes place of a line where a protection has been disabled for test or other reason.

8.0 DISPATCH PROCEDURES

All operational activities (switching etc.) must be coordinated and communicated with the system dispatcher i.e. NTAMC/ RTAMC/ RLDC/ NLDC. In this respect, the general procedures already established by POWERGRID, Regulator and System Operator will be followed.

9.0 SWITCHING PROCEDURES

For each activity, the instructions to the operators and the communications to the dispatchers will be made in writing or by confirmed telephone messages. The switching procedures first to be properly documented step by step and understood by everybody involved in the switching operation prior to the energization. Any clarification required in the procedures must be resolved. The format established by the utility for switching orders and operational data logging shall be followed. Each and every activity must be listed and described, so that complete information is available for detailed investigation, if required in future.

10.0 HANDING OVER

The transmission line shall be inspected prior to Energization and a formal handing over document to be jointly signed by the representative of SUPPLIER (if available), ERECTION AGENCY and POWERGRID. However, all contractual taking over has to be resolved separately as per the terms and conditions of the contract. Handing over shall be limited to the completion of Erection and ready for Energization.

The relevant format No AM/COMM/LINE/1a & AM/COMM/LINE/1b which are in part-B of document for handing over is also a part of documentation

Any outstanding points or remaining activities are to be listed and signed jointly by the representatives of POWERGRID and ERECTION agency as per the Format No: AM/COMM/LINE/2 of part-B of this document. These documents are also to be retained at line office with a copy to regional office. The remaining activities outstanding points are classified in the following category.

Details of the SECTIONS:

- A. List of outstanding activities remaining in any part of the line
- B. A list of temporary arrangements introduced.
- C. Check list of records properly documented, completed and signed as per Format No: AM/COMM/LINE/1 of part-B of this document
- D. Original tracing of Profile, Route Alignment, Tower Design, Structural Drawings, Bill of Materials, Shop Drawings, stringing charts (initial and final as applicable) etc. of all towers/ line submitted to POWERGRID.

After resolving the above-mentioned outstanding activities or with only minor remaining points which do not influence on charging of line, handing over of the

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transmission line shall be accepted by the pre-commissioning team. Handing over of transmission line for Energization with or without remaining activities shall be made by the line in-charge to the commissioning in charge in writing as per the Format No. AM/COMM/LINE/3 of part-B of this document

Shortcomings noticed during inspection, "List of outstanding activities" shall be recorded as per Format No: AM/COMM/LINE/2 of part-B of this document and a copy of the shortcomings noticed is to be given to the responsible parties like SUPPLIER(s) and ERECTION AGENCY etc. for corrective action to be taken on a time bound schedule.

11.0 ENERGIZATION

Execution of the energization is simply the last event in the switching sequence, switching of the close control button for the relevant circuit breaker.

12.0 OBSERVATIONS AND DURATION

Visual and audible inspection (look and listen) of the associated equipment and reading of permanent instruments will be made.

The system shall be kept charged for the duration prescribed as per CERC regulation. During this time, continuous monitoring and inspection will be maintained in control room, auxiliary systems areas and switchyards.

This will include frequent, scheduled inspection of all equipment and reading of all permanent instruments, recorders and surge arrester counters, especially system parameters as per standard procedures adopted by POWERGRID.

13.0 DE-ENERGIZATION

Instructions about de-energization will be given only if, this is part of the test otherwise de-energization will be considered part of regular operation.

14.0 ACCEPTANCE CRITERIA

Neither insulation breakdown nor protective system actions must occur. No irregular equipment behavior noise, vibration, high temperature is permitted.

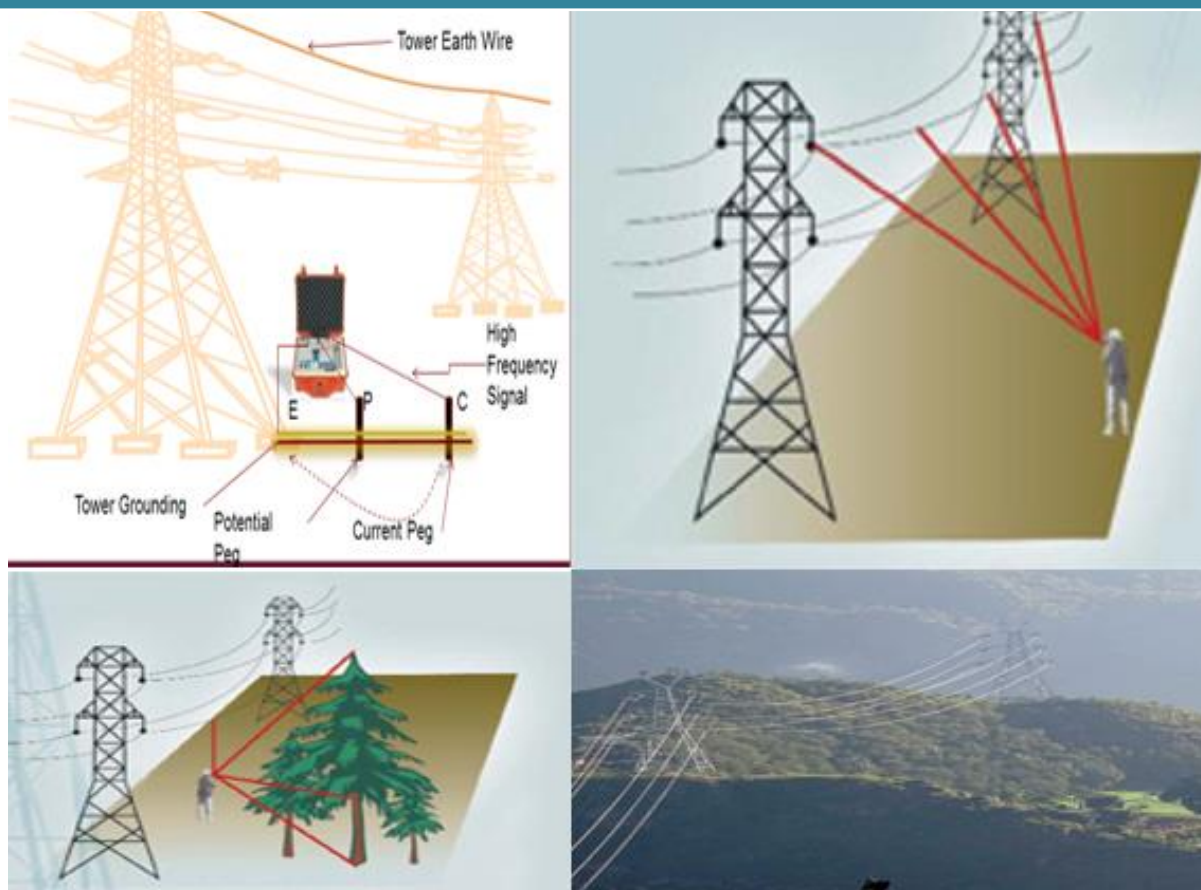
Corona discharges may not be "unreasonable". Local discharges that may be attributable to sharp points, shall be carefully located and recorded. After termination of Energization, the equipment shall be closely inspected and the points rounded or covered.

No unscheduled changes of system or of equipment are permitted during the 8-hour energized condition.

15.0 DOCUMENTATION

Switching and operational activities will be recorded in regular manner in the operator's log. Similarly, all readings of permanent instruments are also to be recorded. Copies of this log notes on special observations from inspections and other measurements will constitute the test records.

PRE-COMMISSIONING FORMATS FOR TRANSMISSION LINE



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Sep '2021

**PRE COMMISSIONING FORMATS
FOR TRANSMISSION LINES**

Earlier Doc. No. D-2-01-70-01-02
Present Doc. No. D-2-01-70-01-03-part B

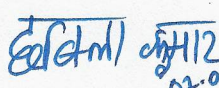
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01	CC(OS)	28/06/2004	Sd/-	Sd/-
02	CC(AM)	15/12/2014	Sd/-	Sd/-
03	CC(AM)	07/09/2021		

Proposed by

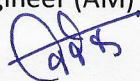
Reviewed by

Recommended by

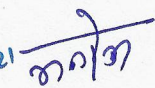
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Sl. No.	Chapter	Revision	Action
1	All	01	Replace All
2	All	02	Replace All
3	All	03	Replace All

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2	General data and information of Line (FORMAT NO: AM/COMM/LINE/1a)	4
3	Checklist for inspection at each tower location (FORMAT NO: AM/COMM/LINE/1b)	6
4	Inspection Record Prior to handing over the Line for energization (FORMAT NO: AM/COMM/LINE/2)	17
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6	Commissioning Format (including all electrical test) FORMAT NO: AM/COMM/LINE/4	20

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ABBREVIATIONS

AC	Alternating Current
AM	Asset Management
CC	Corporate Centre
CEA	Central electricity authority
CLR insulator	Composite Long Rod Insulator
CTUIL	Central Transmission Utility of India Limited
CVT	Capacitive Voltage Transformer
DC	Direct Current
D/C	Double circuit
FR type Foundation	Fissured rock type foundation
FS type Foundation	Fully submerged type foundation
GS	Ground Switch
HR type Foundation	Hard Rock type foundation
HVDC	High voltage Direct Current
ICT	Inter Connecting Transformer
IS	Indian standard
MOEF	Ministry of Environment and Forest
M/C	Multi circuit
NH	National Highway
NTAMC	National Transmission Asset Management System
OPGW	Optical Fiber Ground wire
PS type Foundation	Partially submerged type foundation
PTCC	Power and tele-communication coordination committee
PTW	Permit to work
ROW	Right of way
S/C	Single circuit
WBC type Foundation	Wet black cotton type foundation

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Introduction:

The document consists of 4 formats.

Format 1: This format is divided into two parts. Part 1 covers the general information of Line, in part2 details inspection checklist need to be filled against each tower location.

Format 2: In this format list of pending works in the line, list of temporary arrangement used during line construction, removal of any antitheft measure used before energization of line will be filled and same will be verified in handing over format (**Format 3**)

Format 3: In this format handing over of the records related to statutory clearance documents, **Format -1** and **Format-2** will be done by construction team to the commissioning team and same will be recorded in this format with acceptance of energization of line by the commissioning in charge. The pending work (minor nature type) which will not potentially affect the charging of line will be listed in the format.

Format 4: Carrying out Electrical tests before energization of Line and recording of all electrical parameter such as voltage, current, active Power, reactive power, phase sequence etc. after energization of the line need to be done as per this format and record will be kept for future use.

Table for different type of clearances have given before each format for user reference purpose based on the present version of technical specification of POWERGRID.

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FORMAT NO: AM/COMM/LINE/1a

Name of line	No of Circuit	Date of Energization

GERERAL DATA AND INFORMATION (for Line)

I	Region Name										
II	TL Office Name										
III	Type Of Conductor	Dog	Panther	Zebra	Moose	Snow Bird	AL 59	Bersimis	Lapwing	Others	
IV	No of conductors in bundle	Single	Twin		Triple		Quad	Hexa		Octa	Others
V	Voltage rating(kV)	66	132	220	+/-320	400	+/-500	+/- 800	765	1200	
VI	Type of circuit	S/C			D/C		S/C on D/C Tower			M/C	
VII	Length of Line(in kms) for the jurisdiction										
VIII	Total Nos. of Towers (in the jurisdiction)										
a.	Total no of suspension towers										
b.	Total no of tension towers										

Note: Every row fields are independent and the verifying officer will tick the field as applicable for each location in other type of conductor HTLS or any other type to be mentioned

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IX CROSSING DETAILS

a) River crossing

Span(Loc A-Loc B)	River(Name)	Whether River is navigable or not

b) Railway crossing

Span(Loc A-Loc B)	Name of Railway line

c) NH crossing

Span(Loc A-Loc B)	Name of NH

d) Power line crossing

Span (Loc A- Loc B)	Name of Power Line	Voltage rating of line (in kV)

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FORMAT NO: AM/COMM/LINE/1b

GERERAL DATA AND INFORMATION (To be furnished against each Location)

Tower Location No:												
I	Insulator Type	Porcelain	CLR	Glass	Porcelain Rod	Long	Mixed					
II	Tower type details											
	Tower type (For S/C)	A	B	B1	B2	C	C1	C2	D	D45	D60	
	Tower type (For D/C)	DA	DB	DB1	DB2	DC	DC1	DC2	DD	DD45	DD60	
	Angle of Deviation of Tower	0-2	2-15	2-7	7-15	15-30	15-22	22-30	30-60	30-45	45-60	
	Tower type (For M/C) with angle of deviation	QA (0-2)	QB (2-15)			QC (15-30)			QD (30-60)			
III	Normal Extn. (Meters)	+3		+6		+9		+18		+25		+30
IV	Other Leg/Body Extn. (Meters)	+1.5		+3.0		+4.5		+6.0		+7.5		+9.0
		-1.5		-3.0		-4.5		-6.0				
V	Tower Foundation Type	Dry	Sandy Dry	Wet	Wet cultivated	PS	FS	WBC FR	FR	HR	PILE	
VI	Is the location Vulnerable	Yes					No					

Note: Every row fields are independent and the verifying officer will tick the field as applicable for each location

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VII DETAILED CHECK LIST (To be furnished against locations)

Tower location No:

SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
1	Foundation			
a	Check any damage/ uneven settlement of foundation			
b	Check back filling of foundation is properly filled up to the ground level of all legs			
c	Check surface earth/ concrete after foundation casting is removed from platform of the tower			
d	Check crack or damage to chimney			
e	Check crack or damage to retaining wall/ revetment and proper weep holes are provided for flushing water			
f	Check that all foundation chimneys are covered with soil and compacted specially in hilly terrain and river/ nalas banks up to ground level			
g	Check cliff-in foundation levels are within limit			
h	Check the back to back, diagonal and level of all four stubs (to be measured at stub top level). Refer format-A for filling.			
2	Tower			
a	Check for deformed/ rusted or damaged tower members			
b	Check for missing/hanging/bent tower members			
c	Check for missing bolts & nuts			
d	Check for tightening of all bolts & nuts			
e	Check for any missing joint plates			
f	Check for punching, tack welding (at least 10 mm circular length) and zinc coating of bolts & nuts			
g	Check filling of extra holes in tower members with bolts & nuts			
h	Check verticality of tower			

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SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
i	Check that no tower leg is suspected to be in sinking land or soil erosion field of river bank, if so, proper adequate protection has been provided			
J	Check fixing & visibility of all tower accessories namely danger/ number/ circuit/ phase plate/ step bolts and anti-climbing device (ACD)			
k	Check correct sequence of fixing of phase/ circuit plate at transposition towers			
l	Check that Fixing of bird-guards is done for all suspension towers to prevent birds perching			
m	Geotagged digital photographs (from different angles) of all towers to be taken and preserved.			
3	Removal of T&P and foreign materials			
a	Check temporary Earthing/ Guys used during stringing and jumpering are removed			
b	Check all foreign materials on tower e.g., discharge rod, wire/ropes, kite, bird nests and any other T&P etc. left over on tower/ cross arm are removed			
c	Check that all the insulator discs/ Long rod insulator units are free from any damage			
d	Check for unusual deflection in suspension strings and if found, should be rectified			
e	Check proper aviation warning signals on towers above 45 meter height			
f	Check that red & white paints have been applied on towers which fall in aviation route			
4	Hardware fittings			
a	Check that proper fixing of hardware fittings like corona control ring/ grading ring/ arcing horns/ etc. are provided as per the approved drawing/ specification			
b	Check the condition of cotter pins and ensure that proper size cotter pins have provided as per the approved drawing.			
c	Check that all insulators are thoroughly clean			

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SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
5	Conductor and its accessories			
a	Check that the conductors/ sub-conductors are free from scratches/ rubs			
b	Check that all joints on conductor/ earth wire/OPGW are away from the tower as per the specified distance (at least 30 meters) and joints are as per the approved drawings/ specification			
c	Check that not more than one joint in a sub conductor is provided in one span.			
d	Check that no mid span joints or repair sleeves are provided in major crossings for highway, Railway and major rivers.			
e	Check that all mid span joints on conductors/ Earth wire/OPGW and repair sleeves of compression type are free from sharp edges rust and dust			
f	Check that conductor is properly clipped in the suspension clamp			
g	Check that armor rods are provided on suspension towers			
h	Check that spacers/ spacer dampers are provided between sub conductors on each phase as per approved spacer placement chart/ specification			
i	Check that in case of tension towers, one additional spacer/ spacer damper is placed within 10 meter of dead end clamp.			
j	Check that all the spacers/ spacer-dampers are properly tightened and free from any external damage.			
k	Check that spacing of vibration dampers from the tower and spacing between damper to damper where two vibration dampers provided are properly fixed and tightened as per the damper placement chart/ specification			
l	Check that all the jumpers are properly fixed and torque tightened as per the approved drawing/ specification			

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SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
m	Check that on conductors/ earth wires/OPGW hardware fittings are free from all foreign material like dead bird/ fallen tree/ bird nests etc.			
n	Check that suitable counter weight is provided on Pilot string insulator (CLR type) as per approved drawings			
o	Check that Counter weight is provided for pilot insulator string in case of transposition tower (for both disc type/CLR type string)			
p	Geotagged digital Photographs indicating all jumper bolts are provided and properly tightened for at least 10% jumper connections are taken on random basis and preserved			
6	Different type of Clearances			
a	Check that right of way is not obstructed by any building/hut etc. The vertical clearance and horizontal clearance need to be maintained (if present/applicable) (Refer Table-1 and 2)			
b	Check that minimum clearance with trees is maintained if Trees are present in the corridor (Refer Table-3)			
c	Check that mid span clearance between top conductor and earth wire/ OPGW is adequate (Refer Table-4)			
d	Check that clearance between lowest conductor and ground is more than the required minimum ground clearance (Refer Table-5)			
e	Check that Jumper drop (i.e. distance between cross-arm and null point of jumper) as per design/drawing. All jumpers shall be checked for proper tightening. (Refer Table-6)			
f	Check that minimum clearance at Power line crossing is maintained. (if applicable) (Refer Table-7)			

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SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
g	Check that minimum clearance at railway track crossing is maintained (if applicable). (Refer Table-8)			
h	Check that minimum clearance at NH crossing is maintained. (Refer Table-9)			
i	Check that minimum clearance at River crossing is maintained (if applicable). (Refer Table-10)			
j	Measure the sag in one of the span in each section and check that sag and tension of the section is in line with specification and sag & tension calculation chart is approved by Engg. Refer Format-B for measurement of Sag			
7	Tower footing impedance			
a	Tower footing impedance needs to be measured at each location and it is to be ensured that impedance value is less than 10 ohms Refer Format-C for measurement of Tower footing impedance			
b	Physically check that earthing is at healthy condition (i.e. not damaged/not loose/not open)			
	10% checking			

Format-A for checking Back to Back measurement of stub

	As per drawing	Measured value	Deviation
Leg A-Leg B			
Leg B-Leg C			
Leg C-Leg D			
Leg D-Leg A			
Leg A-Leg C			
Leg B-Leg D			

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Table-1: Clearance for right of way at different voltage level

Transmission voltage (kV)	66	132	220	± 320 HVDC	400 (S/C)	400 (D/C)	± 500 HVDC	± 800 HVDC	765(S/C) *(H/D type)	765 (D/C)	1200 (S/C)
ROW width (Meters)	18	27	35	44	52	46	52	69	85/ 64	67	89

* H-Horizontal configuration
D-Delta configuration
Formats for record

Location No	
ROW width (Meters)	

Table-2: Clearances from buildings of Lines

a) Vertical clearance

Voltage (kV)	66	132	220	400	765	1200
Minimum clearance (mm)	4000	4600	5500	7300	10600	14500

b) The horizontal clearance

Voltage (kV)	66	132	220	400	765	1200
Minimum clearance (mm)	2300	2900	3800	5600	8900	12800

Note: Clearance are calculated as per norms specified in clause no 61 of CEA safety regulation 2010

c) Clearance for DC line

Sl. No	DC Voltage (kV)	Vertical Clearance (in mm)	Horizontal Clearance (in mm)
1.	100 kV	4600	2900
2.	200 kV	5800	4100
3.	300 kV	7000	5300
4.	400 kV	7900	6200
5.	500 kV	9100	7400
6.	600 kV	10300	8600
7.	800 kV	12400	10700

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Formats for record (if applicable)

Building /Structure	HCL	VCL
Clearance from building		

Table will be repeated for more than structure present

Table-3 : Minimum electrical clearance between Conductor & Trees

Voltage (KV)	Minimum clearance between conductors and trees (in meter)
66	3.4
132	4.0
220	4.6
400	5.5
765	9.0
+/-500 HVDC	7.4
+/-800 HVDC	10.7
1200	13

Formats for record (if applicable)

Tree	
Clearance from line	

Table repeated for more than one tree in corridor

Table-4: Minimum clearance for top conductor and Earth wire at mid-span

Voltage (kV)	66	132	220	± 320 HVDC	400	765	± 500 HVDC	± 800 HVDC	1200
Minimum mid span clearance (mm)	3000	6100	8500	9000	9000	9000	8500	12000(pole) 6100(DMR)	18000

Formats for record

Location	
Mid span Clearance value	

Table will be repeated if more than circuit is present in the line

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Table-5: Minimum ground clearance for different voltage level

Transmission voltage kV)	66	132	220	± 320 HVDC	400	765	± 500 HVDC	± 800 HVDC	1200
Minimum Ground Clearance (mm)	5500	6100	7015	8500	8840	18000	12500	18000	24000

Formats for record

Location	
Minimum Ground Clearance (mm)	

Table will be repeated if more than circuit is present in the line

Table-6: Table for Jumper Drop

Transmission voltage kV)	66	132	220	400	765	± 500 HVDC	± 800 HVDC
Jumper Drop (in meter)	1.3	1.8	2.4	3.6	6.1	4	7.8(pole) 2.6(DMR)

*values to be confirmed with respective drawings

Formats for record

Span (Tower location nos.)		Jumper drop for Circuit-I		
		R	Y	B

Table will be repeated for other circuit too in case of D/C or M/C

Table 7: Measurement of minimum clearance when line is crossing another Power line

SI No	Nominal System Voltage (in kV)	132	220	400	+/- 500 HVDC	765 kV	+/- 800 kV HVDC	1200
1.	132KV	3050	4580	5490	6860	7940	9040	1044
2.	220KV	4580	4580	5490	6860	7940	9040	1044
3.	400KV	5490	5490	5490	6860	7940	9040	1044
4.	+/- 500 kV HVDC	6860	6860	6860	6860	7940	9040	1044
5.	765 kV	7940	7940	7940	7940	7940	9040	1044
6.	+/- 800 kV HVDC	9040	9040	9040	9040	9040	9040	1044

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7.	1200 kV	1044	1044	1044	1044	1044	1044	1044
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Formats for record (if applicable)

Span (Tower location nos.)	Crossing Power line details (Name & voltage)	Clearance (mm)

Table 8: Measurement of minimum clearance when line is crossing Railway track

(i) Vertical clearance for OHE (other than high rise OHE):

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line crossing or crossing planned for alteration
1	Above 66 kV & up to 132 kV	15.56 m
2	Above 132 kV & up to 220 kV	16.46 m
3	Above 220 kV & up to 400 kV	18.26 m
4	Above 400 kV & up to 500 kV	19.16 m
5	Above 500 kV & up to 800 kV	21.86 m

(ii) Vertical clearance for high rise OHE*:

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line crossing or crossing planned for alteration
1	Above 66 kV & up to 132 kV	17.56 m
2	Above 132 kV & up to 220 kV	18.46 m
3	Above 220 kV & up to 400 kV	20.26 m
4	Above 400 kV & up to 500 kV	21.16 m
5	Above 500 kV & up to 800 kV	23.86 m

* Applicable only for electrification of routes where double stack container having maximum height of 6809 mm is plying

(iii) Minimum Clearances between Highest Traction Conductor & Lowest Crossing conductors

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line crossing or crossing planned for alteration
1	Above 66 kV & up to 132 kV	3.05
2	Above 132 kV & up to 220 kV	4.58
3	Above 220 kV & up to 400 kV	5.49
4	Above 400 kV & up to 500 kV	7.94

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5	Above 500 kV & up to 800 kV	7.94
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Notwithstanding the above ,Minimum clearance for railway crossings shall be as per Indian Railway Schedule of dimensions(BG) Revised 2004 as amended from time to time.

Formats for record (if applicable)

Span (Tower location nos.)	Railway track details (Name & voltage)	Vertical clearance for OHE	Vertical clearance for high rise OHE	Minimum Clearances between Highest Traction Conductor & Lowest Crossing conductors

Note: Minimum clearance when power line crossing railway track:

Table-9: Minimum Clearance in air above ground and across road surface of Highways or roads for lowest conductor of overhead lines

A) AC system

Nominal system Voltage(in kV)	Clearance above ground			Clearance between conductor & road surface across high way(in meter)
	Across street (in meter)	Along street (in meter)	Elsewhere) (in meter)	
66	6.5	6.1	5.5	11.6 or U/G cable
132	6.5	6.1	6.1	11.6
220	7.02	7.02	7.02	12.52
400	8.84	8.84	8.84	14.0
765	18*	18*	18*	18.8
1200	24*	24*	24*	30

B) DC system

Nominal system Voltage(in kV)	Clearance above ground	Clearance between conductor & road surface across high way(in meter)
+/- 500 kV HVDC	12.5	17.25
+/- 800 kV HVDC	18	22.75

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Formats for record (if applicable)

Span (Tower location nos.)	Name of NH	Clearances	
		Clearance above Ground	Clearance between conductor & road surface across high way(in meter)

Table-10: Minimum Clearance of Power Conductor over the Highest Flood Level in case of navigable/non navigable rivers

AC system

AC Voltage Level in kV (Nominal voltage)	Minimum Clearance above H.F.L (mm)	
	Navigable River	Non-navigable river
66	19000	3650
110	19000	4300
132	19220	4300
220	20100	5100
400	21900	6400
765	25550	9400
1200	29900	11000

DC system

DC Voltage in kV	Minimum Clearance above H.F.L (mm)	
	Navigable River	Non-navigable river
+/- 500	24030	6750
+/- 800	27700	11000

Formats for record (if applicable)

Span (Tower location nos.)	Name of river (navigable/non- navigable)	Clearances	
		Clearance above Ground	Clearance between conductor & road surface across high way(in meter)

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Format-B for measurement of sag in one of the span in each section (as applicable)

Section (Loc A To Loc B)	Span (Loc C To Loc D)	Measured sag(in meter)

Note: Measurement to be repeated for each phases and circuits

Format-C for measurement of Tower footing impedance

Location No.	Leg No	R(in Ω)	Rc (in Ω)	C (in nF)	L (in μ H)	Z (in Ω)
	Leg-A					
	Leg-B					
	Leg-C					
	Leg-D					

(Note: The value should not be more than 10 ohms)

The above inspection and measurements are carried out in the location mentioned above and the remaining activities, temporary arrangements etc. are documented in format no: **AM/COMM/LINE/2**

	Erection Agency Representative	Supplier Agency Representative	Project Execution (POWERGRID)
Signature			
Date			
Name			
Organization			

Note:

- This format is to be filled for each tower location.
- This format is to be kept at group head quarter with a copy to regional head quarter
- This format to be signed not below the level of engineer and important locations like river crossing, railway crossing, National Highway, power line crossing etc. are to be countersigned by minimum Manager for POWERGRID and in-charge of the working agency

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DOCUMENT NO: D-2-01-70-01-03-Part B
DOCUMENT NAME: PRE-COMMISSIONING FORMATS FOR TRANSMISSION LINES

FORMAT NO: AM/COMM/LINE/2

NAME OF LINE	CIRCUIT	DATE OF ENERGISATION

INSPECTION RECORD PRIOR TO HANDING OVER FOR ENERGIZATION

LIST OF REMAINING ACTIVITIES

LIST OF TEMPORARY ARRANGEMENTS

Region:			Location		Observation		Completion		Inspection	
Section A/B/C	Sl. No.	Tower No.	From	To	Date	Sign	Date	Sign	Date	Sign
			Description of remaining activities/ Temporary arrangements							

	Erection Agency representative	Erection (POWERGRID)	Line In-charge (POWERGRID)
Signature			
Date			
Name			
Organization			

Details of sections is to be furnished in this format:

- Outstanding activities remaining in any part of the line
- A list of temporary arrangements introduced.
- Checklist records properly completed and signed as per format **AM/COMM/ LINE/ 1**
- Original tracing of Profile, Route alignment, Tower Design, Structural Drawings, Bill of material, Shop drawings, Stringing Charts indicating initial and final sag etc. of all towers submitted to POWERGRID.

Note: This document is to be retained at Group head S/S or TLM office with a copy RHQ

**POWER GRID CORPORATION OF INDIA LTD.
CORPORATE ASSET MANAGEMENT**

DOCUMENT NO: D-2-01-70-01-03-Part B

DOCUMENT NAME: PRE-COMMISSIONING FORMATS FOR TRANSMISSION LINES

FORMAT NO: AM/COMM/LINE/3

NAME OF LINE	CIRCUIT	DATE OF ENERGISATION

HANDING OVER RECORD FOR ENERGIZATION

A. GENERAL DATA AND INFORMATION:

REGION		Office		TYPE OF TOWERS		S/C	D/C	M/C
VOLTAGE RATING		KV		Tower locations	From		To	
Total no. of towers				Total length			Kms.	

Details:

SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
1	Check list of entire section of the line along with towers and accessories under this Division have carried out and documented in the format no: AM/COMM/LINE/1			
2	Inspection has been carried out in all towers and the outstanding issues along with temporary arrangements are documented in the format no: AM/COMM/LINE/ 2			
3	No. of remaining activities/ points are listed at clause-B in this format these are minor in nature and do not stop charging the line			
4	All Electrical and Ground clearances are as per the Approved drawings issued from CC/ Engg. Dept have been checked and no deviation has been noted.			
5	All man and material and temporary antitheft electrical connection, if any, have been removed from all the locations under this Division .			
6	All electrical clearance has been received from CEA electrical inspector for charging of the line vide order no: Dated: (copy enclosed)			

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DOCUMENT NO: D-2-01-70-01-03-Part B

DOCUMENT NAME: PRE-COMMISSIONING FORMATS FOR TRANSMISSION LINES

SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
7	PTCC clearance has been received from CEA's PTCC Directorate for charging of the line vide order no: Dated: (copy enclosed)			
8	All statutory rules and regulations pertaining to line charging has been carried out and Nothing is pending			
9	All working agencies involved In construction/ erection of this Line are intimated regarding charging of this line and further work, if any, are to be carried out only after availing the Permit to Work (PTW) from the Concerned sub-station operating staff			

B. HANDING OVER CHECK POINTS(Minor nature)

SECTION	Points according to format no: AM/COMM/LINE/1 (Nos of remaining activities)	Points completed and confirmed		Points accepted	
		Date	Sign	Date	Sign
A					
SECTION	Points according to format no: AM/COMM/LINE/1 (Nos of remaining activities)	Points completed and confirmed		Points accepted	
		Date	Sign	Date	Sign
B					
C					
D					

The above line is handed over for Energization with/ without remaining activities

	Handed over by	Accepted for Energization
Signature		
Date		
Name		
Designation	Line In-charge	Commissioning In-charge

Note: For details of section, please refer pre commissioning doc no : D-2-01-70-01-02, format no
AM/COMM/LINE/ 2

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DOCUMENT NO: D-2-01-70-01-03-Part B
DOCUMENT NAME: PRE-COMMISSIONING FORMATS FOR TRANSMISSION LINES

FORMAT NO: AM/COMM/LINE/4

NAME OF LINE	CIRCUIT	DATE OF ENERGISATION

COMMISSIONING FORMAT

A. GENERAL DATA AND INFORMATION:

REGION		Office		TYPE OF TOWERS		S/C	D/C	M/C
VOLTAGE RATING		KV		Tower locations	From		To	
Total no. of towers				Total length			Kms.	

Details:

SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
1	The entire section of the line handed over for energization as per POWERGRID format no: AM/COMM/LINE/3 on Dated:			
2	No. of remaining activities/ points are listed as per format no: AM/COMM/LINE/2 on and these are minor in nature and do not stop charging the line			
3	All the equipments involved in charging of the line are tested and documented as per the pre-commissioning formats of bay equipment			
4	Pre - commissioning tests of bay/ feeder as per approved document has been completed and test results are documented			
5	In case, reactor provided in this line, all tests are carried out as per prescribed format and all test results are documented			
6	All electrical clearance has been received from CEA electrical inspector for charging of the line vide order no: dated: (copy to be enclosed)			

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DOCUMENT NO: D-2-01-70-01-03-Part B

DOCUMENT NAME: PRE-COMMISSIONING FORMATS FOR TRANSMISSION LINES

SL NO	DESCRIPTION	STATUS		REMARKS Record Deficiencies If Any
		YES	NO	
7	All man and material and temporary antitheft electrical connection, if any, removed from all the locations			
8	All electrical clearance has been received from CEA electrical inspector for charging of the line terminating feeder vide order no : dated:			
9	PTCC clearance has been received from CEA's PTCC Directorate for charging of the line vide order no: Dated:			
10	All statutory rules and regulations pertaining to line charging has been carried out and nothing is pending			
11	All working agencies involved in construction/ erection of this line and sub-station Equipments are intimated regarding charging of this line & bay and further work, if any, are to be carried out only after availing the permit to work (PTW) from the concerned sub-station operating staff			
12	All the protections are checked and put into service as per standard format no: and documented			

B. MEASUREMENT INSULATION RESISTANCE FOR LINE (using 5 kV/ 10 kV motorized Insulation Tester):

BETWEEN	MEASURED VALUE IN M - OHM	REMARK	CONDITION
R-PHASE & GROUND			All ground switches at other end are opened. Min. value should be approx. 150 Mega ohm (value may change with weather condition)
Y-PHASE & GROUND			
B-PHASE & GROUND			
R-PHASE & Y-PHASE			
Y-PHASE & B-PHASE			
B-PHASE & R-PHASE			

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C. CONTINUITY TEST OF THE LINE

a. For phase marking confirmation

Sending end Conditions	Receiving end Insulation Resistance between	Measured value In ohms	Remarks
CLOSE R - Phase GS & OPEN Y - Phase GS & OPEN B - Phase GS	R – Phase & Ground		Low
	Y – Phase & Ground		High
	B – Phase & Ground		High
OPEN R - Phase GS CLOSE Y - Phase GS OPEN B - Phase GS:	R – Phase & Ground		High
	Y – Phase & Ground		Low
	B – Phase & Ground		High
OPEN R - Phase GS OPEN Y - Phase GS CLOSE B - Phase GS	R – Phase & Ground		High
	Y – Phase & Ground		High
	B – Phase & Ground		Low
CONNECT R & Y Phase E, all GS open	R & Y-phase		Low
	Y & B-phase		High
	B & R-phase		High
Connect R & B Phase, all GS open	R & Y-phase		High
	Y & B-phase		High
	B & R-phase		Low
Connect Y & B Phase, all GS open	R & Y-phase		High
	Y & B-phase		Low
	B & R-phase		High

Note:

1. If the test values are as per the remarks, phase marking at both ends are correct.
2. This test is to be done if the IR value do not show short circuit of the line with ground or between phases in IR measurement

D. Verification/validation of phase sequence

After closing the breaker from one end only the line can be charged.

- a Check the phase sequence by the phase sequence meter by connecting at the secondary of the CVT

OK	Not OK
----	--------

- b Check the phase sequence by the help of multi-meter in case of a charged sub-station at the secondary of the CVT (old & new) in the control panel as per the

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measurement indicated below:

Sl. No.	Voltage measurement between		Measured voltage (volts)	Remarks
	New circuit	Charged old circuit		
1	R-phase	R-phase		In case of correct phase sequence, the voltage measured between R & R phase, Y & Y phase, B & B phase of old charged line and newly charged circuit will be zero or very small and all other measurements will show full line CVT phase to phase secondary voltage
2	R-phase	Y-phase		
3	R-phase	B-phase		
4	Y-phase	R-phase		
5	Y-phase	Y-phase		
6	Y-phase	B-phase		
7	B-phase	R-phase		
8	B-phase	Y-phase		
9	B-phase	B-phase		

F CHARGING INSTRUCTION

Once the correct phase sequence is established, the charging instruction received from CC-Engg. & CTUIL to be followed and properly documented regarding status of various parameters with other lines and generators (**if any**)

Charging instruction no: Dated: (Copy enclosed)

i. Charging details:

Date: Time:

ii Pre-charging conditions for sending end

a. Voltage kV

b. Generator Details:

Unit No	Capacity	MW Generated	MVAR Generated	Remarks
1				
2				
3				

c. Lines Connected:

Sl. No.	Name of line	MW	MVAR	Line Reactor	
				In service	Capacity
1					
2					
3					

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d. **No. and rating of ICTs connected**

Sl. No.	Rating		MW	Tertiary reactor MVAR
	Voltage	MVA		
1.				
2.				
3.				
4.				

e. **Status of Bus Reactor, if any**

Sl. No.	Rating	Status of charging/Healthiness

iii **On charging condition**

Details	Sending end	Receiving end
Voltage		N/A
MVAR		N/A
Open end voltage	N/A	

iv **Post charging condition**

Details	Sending end	Receiving end
Voltage		
MW		
MVAR		

The line has been/ not has been successfully test charged with or without following operational constraints:

- 1.
- 2.
- 3.

Signature					
Name					
Designation					
Organization				POWERGRID	POWERGRID
Agency	Line Erection	S/S Erection	Line Supplier	Line In-Charge	S/S In-Charge

Standard Manufacturing Quality Plan

For

Galvanized Tower Structures/Parts

(MQP no. CC/QA&I/MQP/Standard/Tower Parts Rev 06)

Valid from 16-10-2024 to 15-10-2027

ROHITAV
BAKSHI

Digitally
signed by
ROHITAV
BAKSHI

Instructions for Code Allocation



Code 1	Indicate place where testing is planned to be performed i.e. Inspection location A At Equipment Manufacturer's works (Transmission Line Tower Manufacturer) B At Component Manufacturer's works (Re-Roller/Plate Manufacturer) C At Authorised Distributor's works D At Independent Lab E At Turn Key Contractor's location F Not specified	Code 2	Indicate who has to perform the tests i.e. Testing Agency J The Equipment Manufacturer K The Component Manufacturer L The Third Party M The Turnkey Contractor
Code 3	Indicate who shall witness the tests i.e. Witnessing Agency P Component Manufacturer Q Component Manufacturer and Equipment Manufacturer R Component Manufacturer, Equipment Manufacturer and Contractor S Equipment Manufacturer T Equipment Manufacturer and Contractor U Equipment Manufacturer and/or Contractor and POWERGRID V Third Party	Code 4	Review of Test Reports/Certificates W By Equipment Manufacturer during raw material / bought out component inspection X By Contractor during product / process inspection Y By POWERGRID during product / process inspection Z By Contractor and / or POWERGRID during product / process inspection
Code 5	Whether specific approval of sub-vendor / component make is envisaged? E Envisaged N Not Envisaged	Code 6	Whether test records required to be submitted after final inspection for issuance of CIP/MICC Y Yes N No

Notes:

1	The MQP should be read in conjunction with POWERGRID specification and shall deem to include additional tests, if any required as per the contract.
2	POWERGRID specification shall include provisions of letter of Award, POWERGRID approved drawings / Technical Data Sheet / BOM / Test Schedule / Test Procedure applicable to the specific contract.
3	In case of any contradiction between MQP and POWERGRID Technical specification/Approved Drawing, the Technical specifications/Approved Drawing of respective project shall have precedence over this MQP.
4	It is the responsibility of the manufacturer to ensure that this document is readily available at their works as well as at the works of their sub vendors in order to avoid any delay at the time of inspection.
5	For the steel sections procured from approved re-rollers of POWERGRID the POWERGRID approved SMQP for re-roller shall be adhered to.
6	All bought out components /fasteners to be procured from POWERGRID approved manufacturers as per their standard/respective manufacturing quality plan approved by POWERGRID/relevant IS and CIP clearance to be obtained.
7	Valid calibration certificates of various testing and measuring instrument / equipments from Labs, accredited as per ISO/IEC -17025 which operates in accordance with the requirements of ISO/IEC 17011 having full membership & MRA of ILAC/APLAC, shall be maintained.
8	In case of any test being carried out at the third party lab, the same should be accredited as per ISO/IEC -17025 which operates in accordance with the requirements of ISO/IEC 17011 having full membership & MRA of ILAC/APLAC
9	The manufacturer shall maintain the proper co-relation of test certificates from raw material stage to finished product stage and the records should be available during inspection by POWERGRID. In absence of proper correlation of test certificates of Raw Material, actual testing to be done during Final Inspection.
10	The manufacturer should progressively align their Quality system and sub-vendors Quality system to the requirements of ISO 9000 series Quality standards and in due course of time should get their quality system certified to ISO 9001.
11	All bent pieces shall be checked at the process of bending by a bend gauge made as per bend ratio/degree shown in the sketch of the item / mark no. On the stand, one piece is thoroughly checked with bend gauge and all other pieces are checked by comparison method and pieces are cleared for further process. If the holes are to be made near the bend line, the same shall be done after bending.
12	The sample pieces consumed in a testing shall be replenished by the manufacturer at the time of dispatch. If the offered material meets the quality requirements, CIP/MICC shall be issued for total quantity offered without deducting the weight of materials consumed in testing.
13	Grades of steel used as well as the relevant standards it is conforming to, shall be as per the approved Drawings/ BOM for the specific contract and the same shall be indicated in the offer list at the time of inspection.
14	Steel plates below 6mm size used for packing plates/packing washers, produced as per IS: 1079 (Grade-0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates , joint splices etc. the same shall conform to IS : 2062 or equivalent standard. Flats of equivalent grade meeting mechanical strength/ metallurgical properties may also be used in place of plates for packing plates/ packing washers.
15	Dispatch of the inspected Tower Structures shall be done with each tower/ panel wise bundling in order to ensure availability of complete Tower parts without missing of any member at site.
16	Pieces of light sections to be wire bundled and those of heavy sections to be supplied loose. Stacking to have proper ventilation and kept inclined. Damage to galvanization coating to be avoided while handling. The manufacturer to ensure sequential supplies and other details as per POWERGRID Technical Specification
17	In case Tower parts are to be used at sub zero temperature, Impact testing at -20° C shall be carried out during final inspection in line with IS/ POWERGRID TS.

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18	Welding procedure and Welder's performance qualification shall be done in line with approved Guideline (attached herewith), in case welding is involved at any stage of fabrication/erection.	
19	All Welding procedures, qualification of welders, operators and procedures, electrodes, preheat, notch toughness and minimum yield of the electrodes needs to be ensured in conformance with the requirements of the latest revision of American Welding Society Structural Welding Code (ANSI/AWS D1.1) or other equivalent National/International standards. Preheating shall be done according to the ANSI/AWS code or the steel producers' recommendations or both.	
20	All relevant standards shall be read along with the latest amendments.	
21	POWERGRID may review the effective implementation of the process during the product inspection/process inspection. In case of any violation in process or process parameters are observed, the reason along with corrective & preventive measure shall be conveyed to POWERGRID.	
22	Any addition /change in new vendor/design/process shall be submitted for review by POWERGRID and necessary change in MQP may be requested, if necessary.	
23	If any activity (for which manufacturer is already approved) is being outsourced due to some exigencies/ unforeseen circumstances, then prior approval from POWERGRID needs to be taken.	
24	If the manufacturer does not have facility for any process, then the same shall be carried out at POWERGRID approved sources/as per the prior approval of POWERGRID. All the tests/checks against this outsourced process shall remain the same as indicated against respective process and the applicable codes shall be A/B, J/K, S/P,W/Z, -,N.	
25	Inspection of angle sections at black stage for galvanised tower structures/parts, irrespective of specific contract can be followed as detailed hereunder:	
25.1	The manufacturer may raise inspection call for angle section at black stage at re-roller's work against any one of the ongoing Contract.	
25.2	The manufacturer may fabricate the raw material, cleared under CAT –A CIP for a particular contractor, for any of its POWERGRID projects under execution.	
25.3	The manufacturer will maintain a separate register indicating splitting and swapping of material between different projects awarded to same contractor, which can be reviewed by POWERGRID inspection engineer. Separate register for each Contractor is to be maintained if the manufacturer is executing jobs for different contractor.	
25.4	The manufacturer as a contractor on whom POWERGRID has placed the contract, shall be allowed to split and swap material in black stage only, amongst its different ongoing contracts with POWERGRID, without any obligation to POWERGRID.	
25.5	The final inspection after fabrication and galvanizing, however, will continue to be contract wise and CIPs will be issued for each contract only.	
26	In case of any failure of samples during mechanical or chemical testing, retesting shall be carried out to nullify any possibility of error during sample preparation or testing. While selecting samples for retesting, one sample shall be taken from the very same section of Tower structure from which the original test sample was taken and another sample shall be selected from any other member (section of same size) in the offered lot. The lot of this particular section size shall be considered acceptable only if both the samples selected for retesting are conforming to acceptance parameters against the test performed. Else, following action shall also be taken .	
a)	For Individual Calls: Any sample(s) out of the selected samples (as per sampling plan) fails in mechanical or chemical testing.	Material corresponding to the failed section(s) shall be rejected . Further, samples of the section(s), from which samples were not selected earlier for testing, shall also be taken for testing.
b)	Combined Calls Any sample(s) out of selected samples for testing (after calls combination) fails in mechanical or chemical testing.	Material corresponding to the failed section(s) against all the inspection calls combined shall be rejected . Further, samples of the section(s), from which samples were not selected earlier for testing, shall also be taken for testing.
27	The manufacturer shall strip off galvanizing of rejected material before re-galvanizing in case the rejection is due to galvanizing defects.	
28	The manufacturer shall dispose off entire section rejected in physical testing by gas cutting or by machine cutting from any end of rejected mark number.	
29	Combined sampling shall be carried out based on the request of contractor/ sub-vendor (TLT manufacturer), an undertaking/ letter (format attached) in this regard shall be taken from the contractor / sub-vendor (TLT Manufacturer).	

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes						Remarks
							1	2	3	4	5	6	
1	RAW MATERIAL												
1.1	STRUCTURAL STEEL (ANGLE SECTIONS, PLATES)											E	
1.1.1	Steel Plates and Angle sections shall be procured from POWERGRID approved Sources. For angle sections procured from approved re-rollers, specific manufacturer approval of POWERGRID for size and Grade of Angle sections shall be ensured along with CIP against every lot at re-roller's works. The acceptance norms shall be as per relevant standards indicated in TS/approved drawing/BOM. However, if different grade is mentioned in the Technical Specifications/approved drawings, acceptance norms shall be as per the relevant standards.												
1.1.2	Mechanical Properties												
1.1.2.1	Yield Stress	Mechanical	Plant Standard of Transmission Line Tower Structure Manufacturer	IS: 2062/Relevant Standard as mentioned in POWERGRID TS	IS: 2062/Relevant Standard as mentioned in POWERGRID TS	Plant Record	A	J	S	W/Z		Y	Applicable for only Grade B0/BR and C as specified in Bill of Material /Drawing or TS
1.1.2.2	Ultimate Tensile Strength	Mechanical				Plant Record	A	J	S	W/Z		Y	
1.1.2.3	Percentage Elongation at 5.65√Area	Mechanical				Plant Record	A	J	S	W/Z		Y	
1.1.2.4	Bend Test	Mechanical				Plant Record	A	J	S	W/Z		Y	
1.1.2.5	Impact Test (if applicable)	Mechanical				Plant Record/Third Party Lab	A/D	J/L	S/N	W/Z		Y	
1.1.3	Chemical properties												
1.1.3.1	Chemical Analysis	Chemical	Plant Standard of Transmission Line Tower Structure Manufacturer	As per Chemistry enclosed at Annexure-I for each source/Relevant standards indicated in POWERGRID TS	As per Chemistry enclosed at Annexure-I for each source/Relevant standards indicated in POWERGRID TS	Plant Record/Third Party Lab	A/D	J/L	S/N	W/Z		Y	
1.1.4	Visual Inspection												
1.1.4.1	Visual	Visual	Plant Standard of Transmission Line Tower Structure Manufacturer	Relevant Standard as mentioned in POWERGRID TS	Material to be free from surface defects like laminations, rough/jagged and imperfect edges, cracks, rounded apex, deep roll marks, pipy and any harmful defects	Plant Record	A	J	S	W/Z		Y	

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes						Remarks
1.1.5	Dimensional Inspection												
1.1.5.1	Angle Sections												
1.1.5.1.1	Tolerances For Leg Length of Angles Equal / Un Equal	Measurement	Plant Standard of Transmission Line Tower Manufacturer	IS 1852/ IS 808/ POWERGRID Spec	As per relevant IS standards	Plant Record	A	J	S	W/Z		Y	
1.1.5.1.2	Out of Square ness	Measurement		IS 1852/ POWERGRID Spec		Plant Record	A	J	S	W/Z		Y	
1.1.5.1.3	Camber	Measurement		IS 1852/ POWERGRID Spec		Plant Record	A	J	S	W/Z		Y	
1.1.5.1.4	Root radius	Measurement		IS 808		Plant Record	A	J	S	W/Z		Y	
1.1.5.1.5	Weight Tolerance For Angle Sections	Unit Weight Test		IS 1852/ IS 808		Plant Record	A	J	S	W/Z		Y	
1.1.5.2	Plates												
1.1.5.2.1	Weight Tolerances	Unit Weight Test	Plant Standard of Transmission Line Tower Manufacturer	IS 1852 / IS 1730	As per relevant IS standards	Plant Record	A	J	S	W/Z		Y	
1.1.5.2.2	Thickness Tolerance	Measurement		IS 2062 IS 1730 / IS 1852		Plant Record	A	J	S	W/Z		Y	
1.2	Zinc (To be procured from POWERGRID approved sources or Imported LME registered source)										E		
1.2.1	Chemical Composition	Chemical	Every Consignment	IS 209/IS 13229	IS 209/IS 13229	Zinc Manufacturer TC	B	K	P	W		N	
			One sample for 100MT or Part thereof	IS 209/IS 13229	IS 209/IS 13229	TPL Reports	D	L	V	W		N	
			One sample of molten zinc taken from bath per quarter	IS 209/IS 13229	Min Zinc purity 98.5%	TPL Reports	D	L	V	W		N	

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes						
								Remarks					
2	<u>IN-PROCESS INSPECTION</u>												
2.1	Fabrication of Tower Parts												
2.1.1	Cropping (Cutting)	Dimensional	1 st Piece and every 50th Piece		Length Tolerance : ± 2 mm, The cut surface to be clean, reasonable square & free from distortion.	Plant Record	A	J	S	Z		N	
2.1.2	Stamping	Visual	1 st Piece and every 50th Piece		Letter size as per POWERGRID Tech. Specn. / TPL norms	Plant Record	A	J	S	Z		N	
2.1.3	Punching / Drilling	Dimensional	1 st Piece and every 50th Piece		Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The punching may be adopted for thickness up to 12 mm. Tolerances regarding punch holes should be as follows:	Plant Record	A	J	S	Z		N	
2.1.4	Edge Security	Dimensional	1 st Piece and every 50th Piece	IS 802 Part II/ IS 7215/ POWERGRID approved Drwg., Shop Sketches		Plant Record	A	J	S	Z		N	
2.1.4.1	For 13.5 mm dia Hole				Sheared 20mm Min. Rolled 16mm Min.								
2.1.4.2	For 17.5 mm dia Hole				Sheared 23mm Min. Rolled 20mm Min.								
2.1.4.3	For 21.5 mm dia Hole				Sheared 28mm Min. Rolled 25mm Min.								
2.1.4.4	For 25 mm & 25.5 mm dia Hole				As per approved drawing								
2.1.5	Drilling & Punching Hole To Hole Distance		1 st Piece and every 50th Piece		Tolerance cumulative and between consecutive hole shall be within ± 2 mm and ± 1mm respectively	Plant Record	A	J	S	Z		N	
2.1.6	Notching Flange Cut Corner Cut Bevel Cut		1 st Piece and every 50th Piece		+ 5mm on specified length of cut, operationally shearing up to 12 mm thick & by gas cutting for material above 12 mm thick	Plant Record	A	J	S	Z		N	

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes						Remarks
2.1.7	Heel Cutting	Dimensional	1 st Piece and every 50th Piece	POWERGRID Approved Drwgs./ Shop Sketches	for members > 12mm thick - gas cutting may be adopted followed By grinding/Machine cutting; Tolerance on heel cutting length: +10mm	Plant Record	A	J	S	Z		N	
2.1.8	Bending		100% Pieces	IS 802(Part II)/ IS 7215/ POWERGRID Approved Drawing / Shop Sketches	(1) HT Sections / Plates - All Sections & all plates to be hot bent. (2) MS Section- i) Cold – Section upto 75X75X6 - Angle Upto 10° ii) Cold – Section upto 100X100X8 – Angle Upto 5° iii) Hot - Section above 75X75X6 – Angle Above 10° iv) Hot - Section above 100X100X8 – Angle Above 5°	Plant Record	A	J	S	Z		N	
2.1.9	Welding												
2.1.9.1	(a) WPS Approval (Welding procedure specification) (b) PQR/WQR Approval (Procedure /Welder qualification record)			As per POWERGRID Technical specn./approved Drg./POWERGRID approved Welding procedure & Welder's qualification		Plant Record	A	J	S	Y		N	WPS and Welder's qualification shall be done in line with Welder's Qualification Guideline
2.1.9.2	Dye-Penetration Test	Visual	Random Basis	As per POWERGRID Technical specn./approved Drg./POWERGRID approved Welding procedure & Welder's qualification		Plant Record	A	J	U	Y		N	CIP
2.1.9.3	Dimensional & visual for welded tower parts	Dimensional	Random Basis	As per POWERGRID Technical specn./approved Drg./POWERGRID approved Welding procedure & Welder's qualification		Plant Record	A	J	U	Y		N	CIP
2.1.10	Final Inspection of Fabricated Parts		Random Basis	All parameters from 2.1.1 to 2.1.13 above are checked and record maintained before releasing the material for galvanizing.		Plant Record	A	J	S	Z		N	

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes						Remarks
2.1.11	Foundation Bolts	Physical	1st piece & every 50th piece	IS 802/POWERGRID Technical spec./Approved drawing		Plant Record	A	J	S	Z		N	
2.1.11.1	Cutting & Shearing												
2.1.11.2	Chamfering												
2.1.11.3	Threading												
2.2	Galvanizing												
2.2.1	Degreasing	Chemical	One sample daily	IS 2629	Manufacturer's plant standard/Relevant IS	Plant Record	A	J	S	Z		N	
2.2.2	Pickling	Chemical	One sample daily	IS 2629	Manufacturer's plant standard/Relevant IS Iron contents 100 to 120 gram/litre. Max	Plant Record	A	J	S	Z		N	
2.2.3	Rinsing	Chemical	One sample daily	IS 2629	Manufacturer's plant standard/IS	Plant Record	A	J	S	Z		N	
2.2.4	Pre Fluxing	Chemical	One sample daily	IS 2629	IS 2629	Plant Record	A	J	S	Z		N	
2.2.5	Pre-heating	Measurement	One Check per day	IS 2629	IS 2629	Plant Record	A	J	S	Z		N	
2.2.6	Dipping After drying is over the material is dipped in molten zinc. Following parameters are controlled												
2.2.6.1	Zinc bath temperature Recording is done by graphical manner or sensors with digital display		Hourly Check	IS 2629	450+/-10° C	Plant Record	A	J	S	Z		N	
2.2.6.2	Immersion & Withdrawal time. Degree of immersion and withdrawal time is decided based on thickness and length of material		Hourly Check	IS 2629	IS 2629	Plant Record	A	J	S	Z		N	

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes		Remarks
2.2.7	Quenching in Running Water: After dipping the material is quenched in running water			IS 2629	IS 2629	Plant Record	A J S Z	N	
2.2.8	Dichromating : After quenching, material is dipped in sodium dichromatic solution to avoid the white rust.(Proprietary Chemicals.)		One Sample daily	IS 2629	IS 2629	Plant Record	A J S Z	N	
2.3	Galvanizing Check								
2.3.1	Visual Checking	Visual	100%	IS 2629	Surface to be free from defects like bare / black spots, (except when small and suitable for patching) heavy ash & flux inclusions, lumps, pimples, runs etc	Plant Record	A J S Z	N	*For marine mentioned in BPS, Coating Thickness shall be $\geq 5\text{mm}=127$ micron, $<5\text{mm}$ & plate= 87 micron *For marine, $\geq 5\text{mm}=900\text{gm/ m}^2$, $<5\text{mm}$ & plate= 610 gm/ m^2
2.3.2	Thickness of Zinc coating	Measurement	8 samples/shift	IS 4759	The minimum average zinc coating for all section shall be 87 microns for thickness ≥ 5 mm & 65 microns for thickness $< 5\text{mm}$ and for plates	Plant Record	A J S Z	N	
2.3.3	Weight of Zinc Coating	Measurement	3 samples/shift	IS 4759 / IS 6745	(a) For thickness below 5mm, but not less then 2 mm and for plates- Average Mass of Coating - 460gm/m^2 (b) For thickness 5mm & above – Average Mass of Coating - 610 gm/ m^2	Plant Record	A J S Z	N	
2.3.4	Uniformity of Zinc coating	Measurement	3 samples/shift	IS 2633	Material to withstand 4 dips of one minute each without showing signs of copper deposits	Plant Record	A J S Z	N	
2.3.5	Adhesion Tests of Zinc coating	Pivoted Hammer Test	3 samples/shift	IS 2629	No removal or lifting of coating in areas between hammer impressions	Plant Record	A J S Z	N	


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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes						Remarks
3	FINAL INSPECTION AND TESTING (Inspection Engineer to ensure/check compliance of Notes/general requirements mentioned in this MQP)												
3.1	Visual and Dimensional Inspection: For Fabrication (as per approved Drawing) & Galvanizing	Visual & Measurement	a. For Angles/Plates etc. which have been procured with CIP (in line with MQP): Total nos. of samples shall be calculated (A) based on One sample/50	Please refer Sr. No 2.1.1 to 2.1.9 /POWERGRID approved drawing	Please refer Sr. No 2.1.1 to 2.1.9 /POWERGRID approved drawing	Test Report	A	J	U	Z		Y	CIP
3.2	Mechanical Properties		MT/Section/Source (Re-roller/Manufacturer). Only 25% of "A" shall be randomly selected for testing.										
3.2.1	Yield Stress Test	Mechanical	b. For Angles/Plates etc. which have been procured without CIP (in line with MQP) Total nos. of samples shall be calculated (B1) & (B2) based on One sample/50 MT/ Section / Source (Re-roller/ Manufacturer) for MS (B1) and HT (B2) items respectively and following sampling plan for inspection shall be adhered:	Please Refer (for test values) Sr. No. 1.2.1 to 1.2.5	Please Refer (for test values) Sr. No. 1.2.1 to 1.2.5	Test Report	A	J	U	Z		Y	
3.2.2	Ultimate Tensile Strength	Mechanical	MS Items: 25% of B1 HT Items: 50% of B2				A	J	U	Z		Y	
3.2.3	Percentage Elongation at 5.65√Area	Mechanical	c. Sampling plan for testing for new vendors (initially for a period of one year and subsequently as indicated in their MQP approval extension letter) and in cases, where material has been procured from traders (after approval from POWERGRID):				A	J	U	Z		Y	
3.2.4	Bend Test	Mechanical	One sample for Every 50 MT/ section/Lot or part thereof for each source (re-roller/manufacturer)				A	J	U	Z		Y	
3.2.5	Impact Test (if applicable)	Mechanical					A/D	J/L	U/V	Z		Y	
3.3	Chemical Properties	Chemical	100% samples selected for testing as per above sampling plan	IS: 2062/Grade as mentioned in POWERGRID TS	IS: 2062/Grade as mentioned in POWERGRID TS	Test Report/ Third party Lab report	A/D	J/L	U/S	Z		Y	CIP

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes							Remarks
3.4	Galvanizing Tests													
3.4.1	Thickness of Zinc Coating (Galvanizing coating check by Elcometer)	Chemical	100% samples selected for testing as per above sampling plan	IS 2629/IS 4759/IS 6745/IS 2633/	Please refer SI. No. 2.3	Test Report	A	J	U	Z		Y	CIP	
3.4.2	Weight of Zinc Coating	Chemical												
3.4.3	Uniformity of Zinc Coating	Chemical												
3.4.4	Adhesion Test of Zinc Coating	Chemical												
3.5	For Foundation Bolt													
3.5.1	Dimensional test	Measurement	Sampling as per IS 1367/2500	POWERGRID Drawing	POWERGRID Drawing	Test Report	A	J	U	Z		Y	CIP	
3.5.2	Mechanical Test UTS, Yield & Elongation	Mechanical	2 samples lot	As per IS 2062/SAE 1018	As per IS 2062/SAE 1018	Test Report	A	J	U	Z		Y		
3.5.3	Chemical Test	Spectro Analysis	2 samples lot	As per IS 2062/SAE 1018	Chemistry needs to be comparable with raw material supplier TC	Test Report	A	J	U	Z		Y		
3.5.4	Impact Test (if applicable)	Mechanical	One sample per section per lot for each source	IS 2062 Grade E250, POWERGRID Tech. Specn.	IS 2062 Grade E250, POWERGRID Tech. Specn.	Test Report	A/D	J/L	U/V	Z		Y		
3.6	Packing, Storing, Bundling and Handling		100%		IS802/POWERGRID specn./Packing list to be submitted along with dispatch documents	Manufacturer's Log Book/Format No								Tower wise bundling shall be carried out. Pieces of lighter sections shall be wire bundled and heavy sections shall be supplied loose. Stacking shall have proper ventilation and be kept inclined. Damage to galvanization coating shall be avoided while handling. Sequential supplies and other details as per POWERGRID technical specification shall be ensured.

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes	पावरग्रिड POWERGRID	
								Remarks	
ANNEXURE-I Agreed Chemical Composition of Billets / Blooms for POWERGRID Projects									
	Rashtriya Ispat Nigam Ltd (RINL):			SAIL (IISCO)		SAIL (BSP)			
Grade	C18HMn-For HT (E350) with V	C18HMn-For HT (E350) with Ti	C20 MMn-For MS (E250)	SAIL Tower Grade VI For HT (E350)	C20 MMn-For MS (E250)	SAIL Tower Grade VI For HT (E350)	C20 MMn-For MS (E250)		
C	0.15-0.20	0.15-0.20	0.17-0.23	0.15-0.22	0.16-0.25	0.15-0.22	0.16-0.25		
Mn	1.1-1.4	1.1-1.4	0.6-0.1	1.15-1.6	0.6-1.05	1.25-1.6 /	0.6-1.05		
Si	0.1-0.35	0.1-0.35	0.1-0.35	0.10-0.35	0.15-0.30	0.15-0.30	0.1 (Max)		
P (Max)	0.04	0.04	0.04	0.045	0.047	0.047	0.047		
S (Max)	0.04	0.04	0.04	0.045	0.047	0.047	0.047		
Cr (Max)	0.08	0.08	0.08	0.1	0.2	0.2	0.2		
Ni (Max)	0.03	0.03	0.03	0.05	0.05	0.05	0.05		
Cu (Max)	0.03	0.03	0.03	0.07	0.1	0.1	0.1		
Mo (Max)	0.005	0.005	0.005	0.05	0.05	0.05	0.05		
V (Min)	0.03			0.025	As per test certificate	0.025 / 0.03*	As per test certificate		
V (Max)	0.08	0.01	0.01						
Nb (Min)				0.015		0.015			
Nb (Max)									
Ti (Min)		0.028							
Ti (Max)	0.01	0.05	0.01						
Al (min)	0.015 for SMS -1 Heats			0.015					
Al (max)	0.04 for SMS -2 Heats								
CE (Min)			0.28		0.28	0.36	0.28		
CE (Max)	0.45	0.45	0.42	0.45	0.42	0.45	0.42		
S+P (Max)				0.09	0.09	0.09	0.09		
N (Max)									
B (Max)	0.004	0.004	0.004	0.005	0.005	0.005	0.005		
Sn (Max)									
Remarks	Variation in Min/Max Limit. C=0.02, Mn=0.03, P=0.005, S=0.005			Si - Traces - 0.35 for Al killed Steel, V=0.025 Min or Nb=0.015 (if added alone), V+Nb+Ti = 0.25 Max, Al=0.015 for Al Killed heats.		Mn 1.25 -1.60 for blooms size 350x150mm; V=0.025 Min for Billets and Blooms up to 150 mm and 0.03 for Blooms of 160 mm and above; Nb=0.015 (if added alone), Al=0.015 for Al Killed heats.			

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	SAIL (DSP)		Electrosteel Steels Ltd		Jindal Steel & Power Ltd (Raigarh & Angul)				
Grade	SAIL Tower Grade VI For HT (E350)	C20 MMn-For MS (E250)	C18HMn-For HT (E350)	C20 MMn-For MS (E250)	C18 HMn-HT (E350)	C20 MMn-For MS (E250)	C18 MMn-For MS (E250)		
C	0.15-0.22	0.16-0.25	0.15-0.22	0.17-0.25	0.15-0.20	0.17-0.23	0.15-0.21		
Mn	1.25-1.6 /	0.6-1.05	1.20-1.50	0.6-1.00	1.20-1.50	0.60-1.00	0.60-1.00		
Si	0.15-0.30	0.15-0.30	0.10-0.35	0.10-0.35	0.15-0.30	0.10-0.40	0.10-0.40		
P (Max)	0.047	0.047	0.045	0.045	0.03	0.04	0.04		
S (Max)	0.047	0.047	0.045	0.045	0.03	0.04	0.04		
Cr (Max)	0.2	0.2	0.08	0.08	0.07	0.07	0.07		
Ni (Max)	0.05	0.05	0.03	0.03	0.07	0.07	0.07		
Cu (Max)	0.1	0.1	0.03	0.03	0.1	0.1	0.1		
Mo (Max)	0.05	0.05	0.005	0.005	0.07	0.07	0.07		
V (Min)	0.025 / 0.03*	As per test certificate	0.03		0.03				
V (Max)			0.06	0.005					
Nb (Min)	0.015				0.015				
Nb (Max)									
Ti (Min)									
Ti (Max)									
Al (min)					0.015	0.01	0.01		
Al (max)									
CE (Min)	0.36*/0.38	0.28	0.36	0.28					
CE (Max)	0.45	0.42	0.45	0.42	0.45	0.42	0.42		
S+P (Max)	0.09	0.09							
N (Max)									
B (Max)	0.005	0.005	0.004	0.004					
Sn (Max)									
Remarks	* 0.36 for 125x125 mm Billets Mn 1.25 -1.60 for blooms size 350x150mm; V=0.025 Min for Billets and Blooms up to 150 mm and 0.03 for Blooms of 160 mm and above; Nb=0.015 (if added alone), Al=0.015 for Al Killed heats.				Variation in Min Limit: C=0.02, Mn=0.03, P=0.005, S=0.005, Nb when added alone V+Nb+Ti<=0.25				


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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes	
								Remarks
	JSW Steel Ltd			Jayaswal Neco Industries Ltd				
Grade	C18 HMn-HT (E350)	C20 MMn-For MS (E250)	C18 MMn-For MS (E250)	C18 /C20 HMn- HT (E350)	C18 MMn MS (E250)	C20 MMn- MS (E250)		
C	0.15-0.21	0.17-0.23	0.15-0.21	0.15-0.20	0.15-0.20	0.17-0.23		
Mn	1.20-1.50	0.60-1.00	0.60-1.00	1.2-1.50	0.6-1.00	0.6-1.00		
Si	0.10-0.35	0.10-0.35	0.10-0.35	0.15-0.35	0.15-0.35	0.15-0.35		
P (Max)	0.04	0.04	0.04	0.035	0.035	0.035		
S (Max)	0.03	0.04	0.04	0.035	0.035	0.035		
Cr (Max)	0.07	0.07	0.07	0.05	0.05	0.05		
Ni (Max)	0.07	0.07	0.07	0.05	0.05	0.05		
Cu (Max)	0.1	0.1	0.1	0.1	0.1	0.1		
Mo (Max)	0.07	0.07	0.07	0.05	0.05	0.05		
V (Min)	0.025			0.03				
V (Max)								
Nb (Min)	0.015*							
Nb (Max)								
Ti (Min)								
Ti (Max)								
Al (min)	0.015	0.01	0.01	0.015	0.01	0.01		
Al (max)	0.06			0.035	0.035	0.035		
CE (Min)				0.38				
CE (Max)	0.45	0.42	0.42	0.42	0.41	0.41		
S+P (Max)								
N (Max)								
B (Max)								
Sn (Max)				0.1	0.1	0.1		
Remarks	Total Microalloying (Ti+Nb+V) <= 0.20 * Nb=0.015 (Min) if added alone			Variation in Min/Max Limit: C=0.02, Mn=0.05				


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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes	
								Remarks
	Tata Steel, Kalinganagar (For Plates)			Electrotherm India Pvt Ltd				
Grade	C18 HMn- HT (E350)	C18MMn-For MS (E250)		C18 HMn-HT (E350)	C20 MMn-For MS (E250)	C18 MMn-For MS (E250)		
C	0.12-0.18	0.15-0.20		0.15-0.21	0.17-0.23	0.15-0.21		
Mn	1.05-1.45	0.6-1.0		1.20-1.50	0.60-1.00	0.60-1.00		
Si	0.14-0.25	0.15-0.30		0.10-0.35	0.10-0.35	0.10-0.35		
P (Max)	0.030	0.035		0.04	0.04	0.04		
S (Max)	0.020	0.035		0.04	0.04	0.04		
Cr (Max)	0.1	0.05		0.1	0.1	0.1		
Ni (Max)	0.1	0.05		0.07	0.07	0.07		
Cu (Max)	0.1	0.05		0.1	0.07	0.07		
Mo (Max)	0.1	0.05		0.07				
V (Min)				0.025				
V (Max)				0.05				
Nb (Min)				0.015				
Nb (Max)	0.15							
Ti (Min)								
Ti (Max)	0.1	0.01						
Al (min)	0.02			0.015	0.02	0.02		
Al (max)		0.025						
CE (Min)								
CE (Max)	0.45	0.39		0.47	0.42	0.42		
S+P (Max)								
N (Max)	0.012							
B (Max)	0.0005							
Sn (Max)								
Remarks	Total Microalloying (Ti+Nb+V) = 0.025 (Min) and 0.25 (Max)			Nb = 0.015 Min if added alone Ti+Nb+V <= 0.20				

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SI No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling with basis	Reference document for testing	Acceptance norms	Form of record	Applicable Codes	
								Remarks
	Bhushan Steel Ltd							
Grade	C18 HMn-HT (E350)	C20 MMn-For MS (E250)						
C	0.15-0.21	0.17-0.23						
Mn	1.20-1.60	0.60-1.00						
Si	0.35	0.35						
P (Max)	0.04	0.04						
S (Max)	0.04	0.04						
Cr (Max)	0.12	0.12						
Ni (Max)								
Cu (Max)								
Mo (Max)	0.07							
V (Min)	0.03							
V (Max)								
Nb (Min)								
Nb (Max)								
Ti (Min)								
Ti (Max)								
Al (min)	0.01	0.01						
Al (max)								
CE (Min)								
CE (Max)	0.45	0.42						
S+P (Max)								
N (Max)								
B (Max)								
Sn (Max)								
Remarks	Ti+Nb+V <= 0.20							

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Request Letter

On Official Letter Head

To

RIO Incharge, -----

POWERGRID

Sir,

We (Name of the Manufacturer)..... are offering material for inspection vide following Inspection Call nos:

1.,
2.
3.
4. -----,
5. -----

As the material is of the same design and specification, We want to offer this material for inspection in single lot. We understand that in case of failure of any section(s) , the material corresponding to the failed section(s) in all the above-mentioned inspection calls shall be rejected.

Thanking you.

Yours sincerely,

(Seal & Signature of the Quality In-charge)

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Guidelines for welder/brazer Qualification by POWERGRID

Revised guidelines for welder/ brazer qualification /certification are as follows:

1. The welder/brazer shall be qualified as per provision in ASME Section-IX/ AWS D1.1.
2. The manufacturer shall engage a certified third-party agency for WPS and witness the welding process in line with the approved WPS (Welding Procedure Specification) for qualification of welder.
3. The third-party agency must be a Type-A inspection body accredited as per ISO/IEC 17020:2012 from an IAF member body which is signatory to their Multilateral Recognition Arrangement (MLA) for the certification bodies as a requirement and having scope of accreditation-IAF scope 17 (i.e. as per ASME section IX & AWS D1.1).
4. As per Clause QW-322 of ASME Sec-IX:2019, the performance qualification of the welder shall remain valid, provided that not more than 6 months have passed since the qualified welding process was last used. Hence, the manufacturer shall re-validate their qualification at every two years interval, as per the existing practice followed by POWERGRID.
5. The validity of the welders approved by POWERGRID shall remain valid and existing POWERGRID certified welders will continue to be considered approved. After expiry of their approval or for new welder qualification, the certification shall be done by certified third party agency as per above mentioned procedure.
6. POWERGRID QA&I dept shall review the welder certification during product and process inspection.
7. POWERGRID reserves the right to carry out welder qualification as per earlier practice as and when required (i.e. *Welding brazing procedure is approved by POWERGRID and Welders/ Brazers are qualified based on witnessing of welding/ brazing work by POWERGRID representative*)

The above guidelines shall be implemented with immediate effect.

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Appendix – IV

**LIST OF SPECIAL TOOLS & TACKLES USED IN STRINGING OF HTLS
CONDUCTOR**

List of Special Tools & Tackles for Stringing of HTLS Conductor

Sr. No.	Item Description	Quantity (Nos.) required for One Set	Broad Technical Parameters & Standards	Remarks
1	Pulling Eye/String Clamp	24	Suitable for offered size of HTLS Conductor	Only Applicable for GAP type
2	Core Retainer	6	Suitable for offered size of HTLS Conductor	Only Applicable for Composite Core type
3	Automatic Conductor Come Along Clamp	12	Long Jaw Clamps, Lever Type Suitable for offered size of HTLS Conductor	
4	Automatic Core (Steel) Come Along Clamp	12	Long Jaw Clamps, Lever Type Suitable for offered size of HTLS Conductor core	Only Applicable for GAP type
5	Tandem Sheaves/Rollers	3	Suitable for conductor bundle & offered size of HTLS Conductor	Only Applicable for Composite Core type
6	Motorized Hydraulic Compression Machine with Compression Head & Die set	1	Light weight, 100 T compression capacity, Compression Head & Die set shall be suitable for offered size of HTLS Conductor	
7	Tensioner Feed Sheave	2	Sheaves - Al alloy rubber lined mounted on ball bearing, Frames - Mild Steel	
8	Hoist Hook or Lifting Hook	2	With Broad base for avoiding sharp bending of composite core conductor during lifting.	Only Applicable for Composite Core type

Note:

- Contractor may also use/deploy special tools & tackles other than those listed above, if required for proper stringing of offered HTLS conductor.
- Above technical parameters indicate the basic minimum requirements of T&Ps. All T&Ps shall confirm to Indian standards, wherever applicable. Other International standards, which ensure equal or better properties/performance shall also be acceptable.

04_4 Section IVC Appendix -V

Minimum man-power requirement for Tower Erection Gang (For line diversion works):

S.No.	Man-power description	Nos.	Remarks
1	Tower Erection gang		Minimum T&P for Tower Erection shall be as per 04_4 Section IVC Appendix I (List of T&P)
	Gang leader	01	
	Drawing master	02	
	Fitters	12-14	
	Workers	18-20	
	Total	33-37	

During Shutdown Two gangs shall be deployed per Tower and minimum T&P shall be twice of what is required for Tower Erection of one tower.

Minimum man-power requirement for Stringing Gang (For line diversion works):

S.No.	Man-power description	Nos.	Remarks
1	Stringing (1 gang) - Manual		Minimum T&P for Stringing shall be as per 04_4 Section IVC Appendix I (List of T&P)
	Gang leader	01	
	Fitters	25-30	
	Workers	30-35	
	Total	56-66	

During Shutdown One gang shall be deployed per span alongwith minimum T&P per gang as mentioned above.

Note: Shutdown shall be provided only after confirmation of above gangs deployment.

SECTION-IVD

CONTRACTOR DESIGN FOUNDATIONS

**(Applicable for Transmission Lines
wherein Foundation Design is in
Contractor's scope)**

TECHNICAL SPECIFICATIONS

SECTION-IV D

CONTRACTOR DESIGN FOUNDATIONS

Revision History

Revision No.	Date	Clause Ref	Description
Rev-0	June'2021		First Release
Rev-1	Sept'2021		First Revision
Rev-2	Jan'2022		Second Revision
Rev-3	Apr'2022		Third Revision
Rev-4	Oct'2022		Fourth Revision
Rev-5	Mar'2023		Fifth Revision
Rev-6	Dec'2023		Sixth Revision
Rev-7	Jan'2025		Seventh Revision

TECHNICAL SPECIFICATIONS

SECTION-IV D

CONTRACTOR DESIGN FOUNDATIONS

CONTENTS

Clause No.	Description	Page No.
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1.5	Design of Foundations	4
1.6	Design Criteria	6
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1.9	Construction of Tower Foundation	14

TECHNICAL SPECIFICATIONS

SECTION- IV D

CONTRACTOR DESIGN FOUNDATIONS

1.1 Foundations

Foundation includes supply of all labour, tools & machineries, materials such as cement, sand, coarse aggregates and reinforcement steel and all associated activities, such as, excavation, concreting and back filling etc.

1.2 Type of Foundations

The foundation shall generally be of open cast type Reinforced Cement Concrete footing shall be used for all type of normal towers. In case of tension towers, the contractor may choose to adopt two different foundation design in a tower location, one type for legs in compression with side thrust cases and another type for legs in tension with side thrust cases. To capture maximum uplift force in compression leg and visa versa, reverse wind load cases for minimum angle of deviation with maximum span as per tower spotting data, shall be incorporated in tower design document of the tower for which two different foundation (one type for legs in compression with side thrust cases and another type for legs in tension with side thrust cases) are adopted. The Bidder shall offer open type of foundation (i.e., slab and chimney) with maximum depth of foundation up to 3.5 meters for above classification of foundations depending on economy and feasibility of construction at site. However, Bidder may offer foundation depth up to 4.0 m in case of Dry type of foundation depending on economy and feasibility of construction at site with compatible stub. Further, for tower type DN/DDN/QDN (as mentioned in clause section 1.2.2 IVA)/special river crossing/anchor tower, the Bidder shall offer open type of foundation (i.e., slab and chimney) with maximum depth of foundation up to 5.0 meters (while taking proper safety precaution during excavation in line with IS 3764) for above classification of foundations, depending on economy and feasibility of construction at site with compatible stub. For Hard Rock type and also where specific site conditions/ properties demand foundation of different depths (lower or higher), the same shall be adopted. Minimum reinforcement as 0.12% of cross section area shall be provided in raft/ block of hard rock foundation. The raft/ block shall also satisfy the design criteria as per IS 456.

Bidder has to furnish along with the bid one sample calculation for assessment of present design capability of the Bidder.

1.3 Classifications of Foundations:

The foundation designs shall depend upon the type of soil, sub soil water level and the presence of surface water which have been classified as follows (except pile foundations which is described in relevant section of this specification).

1.3.1 Normal Dry

To be used for locations where normal dry cohesive or non-cohesive soils are met. Foundations in areas where surface water encountered from rain runoff shall also be classified as normal dry.

1.3.2 Sandy Dry Soil

To be used for locations where cohesion less pure sand or sand with clay content less than 10% met in dry condition. If the clay content is more than 10 % met in dry condition, the foundation shall be classified as Normal Dry.

1.3.3 Wet

To be used for locations where sub-soil water table is met between 1.5 meters from ground level and the depth of foundation below the ground level.

1.3.4 Wet Cultivated

To be used for locations where there is no sub-soil water within the foundation depth but which are in surface water for long period with water penetration not exceeding one meter below the ground level e.g. paddy fields/ cultivated field. However, if water penetration due to surface water is more than one meter below ground level, the adoption of suitable foundation shall be decided by site In-charge in consultation with Corporate engineering Department.

1.3.5 Partially Submerged

To be used at locations where sub-soil water table is met between 0.75 meter and 1.5 meter below the ground level.

1.3.6 Fully Submerged

To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.

1.3.7 Black Cotton Soil

To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is considered submerged in nature.

1.3.8 Fissured Rock

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. Where fissured rock is encountered with subsoil water table less than 1.5 meter below ground level, submerged fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

1.3.9 Hard Rock

The locations where chiseling, drilling and blasting is required for excavation for monolithic rock for a particular leg/tower, Hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.

For quoting prices of Hard Rock foundations, Rock level shall be assumed at 1.5 meters below the ground level. Due to change in Rock level, no extra payment shall be payable on account of increase in concrete volume, excavation volume and weight of reinforcement. Also, no recovery shall be made if the actual volume of concrete, excavation and weight of reinforcement are less than that quoted in Schedule of prices. However, for design purpose, Rock level shall be considered at ground level and no over burden soil weight shall be considered for resisting the uplift.

1.3.10 The sub-soil water table is not constant and its level changes during different seasons due to various factors. In case during soil investigation/ trial pit or during excavation, if wet soil/ fissures rock is encountered within the foundation depth, it is to be considered that water table has been encountered (considering that water table had reached that level sometime in past) and accordingly type of foundation shall be classified.

1.3.11 Where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the foundation pit.

1.3.12 The foundation classification at any particular location shall be based on the type of soil (clay/ sandy/ silt/ fissured rock etc.) and water table, presence of surface water, etc. at the location. However, in case of locations which are in vicinity of rivers, depending upon case to case, type of foundation is to be decided considering other aspects also e.g. in case RL (reduced level) of a location in comparison to the HFL is lower and there is possibility of submergence at the time of floods due to absence of river bunds/ protection etc., FS type foundation with suitable raised chimney is to be adopted. Further in case there is a possibility of change in river course, considering the nature and turbulence of probable water

flow and subsequent scouring of soil, pile type or special foundation may be considered for these locations.

1.3.13 In addition to above, if required, depending on the site conditions, special type foundations shall also be provided by the Contractor suitable for intermediate conditions under the above classifications to affect more economy for following reasons:

- (a) Shallow Depth or Raised Chimney foundations are necessarily required to suit the site condition or
- (b) Soil properties as per the soil report at particular location are found inferior/superior to the properties specified in the bid documents and considered for normal foundation design.

1.3.14 The proposal for special foundations shall be submitted by the Contractor based on the detailed soil investigation report/ to suit site conditions and approval for the same shall be obtained from the Employer. Decision of the Employer shall be final and binding with respect to requirement of special foundation. In case of Special foundations, payment for installation of stub shall be made on pro-rata basis of installation rate of approved stub weight of normal tower up to +9m extension.

1.3.15 During execution of the Line, if foundation for other types of towers/ structures viz Gantry, single circuit/ Multi circuit towers in Double circuit line, Double circuit/ Multi-circuit towers in a Single circuit line, Single circuit/ Double circuit towers in a Multi circuit line, Narrow base towers, Towers of higher extensions (viz. +43m/ +55 m for 765kV D/C lines wherever applicable), Towers of different configuration, etc. are required, for which design is not in the scope of Contractor, supply & all works associated for installation of these shall be carried out by the contractor as per Employer supplied design/ drawings.

If Employer designed towers are not covered in the BPS, Payment for these, shall be made on mutually agreed rates to be derived on the basis of rates available in the Contract during execution stage.

1.3.16 Design and Casting of Foundations for Contractor design towers including Raised Chimney foundations, which are not specified in the Final BPS of the Contract Agreement, but required during execution of the project and authorised by the Employer, shall have to be carried out by the Contractor. No additional payment on account of Design charges shall be payable. Payment for execution of such foundations shall be made on mutually agreed rates to be derived on the basis of rates available in the Contract during execution stage.

1.4 Soil Investigation

The contractor may be required to undertake soil investigation as per *clause 4.0 of Section-3* at tower locations as required by the Employer. The bearing capacity of soil is to be derived from both shear and settlement criteria. The total permissible settlement of soil may be considered as 50 mm in case of suspension towers and 40 mm in case of tension towers for determining bearing capacity of soil from settlement criteria. The provisional number of soil testing locations is furnished in Schedule of Prices. However, contractor shall take reference to the soil investigations wherever already carried out by the Employer.

1.5 Design of Foundations

Design of foundations as classified under *Clause 1.3* for all towers and towers with extensions shall be developed by the Contractor based on the standard soil properties of the concerned state and shall be submitted for approval of Employer, irrespective of the actual site requirement. However, delay in submission/approval of foundation designs/drawings which are not required for project execution, shall not be considered for Liquidated damages (LD) calculation. Charges for the same are deemed to be included in the quoted prices.

The indicative shape of foundation is enclosed in this specification. In case of normal foundation, minimum clearance between chimney concrete level and ground level shall be 225 mm. Based on specific site condition to avoid rusting of stubs, foundation with 500 mm clearance between concrete level and ground level may be used on case to case basis as may decide by Site In-charge.

1.5.1 Loads on Foundations

1.5.1.1 The foundations shall be designed to withstand the specific loads of the superstructure and for the full footing reactions obtained from the structural stress analysis in conformity with the relevant factors of safety.

1.5.1.2 The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:

- a) Maximum Tension or uplift along the leg slope.
- b) Maximum Compression or down-thrust along the leg slope.
- c) Maximum Horizontal shear or side thrust.

1.5.2 Stability Analysis

1.5.2.1 In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

- 1.5.2.2 The following primary types of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:

A) Resistance Against Uplift

The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth of this Section on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-impose each other, the earth frustum will be assumed truncated by a vertical plane passing through the centre line of the tower base. In case of foundation with undercut, resistance provided by weight of earth in an inverted frustum of a conical pyramid shall be increased by 25 %. This shall also be applicable for stability analysis check for over turning in case of foundation with undercut.

B) Resistance Against Down Thrust

The down-thrust loads combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.

C) Resistance Against Side-Thrust

The lateral load capacity of a chimney foundation shall be based on chimney acting as a cantilever aided by passive earth resistance developed 500 mm below the ground level.

The chimney shaft shall be reinforced for the combined action of axial force, tension and compression and the associated maximum bending moment. In these calculations, the tensile strength of concrete shall be ignored. The contribution of stub for chimney design may be considered as per latest CBIP Manual. However, if the contribution of stub is considered, the yield stress of stub shall be restricted to 250 N/mm².

The increase in vertical toe pressure due to maximum bending moment at the bottom of the slab shall be taken into account and the base itself shall be designed for structural adequacy. In this case, the allowable vertical toe pressure may be increased by 25%. The unit weight of reinforced concrete is stipulated in **Table 2-2**.

1.6 Design Criteria

- 1.6.1 As per IS 456: 2002 Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel.

- 1.6.2 The overload factors for open type foundations shall be as 1.1 i.e. all the reactions (compression, tension and side thrust) on foundations shall be increased by 10 percent for development of foundation design.
- 1.6.3 The physical properties of soil under various conditions are furnished in **Table 2.1** to be considered for the design of foundations. These types of foundations correspond to list of foundations furnished in Schedule of prices.
- 1.6.4 The composite rate shall be paid to the contractor for above foundations irrespective of approved design volumes except for Gantry, Single circuit & Multi circuit towers, not specified in BPS, for which payment shall be made on mutually agreed rates to be derived on the basis of rates available in the Contract during execution stage. Further, once the foundations are classified based on the preponderant soil, extra claim is not admissible for excavation in different kinds of soil encountered inside the pit.

It may be noted that the soil properties furnished in **Table 2.1** are standard for respective states. However, after soil investigations, if it is found that the foundations listed in Schedule of Prices Vol. III cannot be used at that location; new foundation design shall be developed by the Contractor based on properties furnished in soil report. No additional payment on account of Design charges shall be payable.

Any such foundations required during execution of the project and authorised by the Employer, shall have to be carried out by the Contractor for which payment shall be made on mutually agreed rates to be derived on the basis of rates available in the Contract during execution stage.

- 1.6.5 The foundation shall be designed such as to satisfy the following conditions:
- 1.6.5.1 The thickness of concrete in the chimney portion of the tower footing shall be provided with minimum cover of not less than 100 mm from any part of the stub angle to the nearest outer surface of the concrete in respect of all dry locations limiting the minimum section of chimney to 300 mm square. In respect of all wet locations, the chimney should have all around clearance of 150 mm from any part of stub angle limiting the minimum section of chimney to 450 mm square.
- 1.6.5.2 The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended up to lower most joint level between the bottom lattices and the main corner legs of the tower. Effective length of 1.5 times the unsupported length shall be considered for evaluating the slenderness ratio of chimney.
- 1.6.5.3 The centroidal axis of slab shall coincide with the axis of the chimney and pass through the center of foundation base. The design of the foundation (base slab and its reinforcement) shall take into account the additional stresses in the

foundation resulting from the eccentricity introduced due to non-compliances of this requirement.

- 1.6.5.4 In case of RCC type foundations, the frustum can be single or multi stepped. The thickness of bottom slab (including slopped slab portion) should not be less than 300 mm. The bottom portion of minimum 100 mm thickness of the slab shall have vertical sides and balance portion shall have 45° slope as indicated in drawing enclosed in the bidding documents. In case of sloped pad/haunch foundation, If the total thickness of sloped pad/ haunch is more than 750mm, minimum reinforcement of 0.1% of cross section area of haunch shall be provided perpendicular to the slope at both faces of haunch (0.05% in each face). Further 4 bars of minimum 10 mm diameter along the slope of haunch shall also be provided in addition to the minimum reinforcement in haunch as stated above.
- 1.6.5.5 The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100 mm or more than 150 mm in case of dry locations and not less than 150 mm or more than 200 mm in case of wet locations.
- 1.6.5.6 The total depth of open type foundations below the ground level (including lean concrete pad) shall not be less than 1.5 meters and more than 3.5 meters.
- 1.6.5.7 The portion of the stub in the slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and slab concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design. Bolted cleat angles evenly spaced in sets of 4 along all sides of embedded portion of the stub shall be provided to act as shear connector with sufficient number of bolts.
- 1.6.5.8 In case of R.C.C. foundations having steel reinforcement in base slab, at least 50 mm. thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided below the bottom slab.
- 1.6.5.9 The base slab of the foundation shall be designed for additional moments due to eccentricity of the loads.
- 1.6.5.10 The additional weight of concrete in the footing below ground level over the earth weight & full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.

TABLE 2.1: Soil Properties

Sl. No	Properties of Soil	Ultimate Bearing Capacity in KN/M ² (Kg/M ²)	Angle of Repose (Degree)
1	For Normal Soil (UP, Uttarakhand, Haryana, Delhi, Bihar, Jharkhand, WB, MP, Chhattisgarh, Kerala, J&K, Ladakh, Assam, Andhra Pradesh, Telangana, Tamil Nadu)		