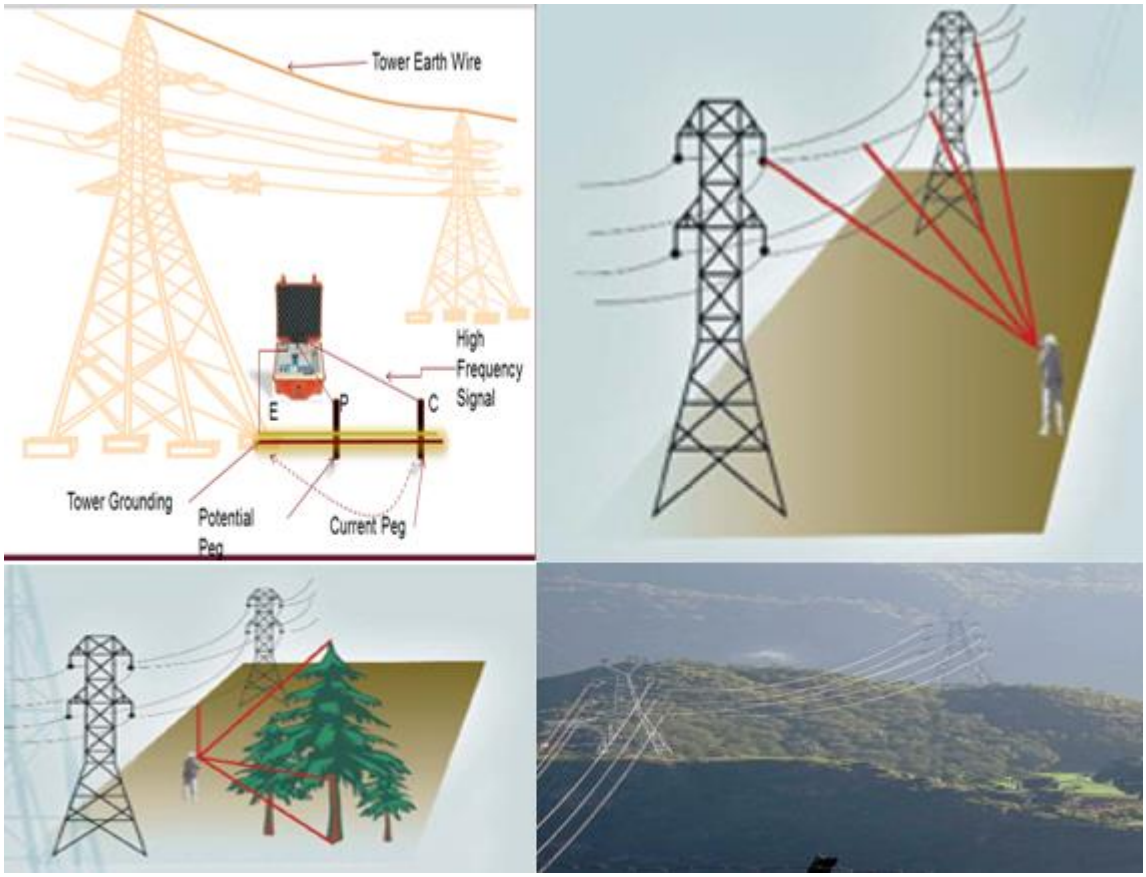
PRE-COMMISSIONING PROCEDURES FOR TRANSMISSION LINE



पावरग्रिड
POWERGRID

CORPORATE ASSET MANAGEMENT
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Sep ’2021

PRE-COMMISSIONING PROCEDURES FOR TRANSMISSION LINES	Earlier Doc. No. D-2-01-70-01-02 Present Doc. No. D-2-01-70-01-03-Part-A				
	Rev.	Dept.	Date	Signature	Signature
	00	CC(OS)	30/11/1995	Sd/-	Sd/-
	01	CC(OS)	28/06/2004	Sd/-	Sd/-
	02	CC(AM)	15/12/2014	Sd/-	Sd/-
	03	CC(AM)	07/09/2021		

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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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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

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

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)

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

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

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

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**

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:

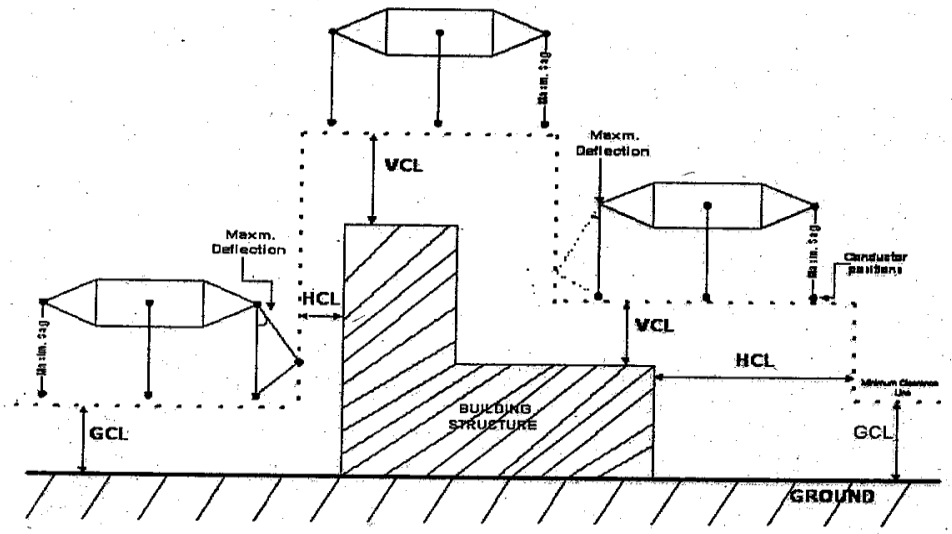
Sl. No	DC Voltage (kV)	Vertical Clearance (in mm)	Horizontal Clearance (in mm)
1.	100 kV	4600	2900
2.	200 kV	5800	4100
3.	300 kV	7000	5300
4.	400 kV	7900	6200
5.	500 kV	9100	7400
6.	600 kV	10300	8600
7.	800 kV	12400	10700

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

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*

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

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:

<u>Deformed/ Buckled/ Missing/ Rusted Members and Nuts and Bolts</u>

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

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.

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 $1/6^{th}$ 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 EARTHWIRES/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

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.

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:

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.

6.2.3 Transmission Line parameters (Z1, Z_0, Zn) 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

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

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.