ELECTRICAL SAFETY PROCEDURE

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Rev 02	Inclusion of ELCB testing	Navendra Singh Head- Safety (T&D) Corp safety	Rajesh Sharma Head- Safety (Generation) Corp safety	Suresh Khetwani Chief - Corporate Safety & Environment

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1. OBJECTIVE:

The objective of these procedure is to specify minimum mandatory requirements and advisory guidance for identifying and controlling hazards to ensure 'Zero Harm' with regard to operation maintenance and testing of electrical equipment. The established documentation for the elimination and control of hazards is henceforth referred to as **Electrical Safety Procedure**.

2. SCOPE:

This procedure applies to all operating and project sites of Tata Power Group companies including JVs/ Subsidiaries.

3. EXPECTED RESULTS:

3.1. Manage activities/jobs associated with electrical hazards safely.

3.2. Control of incidents related to electrical shock and hazards.

3.3. Compliance to Regulatory requirements to make work place safe.

4. ACCOUNTABILITY & RESPONSIBILITY:

ACCOUNTABILITY: Concerned Division's Heads / Assets Custodian

RESPONSIBILITY: Concerned Permit-To-Work Approver/Receiver

LINE MANAGEMENT IN SBU'S AND SITES HAS THE RESPONSIBILITY TO IMPLEMENT THIS STANDARD

5. GLOSSARY/ DEFINITIONS:

ELCB: Earth Leakage Circuit Breaker

ELV: Extra Low Voltage (< 50V AC and < 120V DC)

HIRA: Hazard Identification and Risk Assessment

JSA: Job Safety Analysis

LOTO: Lock Out Tag Out

PPE: Personal Protective Equipment

PTW: Permit to Work

Shall: Mandatory requirement

Should: Optional requirement

TBT : Test Before Touch

Work Permit - The written or printed document that is issued to control working in operational area/ in vicinity of electrical equipments.

Work supervisor - A person who is authorized; to verify that all conditions for working have been met, to define ongoing precautions to maintain safe working conditions during the work, to authorize the work to occur, and to cancel the permit allowing the work; also known as proprietor, work group supervisor, or authorizing person.

6.0 PROCEDURES

6.1 ESSENTIALS

6.1.1 Personnel (both Company employees and Contractors) shall be competent to carry out electrical work and shall possess Tata approved government authorized competency certificate for work at working voltage levels.

6.1.2 Employees/contractors working on/near electrical equipment shall be trained in emergency response/first aid.

6.1.3 Prior to carrying out any activity related to operation, maintenance or testing of electrical equipment, it shall be ensured that there is an appropriate Job Safety Analysis (JSA) supported with Hazard Identification and Risk assessment (HIRA) done and recorded.

6.1.4 Fire and explosion hazards associated with electrical equipment shall be assessed and managed.

6.1.5 Permit to Work (PTW) - TPSMS/CSP/PTW/008, and Lock Out Tag Out (LOTO) - TPSMS/CSP/LOTO/001 Procedures to be followed.

6.1.6 All electrical work shall be done in compliance to Standard Operating Procedure (SOP)/ Standard Maintenance Procedure (SMP).

6.1.7 Checklist should be made available and filled up copies recorded.

6.1.8 Isolation and subsequent confirmation test shall be carried out to verify absence of voltage.

6.1.9 Authorized Work Area cordoning off by barricading tape/Hard barricades shall be done prior to maintenance/testing.

6.1.10 Proper illumination shall be provided if the work has to be continued during dark hours. If any hand lamp is to be used it should be of voltage level equal to or less than 24V AC.

6.1.10 Hazard/flashing lights shall be installed if the work involves HV testing at 1 kV and above.

6.1.14 The room in which work is being carried out should have adequate ventilation system and emergency exit points. Adequate communication systems should be made available.

6.1.15 While working in the vicinity of live equipment the Engineer to whom PTW has been issued shall give proper information to PSCC and instructions to Staff carrying out work.

6.1.16 Appropriate PPE and adequate safety apparel like arc suits shall be worn.

6.1.17 Certified and insulated tools shall be used while performing electrical work.

After completion of work the Removed material shall be stored / shipped to safe location.

6.1.18 After completion of work Permit Issuer shall physically check and ensure that the following are cleared before closing of PTW.

a. Grounds
b. Tools
c. Spares
d. Personnel
e. Debris
f. Scrap

6.1.20 All Electrical equipment, spares and tools should be inspected and maintained at regular intervals as per proper approved schedule.

6.2 COMPLIANCE TO WORK PROCEDURES

6.2.5 Persons who work near electrical equipment and are potentially exposed to electrical hazards, shall be made fully aware of the hazards and should be suitably trained on how to work safely. All the work procedures should aim at minimizing exposure to electrical hazards to an acceptable level on the basis of HIRA.

6.2.6 Energy isolation shall be done before carrying out work on electrical equipment as per Lock out Tag out (LOTO) procedure.

6.3 WORKING ON OR NEAR ELECTRICALLY ENERGIZED EQUIPMENT

6.3.1 Work on or near any live conductor shall be carried out only in case of exceptions, after a thorough HIRA has been carried out.

6.3.2 When working on or near energized electrical equipment it shall be ensured that no other work should be performed within the prohibited approach boundary. (Work in switchyard, multi circuit tower with other lines charged)

6.3.3 Permission to work on such locations requires authorization from a senior authorized person/Engineer in charge (as per company standard/procedure) regardless of the PPE used or design of equipment. Appropriate control measures and suitable precautions (including the provision of suitable PPE) have been taken.

6.3.4 Energised Equipment may include working on both Extra Low Voltage (ELV) systems (<50 AC or < 120 DC) and non ELV systems

6.3.5 Testing which calls for Voltage injection is allowed within the prohibited approach boundary provided proper test equipments and PPE are used and the personnel are competent and qualified.

Recommended PPE: Helmet, voltage rated hand gloves, safety shoes, safety goggle with face shield, FR (Flame Resistant) coat, gas mask, acid resistant aprons.

6. 4 TESTING FOR ABSENCE OF VOLTAGE

6. 4.1 All circuits are considered energized until verified dead by testing it with appropriate instruments such as non-range selectable voltage indicators (Common DC/AC range voltmeter while verifying whether LV circuits are de-energised)

6. 4.2 All MV Cable Compartments of switchgears shall have back charge indicators. These back charge indicators shall be checked for no voltage before accessing the cable compartment. The healthiness of these back charge indicators must be monitored as per Standard Operating Procedure (SOP)/ Standard Maintenance Procedure (SMP).

6. 4.4 Ensure metallic segregation of Bus side (source) and Cable side (load) Compartment before entering any compartment for maintenance testing inspection. Metallic segregation shall be ensured between cable side (load) compartments.

6. 4.5 Ensure that all test instruments or equipment used are designed and certified to meet the requirements and are rated in all aspects for the category of the task to be performed.

6. 4.6 Practice of “Test Before Touch” (TBT) and performance of positive confirmatory test of the instrument before every use should be followed. Insulation healthiness level of test instrument should be confirmed before using them as it is likely to be in contact with a live 220 kV line. Insulation should be physically checked for cleanliness, dryness and free of cracks/breakages. Always store such instruments in protected cases.

6. 4.7 Recommended PPE: Helmet, Shoes, voltage rated hand gloves, safety shoes, safety goggles with face shield and Flame Resistant coat.

6. 5 DISMANTLLING OF ELECTRICAL RACEWAYS AND CABLES

6.5.1 The identification, cutting, and removal of electrical raceways and cables often involve a high level of risk in determining that cables are not damaged while removed cable trays and that in case of cable removal the correct cable is removed.

6.5.2 The cable left behind after removal of cable tray must be adequately supported and protected from damage by adjacent equipment, moving parts, UV rays, hot pipe lines, etc.

6.5.3 Maintain proper labelling and identification of cables at both ends to avoid the error of mistaken identity (Refer Lockout Tag Out Procedure).

6.5.4 Test for the absence of voltage at the source and destination ends of each cable. Follow live cable identification procedures and positively identify each cable before it is cut.

6.5.5 Ensure all protection and isolation system are working.

6.5.6 A good practise would be to positively identify other cables in the vicinity.

6. 6 RELOCATION OF EQUIPMENT

6.6.1 Before relocation of equipment / electrical systems from one place to another a formal risk assessment should be carried out.

6.6.2 When equipment / electrical system are relocated to a new place it shall be ensured that it will work in a safe manner.

6.6.3 Alternate power supply should be made available during relocation work wherever applicable/possible. This will improve availability and reduce pressure of time constraint while carrying out replacement job.

6. 7 EXCAVATIONS AND DRILLING IN WALLS

6.7.1 Ensure that the electrical lines, conduits, and cables in the area of work activity are identified before performing excavation and drilling of floors, roofs, walls.

6.7.2 Up-to-date maps / drawings/electronic tracers systems may be used for locating underground / concealed cables

6.7.3 GIS system may be referred to wherever it is available.

6.7.4 Prior to excavation and penetration, it shall be ensured that there is an appropriate Job Safety Analysis (JSA), Permit to Work (PTW) and Lock Out Tag Out (LOTO) compliance supported with Hazard Identification and Risk Assessment (HIRA).

6.8 MANAGEMENT OF ELECTRICAL HAZARDS

6.8.1 SHOCK HAZARD

The following technologies should be adopted to complement the overall shock protection program and to minimize the risk of shock:

a. Voltage-rated gloves shall be worn wherever a shock hazard is present.
b. Proper design, installation, and maintenance of equipment earthing which is critical to managing shock hazards shall be ensured.
c. Installation of RCCB (Residual Current Circuit Breakers)/ELCBs (Earth Leakage Circuit Breaker) shall be carried out based on the company's standards / procedures. Periodic test of RCCB/ELCB should be carried out.
d. Battery-powered tools instead of AC power driven tools to be used wherever possible.
e. Reduced-voltage equipment
f. Double-insulated equipment
g. Shrouding and barriers
h. Insulated or voltage-rated tools
i. Voltage-rated PPE (e.g., gloves or helmets)
j. Insulated mats for floors
k. Insulated, flexible barriers for exposed equipment parts
l. Identification of multiple voltage sources inside cabinets
m. Segregated voltages to prevent accidental contact where multiple voltage sources exist in one unit, terminal blocks, marshalling boxes,
n. Finger-safe terminals to prevent finger contact
o. Prohibited approach boundary limit for circuit parts and conductors shall be crossed only by a qualified and competent person under the written authorization from management.

6.8.2 ARC / FLASHOVER HAZARDS

Arcing faults in electrical equipment are multi-energy events (i.e., involving heat, blast, light, and sound) that generally produce high levels of energy release in a short-duration.

a. It takes place due to phase to phase and phase to earth fault conditions. It may cause heavy flashover which may result in severe injury to employees in the close vicinity.

b. Tata Power shall clearly specify the level of Incident Energy above which the recommended PPE's (such as cool coat, face shield with goggles, safety shoes, hand gloves and insulated electrical hand tools) are to be used.

c. Areas where dangers of Arc/Flashover hazards can occur should be identified.

d. There should be warning boards wherever use of ARC SUIT is mandatory.

e. This phenomenon can occur at low voltage levels as well.

Areas where dangers of Arc/flashover hazards can occur should be identified. There should be warning boards wherever use of ARC SUIT is mandatory.

6.8.3 STATIC ELECTRICITY HAZARDS

a. Static electricity hazards, including lightning can be a source of ignition, and injuries. It can result in shock to personnel and damage to equipment directly. It may also lead to fires.

b. Some operations (e.g. handling or transporting liquids, solids, or gases in portable containers or piping systems) generate static electricity hazards.

c. Certain maintenance activities (e.g. steam cleaning, industrial vacuuming, and sandblasting), generate static electricity hazards.

d. Ensure proper earthing and bonding of earthing conductors to equipment and structures to prevent generation of static electricity.

e. Each site shall be equipped with adequate lightning arrestors (Refer to local standards / regulations for guidance).

6.8.4 FIRE AND EXPLOSION HAZARDS

Assess and manage the risk of explosion hazards associated with electrical equipment .e.g. Hydrogen filled generators. These should include, but are not limited to:-

a. Provision and maintenance of drawings and documents describing the limits of the hazardous area and its classification.
b. Selection and procurement of electrical and non-electrical equipment appropriate for the area classification (refer note below).
c. Maintenance of the mechanical integrity of the installation, including grounding and bonding.
d. Promptly arresting the leakage of combustible gases and liquid and avoid accumulation of combustible waste.
e. No hot work to be carried out without “HOT WORK PERMIT”
f. In the absence of Work Permit System in that particular site, a system should be put in place to ensure that hot work is conducted in a safe and secure manner

6.8.5 FLAMMABLE AND TOXIC GAS HAZARDS

a. Assess and manage the risk of hazards associated with handling flammable and toxic gases. These include Cl2, SF6, H2, N2, CO2, Furnace Exhaust gases, (while working in ESPs, Chlorination Plant, Chimney, Boilers)
b. Promptly arresting the leakage of combustible gases and liquid and avoid accumulation of combustible waste.
c. Warning signs shall be put up with instruction for emergencies.
d. No hot work to be carried out near flammable gases.

Note: Entry into these areas by electrician may be required for installation of lighting purposes.

6.8.6 MECHANICAL ENERGIZED SPRING HAZARDS

a. Assess and manage the risk of hazards associated with Mechanically Charged Springs.
b. Ensure all springs are discharged before maintenance activity is carried out.
c. When work to carried out in vicinity of charged springs adequate knowledge of the hazards associated should be possessed. Ensure that either the springs are discharged or they are in locked in position.

6.8.7 PRESSURIZED GAS CYLINDER HAZARDS

a. Assess and manage the risk of explosion hazards associated with Pressurized Gas Cylinders.
b. Follow Tata Power Safety Procedures for Handling and Storage of Pressurized Gas Cylinders.
c. Empty Cylinders should be clearly identified.
d. All Cylinders should be stored vertically.

6.8.8 BATTERY ACID HANDLING HAZARDS

6.8.8.1 Storage of Acid Cans/Containers

a. Acid cans should be clearly labelled with danger sign.
b. Emergency Contact Numbers should be clearly printed.
c. Board with Instructions for actions to be taken in case of emergency should be put up at entrance to storage area.
d. It should be fool proof against mistakenly being taken to be water.
e. Acid containers should be stored away from reach of general public.
f. Adequate ventilation should be provided.
g. Availability of fire fighting equipment should be ensured.
h. Provision of eye wash and shower should be ensured.
i. Containers should be durable and UV proof
j. Do not bring naked flame in vicinity of storage area
k. Never pour water into concentrated acid for preparation of dilute acid.
l. Acid should be handled by approved personnel
m. Necessary PPE should be used before handling Battery Acid.
n. Instrument used for measuring specific gravity should be calibrated.

6.9 PERMIT TO WORK (PTW), LOCK OUT TAG OUT (LOTO), HAZARD IDENTIFICATION AND RISK ASSESSMENT (HIRA)

6.9.1 Documented “Permit to Work (PTW) System” shall be implemented with total compliance to LOTO.

6.9.2 Concept of test before touch should be followed by everyone working with electrical systems.

6.9.3 Control circuit isolation is not considered safe for electrical working.

6.9.4 Power circuit of all voltage levels shall be isolated, locked and tagged. Keep in mind that 415V power circuit are equally hazardous especially in case it is fed directly from transformer output.

6.9.5 Permit for working on energized circuits shall be supported by HIRA and it shall be discussed with the working team for developing an understanding of involved hazards and precautionary measures.

6.9.6 After checking absence of voltage by neon tester of appropriate voltage rating, the discharging of residual charge from the cables, capacitors, transformers and other equipment by short circuiting and earthing should be done before touching un-insulated portion of the equipment.

6.10 TEMPORARY WIRING

6.10.1 Temporary wiring shall be done with all safety systems, ELCBs, warning signs, in place and in working condition.

6.10.2 Knowledge of source isolation points shall be known to the working personnel.

6.10.3 Wiring for temporary supply shall be done with proper plug and socket arrangement.

6.10.4 Proper earthing should be applied to all equipment and tools used.

6.10.5 Temporary wiring will be allowed only in the following cases:

a. Construction, remodelling, demolition of buildings and / or structures. Maintenance, repair of equipment

b. Emergencies, testing activities, experiments and developmental work

c. Temporary wiring shall be removed immediately upon completion of construction, or the purpose for which it was installed

6.10.6 Special precautions should be taken in case of temporary wiring installation. The precautions taken shall provide a level of safety equivalent to or greater than that provided by fixed / permanent wiring.

6.11 EARTHING

6.11.1 All extraneous metal parts of an electrical installation and adjacent metal work shall be connected to earth.

6.11.2 The design of the earth system shall take into account the protection of life from raised voltages on external parts and the correct operation of the electrical protection systems.

6.11.3 Dual earthing should be provided.

6.11.4 Appropriate means shall be used to test the integrity of earthing systems periodically.

6.11.5 The design of the system should consider the requirement to test wherever possible.

6.13.6 Proper symbols and colour codes should be used for earthing system.

6.13.7 Earthing System should be theft proof. In case of theft it should be replaced immediately.

6.14 OVERHEAD LINES

6.14.1 Work in areas where overhead lines are present should be monitored carefully. A formal risk assessment / Job Safety Analysis shall be carried out and adequate precautions taken before such work is permitted.

6.14.2 Adequate precautions should be taken while using long length equipment and tackles in these areas.

6.14.3 Reduction in clearances should be considered while working in vicinity of HV lines.

6.14.4 Personnel working in these areas should be aware of Induction Voltages present.

6.14.5 Personnel should be alert to fault occurring on adjacent lines.
Working at height Procedure shall be followed.

6.15 OTHER ASPECTS

6.15.1 Access to high tension areas and vital installations shall be controlled.

6.15.2 Access control should be maintained for Capacitor Bank Cages

6.15.3 Appropriate signage shall be displayed in hazardous areas and on equipment as per statutory requirements.

6.16 SAFETY PRECAUTIONS WHILE CARRYING OUT TESTING OF EQUIPMENT RELAYS INSTRUMENTS

a. Instruction Manuals of equipment shall be studied before carrying out any activity.
b. LOTO system will be used for de-energizing stored energy.
c. Working at Heights Standards shall be referred wherever appropriate.
d. While working in switchyard one must be aware of levels of induction voltages and its dangers to personnel and test equipment.
e. Umbrellas and metallic ladders shall NOT be used in the switchyard.
f. Transportation in switchyard shall be done considering safe clearances.
g. While working with SF6 environmental precautions shall be strictly followed.
h. Other standards wherever applicable shall be adhered to.

6.17.1 SAFETY PRECAUTIONS DURING HIGH VOLTAGE TESTING

a. Before Hi-pot of any equipment get confirmation of the test voltage to be applied.
b. Before Hi-pot flashing light and alarm system should be made available.
c. Before Hi-pot of any equipment, conduct the leakage current trial trip test of the test set by grounding the equipment under test.
d. Discharge all equipment by proper discharge rod after every Hi-pot test.
e. Ensure proper duration of discharge
f. While doing Hi-Pot ensure that IR shall be taken before and after test.
g. Ensure minimum value of IR is met before Hi-Pot test.
h. While doing Hi-Pot ensure proper cordoning of the area under test
i. Testing engineer should maintain safe distance from high voltage by locating control unit outside cordoned area
j. After every test before discharging, isolate 230 V AC power supply by physically removing three pin plug from socket.

k. Discharge after DC Hi-Pot should be very slow, gradual and will consume more time.

l. Ensure proper identification and connection of phase and neutral of variac for input to the kit.

m. Ensure firm connection of leads so that they do not break fall while the test is in progress

6.17.2 SAFETY PRECAUTIONS WHILE TESTING TRANSFORMER

a. While doing magnetic balance test from LV side, ensure that the HV side is not shorted and clearances for induced HV voltages are taken care of. The area should be well cordoned-off to prevent anybody from coming close to the equipment which may include connected switchgear.

b. While doing magnetic balance (without variac) with one shot direct voltage application, ensure proper ELCB protection on supply side to take care of inadvertent shorting on secondary side or fault in transformer.

c. While arranging for silica gel replacement ensure Buchholz relay trip and PRD trip is taken care of.

d. Before clearing transformer for charging confirm that the transformer neutral has been earthed.

e. Before clearing transformer for charging ensure that unused transformer CT cores are shorted and grounded in its marshalling boxes.

f. No transformer should be cleared for charging without all device trials.

g. Ensure proper and safe discharge of transformer after every HV test (e.g. IR, HV tan delta, etc.)

h. Ensure firm connection of leads so that they do not break and fall while the test is in progress

i. Do not touch any exposed leads for making connections without insulated rubber hand gloves.

j. Winding Resistance: After discharge of winding by test set, Switch off test supply. While changing the lead connection for different phase measurement, ensure supply plug is disconnected in addition to the above. Additionally, a banana

shorting across terminal of transformer or test set may be used to ensure complete discharge.

k. TTR / Voltage Ratio / Vector Group Test: Test should be done by injecting voltage on HV side

l. Buchholz trials to be conducted by draining oil. Ensure all the related isolating valves are opened after the test and proper venting is done.

m. WTI / OTI Maximum Temp Indicator should be noted before the test and should be set to same value after the test. During this test ensure that All fans and pumps are ready for operation.

6.17.3 SAFETY PRECAUTIONS WHILE TESTING TRANSFORMER BUSHING

a. Test tap is normally rated up to 1 kV and should be grounded in service condition. During HV tan delta, the connection to test tap point should be made firmly so that the leads do not come out while test is in progress.

b. Ensure proper connection of HV lead to the bushing HV cylinder. Connection to conductor coming out of bushing need not always be connected firmly to bushing cylinder in case through put bushing.

c. Ensure proper grounding and protection from moisture ingress of the test tap after completion of the test.

6.17.4 SAFETY PRECAUTIONS WHILE TESTING CT / CVT / PT

a. Test tap is normally rated up to 1 kV and should be grounded in service condition. During HV tan delta, the connection to test tap point should be made firmly so that the leads do not come out while test is in progress.

b. Ensure proper grounding and protection from moisture ingress of the test tap after completion of the test.

c. While doing primary injection ensure LBBU, B/F and Transformer differential relay are properly identified and blocked if necessary.

d. While bypassing i.e. connecting measuring instrument across CT links and dropping them for current measurements, ensure continuity of current measuring circuit. There should be no fuse in that measuring circuit.

e. After raising CT link by two screw driver method only, ensure current in the test measurement circuit for which the link was dropped has gone to zero.
f. Do not short secondary of CVT/PT
g. While doing CVT/PT secondary voltage injection ensure the HV side is not shorted and that it is cordoned off and protected.
h. Do not leave any CT secondary open circuit
i. There should be only one ground in each core / winding of CT/CVT/PT secondary circuit.
j. Follow the instructions of HV Test Kit while doing secondary induced voltage testing on PT.

6.17.5 SAFETY PRECAUTIONS WHILE TESTING CAPACITOR BANK

a. While entering Capacitor bank cage ensure that it is fully discharged.
b. Do not reclose capacitor bank breaker immediately after tripping.
c. Ensure Discharge Timer in Protection circuit for the above.
d. One must be aware of the corrosive and dangers of the electrolyte in the capacitor
e. Ensure proper Voltage and KVAr rating of the capacitor being commissioned /replaced.

6.17.6 SAFETY PRECAUTIONS WHILE TESTING GENERATOR

a. While entering GT/UAT/Generator HV side bus duct, etc. ensure that the generator is at standstill and not on turning gear. Ensure primary drive is isolated.
b. Ensure to disconnect space heater supply during work. If space heater is to be kept in service this condition should be clearly highlighted. Space heater terminals should be adequately covered to prevent personnel coming in contact to live terminals. Precaution against contact with hot surface of space heater should also be taken.
c. Ensure that Generator is not taken on turning gear when testing in Generator Bus duct is in progress.
d. Ensure proper sound protection for ears while working in vicinity of running generators
e. While doing generator shaft voltage measurements ensure proper safety.

f. In case of Hydrogen filled generators follow the laid down procedures as Hydrogen gas is highly explosive.

g. Ensure decoupling of generator from primary mover where ever possible. The isolation valves to the turbine should be closed.

6.17.7 SAFETY PRECAUTIONS WHILE TESTING MOTOR

a. Ensure that the motor is at standstill and not on turning gear. Even after standstill ensure the windings are discharged before testing.

b. It should be decoupled from load. The motor should not drive the load and vice versa the load should not rotate the motor during testing.

c. Ensure to disconnect space heater supply during work. If space heater is to be kept in service this condition should be clearly highlighted.

d. Space heater terminals should be adequately covered to prevent personnel coming in contact to live terminals.

e. Precaution against contact with hot surface of space heater should also be taken.

f. Ensure that Motor is not taken on turning gear when testing.

g. Ensure proper sound protection for ears while working in vicinity of running motors

h. While disconnecting motor make sure to note down cable connections to prevent reverse rotation. One should ensure correct rotation of motor before coupling to load after overhaul or testing. Wrong direction of rotation may cause severe damage.

6.17.8 SAFETY PRECAUTIONS WHILE TESTING SWITCHGEAR

a. Ensure all entry points and doors are closed and vermin proof before clearing equipment.

b. Especially for outdoor equipment ensure proper monsoon, water ingress protection.

c. During Testing, do NOT put hands in moving parts of breaker mechanism

d. While entering cubicle for CT or PT connection, ensure metal clad isolation between live bus bar compartment & cable compartment of feeders, incomers etc.

e. IR of Vacuum bottle must be done with X-Ray exposure shield.

6.17.9 SAFETY PRECAUTIONS WHILE TESTING RELAY

a. While doing carrier trials ensure that it is not used for direct trip as a special case.

b. During testing ensure isolation of relay binary outputs accounted for. There should be no Remote, Bus Coupler, Lock Out tripping (other than the feeder which is being tested) connected.

c. Confirm B/F, Differential Stability, Shinkle test while taking new equipment in service.

d. Test charge equipment with B/F, LBBU kept inoperative. These should be taken into service after spill current measurements.

e. Ensure safety ground in CT and PT secondary circuits.

f. Ensure DC on while carrying out changeover before release so the juice is available for changeover relays.

6.17.10 SAFETY PRECAUTIONS WHILE USING TEST INSTRUMENT

a. Ensure proper grounding of test instruments especially while working in High Voltage areas

b. Ensure proper grounding of equipment under test before test lead connections

c. Ensure all grounds are removed after completion of all tests.

d. Do final Maintenance IR measurement before charging the equipment.

e. Use of Dimmerstat should be done keeping in mind that both phase and neutral may have high voltages with respect to ground.

f. Dimmerstat body should be earthed properly before it is used.

g. Before HV tan delta measurement at high voltage do one reading at low voltage to ensure healthiness of circuit.

h. Keep all test instruments in cool place/shaded area for protection against heat.

i. Ensure field calibration of instrument if required, e.g. leads of SFRA test set.

6.17.11 GENERAL SAFETY PRECAUTIONS WHILE TESTING

a. Cross check if any doubt about test results or variations in test results.

b. Wherever working with high pressure vessels/ cylinders person must be aware of the dangers.

c. Wherever working with corrosive liquids like battery acid, cleaning liquids, alcohol all precautions and emergency procedures are understood.

6.17.12 SAFETY PRECAUTIONS FOR POWER SUPPLY USED FOR TESTING

a. Ensure ELCB.
b. Test ELCB.
c. Ensure 3 pin plugs for 1 phase supply.
d. Ensure proper earthing of the earth point in the supply system.
e. Ensure healthiness and firmness of Phase Neutral and Earthing wire connections.
f. Measure the supply voltage.
g. Ensure adequate rating of supply point so that ELCB / MCB do not trip during test.
h. Ensure proper phase sequence in case of three phase supply.
i. Ensure adequately rated cables and hardware.

7.0 RECORDS :

All Check Lists as annexed with this procedure. Records to be kept minimum three years.

8.0 TRAINING & COMMUNICATION

8.1 Training of procedure shall be covered as part of electrical safety Training.

8.2 Initial Communication to be done through Corporate Communication, Email and subsequently shall be made available at safety portal at Sangam.

9.0 VERIFICATION

9.1 Verification of implementation shall be done during safety audit, field safety visit and site inspections.

10.0 EXCEPTION: Any Exception to this procedure shall only be done as per Document Control .Procedure (TPSMS/GSP/DOC/014).

11.0 REFERENCES

11.1 Tata Group Job Safety Analysis (JSA) Procedure - TPSMS/CSP/JSA/009

11.2 Tata Power Permit-To-Work (PTW) Procedure - TPSMS/CSP/PTW/008

12.0 REVIEW:

12.1 Review of this procedure shall be done as and when but not later than once in every three (03) years. Typical Factors like Changes in legislation, Review of Incident Reports, Inspection & Audit findings, Feedback from users, Recommendations in Incident investigation reports may be inputs for the review and revision of the procedure.

12.2 In case release of revised procedure gets delay due to obtaining feedback or any other reasons, safety advisory may be issued immediately to take precautions for the proposed changes in the procedure and revised procedure should be released subsequently.

13.0 ATTACHMENTS/APPENDIX :

SAFETY CHECK LIST FOR TESTING ACTIVITIES: In addition to checklist given below each division shall prepare its own equipment specific checklist. PTW acceptor (usually the O&M engineer in the particular shift) and testing engineer shall fill the checklist before carrying out any testing activity and keep signed copy for record. The check list is valid only once for the duration of the caution/release/operation order. List of Annexure enclosed in this procedures:

13.1 **Annexure-1**:Safety Check List for HV Testing :
TPSMS/CSP/ELEC/010/FORM/001

13.2 **Annexure-2**:Safety Check List for Transformer Testing :
TPSMS/CSP/ELEC/010/FORM/002

13.3 **Annexure-3**:Safety Check List for Transformer Bushing Testing :
TPSMS/CSP/ELEC/010/FORM/003

13.4 **Annexure-4**:Safety Check List for CT/CVT/PT Testing:

13.5 TPSMS/CSP/ELEC/010/FORM/004

13.6 **Annexure-5**:Safety Check List for Capacitor Testing:
TPSMS/CSP/ELEC/010/FORM/005

13.7 **Annexure-6**: Check List for Generator Testing:
TPSMS/CSP/ELEC/010/FORM/006

13.8 **Annexure-7**:Safety Check List for Switch Gear Testing :
TPSMS/CSP/ELEC/010/FORM/007

13.9 **Annexure-8**: Check List for Relay Testing:
TPSMS/CSP/ELEC/010/FORM/008

13.10 **Annexure-9**: Check List for Handling Test Instruments
TPSMS/CSP/ELEC/010/FORM/009

13.11 **Annexure-10:** Check List General For Testing Activity
TPSMS/CSP/ELEC/010/FORM/010

13.12 **Annexure-11**: Checklist for Power Supply Used for Testing:
TPSMS/CSP/ELEC/010/FORM/011

Annexure- 1

TPSMS/CSP/ELEC/010/FORM/001

SAFETY CHECK LIST FOR HV TESTING

DATE OF TESTING:----------

1	Hi-Pot Test Voltage to be applied available	____ kV	
2	Cordoning of the area under test done	Yes	
3	IR before Hi Pot test > 10 Mohm (>minimum value).	Yes	
4	Proper identification and connection of phase and neutral of variac for input to the kit.	Yes	
5	Flashing light, alarm system working.	Yes	
6	Testing engineer at safe distance from high voltage by locating control unit outside cordoned area	Yes	
7	Ensure firm connection of leads so that they do not break fall while the test is in progress	Done	
8	Leak trip test of Hi-pot set	Done	
9	After Hi-Pot test before discharging, isolate 230 V AC power supply by physically removing three pin plug from socket.	Done	
10	Equipment discharged for sufficient duration by proper discharge rod after Hi-pot test.	Yes	
11	Discharge after DC Hi-Pot should be very slow, gradual and will consume more time.	Yes	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 2

TPSMS/CSP/ELEC/010/FORM/002

SAFETY CHECK LIST FOR TRANSFORMER TESTING

DATE OF TESTING:----------

1	Magnetic Balance Test: While doing magnetic balance test from LV side the area should be well cordoned off to prevent anybody from coming close to the equipment which may include connected switchgear.	Done	
2	Magnetic Balance Test: While doing magnetic balance test from LV side, ensure that the HV side is not shorted and clearances for induced HV voltages are taken care of.	Done	
3	While doing magnetic balance (without variac) with one shot i.e. direct full voltage application, proper ELCB protection on supply side available to take care of inadvertent shorting or fault on secondary side of transformer.	Yes	
4	Transformer neutral has been earthed after test.	Done	
5	CT cores are shorted and grounded in its marshalling boxes.	Done	
6	Device trial alarm and trip done.	Yes	
7	Proper and safe discharge of transformer after every HV test (e.g. IR, HV tandelta, etc) done.	Yes	
8	Firm connection of test leads so that they do not break and fall while the test is in progress	Done	
9	Put on Rubber hand gloves before test lead connection.	Yes	
10	Winding Resistance: After discharge of winding by test set, Switch off test supply. While changing the lead connection for different phase measurement, ensure supply plug is disconnected in addition to the above. Additionally, a banana shorting across terminal of transformer or test set may be used to ensure complete discharge.		
11	TTR / Voltage Ratio / Vector Group Test: Test should be done by injecting voltage on HV side	Yes	
12	Buchholz trials to be conducted by draining oil.	Yes	
13	After Buchholz trials all the related isolating valves are opened and proper venting is done.	Yes	
14	WTI / OTI Maximum Temp Indicator noted before the test.	Yes	
15	WTI / OTI test all fans and pumps are ready for operation The fans are either covered or nobody is near the fan. Pump suction and discharge lines are lined up	Yes	
16	WTI / OTI Maximum Temp Indicator reset after the test.	Yes	

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 3

TPSMS/CSP/ELEC/010/FORM/003

SAFETY CHECK LIST FOR TRANSFORMER BUSHING TESTING

DATE OF TESTING:----------

1	During HV tan delta test, the test tap point should be connected firmly so that the leads do not come out while test is in progress.	Done	
2	Ensure proper grounding and moisture ingress protection of the test tap point after completion of the test.	Done	
3	Proper connection of HV leads to the bushing HV during test.	Done	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 4

TPSMS/CSP/ELEC/010/FORM/004

SAFETY CHECK LIST FOR CT/CVT/PT TESTING

DATE OF TESTING:----------

1	Secondary of CVT/PT kept open and grounded at one point.	Yes	
2	Secondary of CT kept shorted and grounded at one point.	Yes	
3	Before primary injection LBBU, B/F and Transformer differential relay are properly identified and blocked if necessary.	Yes	
4	There should be no fuses in the meters used for current measurements on CT secondary circuits.	Yes	
5	While dropping CT links for current measurements ensure continuity of current measuring circuit.	Yes	
6	After raising CT link by two screw driver methods only, current in the meter across the link has gone to zero before removing the meter.	Yes	
7	While doing CVT/PT secondary voltage injection ensure the HV side is not shorted and that it is cordoned off and protected.	Yes	
8	There should be only one ground in each core / winding of CT/CVT, PT circuit. IR of secondary circuit after removing single ground > 2Mohm	Yes	
9	Follow the instructions of HV Test while doing secondary induced voltage testing on PT.	Yes	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 5

TPSMS/CSP/ELEC/010/FORM/005

SAFETY CHECK LIST FOR CAPACITOR TESTING

DATE OF TESTING:----------

1	While entering Capacitor bank cage ensure that it is fully discharged.	Yes	
2	Do not reclose capacitor bank breaker immediately after tripping.	Yes	
3	Ensure Discharge Timer in Protection circuit for the above.	Yes	
4	One must be aware of the corrosive and dangers of the electrolyte in the capacitor	Yes	
5	Ensure proper Voltage and KVAr rating of the capacitor being commissioned /replaced.	Yes	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 6

TPSMS/CSP/ELEC/010/FORM/006

SAFETY CHECK LIST FOR GENERATOR TESTING

DATE OF TESTING:----------

1	While entering GT/UAT/Generator HV side bus duct, etc. ensure that the generator is at standstill and not on turning gear.	Yes	
2	Ensure that Generator is not taken on turning gear when testing in Generator Bus duct is in progress.	Yes	
3	Ensure proper sound protection for ears while working in vicinity of running generators	Yes	
4	While doing generator shaft voltage measurements ensure proper safety.	Yes	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 7

TPSMS/CSP/ELEC/010/FORM/007

SAFETY CHECK LIST FOR SWITCHGEAR TESTING

DATE OF TESTING:----------

1	Ensure all entry points and doors are closed and vermin proof before clearing equipment.	Yes	
2	Especially for outdoor equipment ensure proper monsoon, water ingress protection.	Yes	
3	During Testing, do not put hands in moving parts of breaker mechanism	OK	
4	While entering cubicle for CT or PT connection, ensure metal clad isolation between live bus bar compartment & cable compartment of feeders, incomers etc.	Yes	
5	IR of Vacuum bottle must be done with X-Ray exposure shield.	Yes	
6	DC clearance and AC clearance are adequate (of different criteria?)	Yes/NO	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Reviewed By (Name & Signature) :

Annexure- 8

TPSMS/CSP/ELEC/010/FORM/008

SAFETY CHECK LIST FOR RELAY TESTING

DATE OF TESTING:----------

1	Direct Trip links if any kept dropped during carrier trials	Yes	
2	During testing ensure isolation of relay binary outputs accounted for. There should be no Remote, Bus Coupler, Lock Out tripping (other than the feeder which is being tested) connected.	Yes	
3	Confirm B/F Stability while taking new equipment in service.	Yes	
4	Confirm Differential Stability test while taking new equipment in service.	Yes	
5	Confirm Shinkle test while taking new equipment in service.	Yes	
6	B/F, LBBU trip links kept inoperative for test charging and/or taking equipment on load service	Yes	
7	B/F, LBBU normalized after making spill current measurements.	Yes	
8	DC and Positive to Trip circuits IR taken.	Yes	
9	CT and PT secondary circuits IR taken.	Yes	
10	Ensure safety ground in CT and PT secondary circuits.	Yes	
11	Ensure DC on while carrying out changeover before release so the juice is available for changeover relays.	Yes	

Remarks (If any):

Prepared & Checked By (Name & Signature):

Reviewed By (Name & Signature):

Annexure- 9

TPSMS/CSP/ELEC/010/FORM/009

SAFETY CHECK LIST FOR HANDLING TEST INSTRUMENTS

DATE OF INSPECTION:----------

1	Proper grounding of test instruments especially while working in High Voltage areas	Yes	
2	Proper grounding of equipment under test before test lead connections	Yes	
3	All grounds are removed after completion of all tests.	Yes	
4	Final Maintenance IR measurement before charging the equipment.	Yes	
5	Dimmerstat leads and terminals properly covered (both phase and neutral may have high voltages with respect to ground.)	Yes	
6	Dimmerstat body earthed properly before it is used.	Yes	
7	Before HV tan delta measurement at high voltage do one reading at low voltage to ensure healthiness of circuit.	Yes	
8	Shaded area and table provided for all test instruments in field testing activity for protection against heat and rain.	Yes	
9	Field calibration of instrument carried out. (e.g. leads of SFRA test set.)	Yes	

Remarks (If any):

Prepared & Checked By (Name & Signature):

Annexure- 10

TPSMS/CSP/ELEC/010/FORM/010

SAFETY CHECK LIST GENERAL FOR TESTING ACTIVITY

DATE OF INSPECTION:----------

1	Cross check if any doubt about test results or variations in test results.	Yes	
2	Wherever working with high pressure vessels/ cylinders person must be aware of the dangers.	Yes	
3	Wherever working with corrosive liquids like battery acid, cleaning liquids, alcohol all precautions and emergency procedures are understood.	Yes	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :

Annexure- 11

TPSMS/CSP/ELEC/010/FORM/011

SAFETY CHECK LIST FOR POWER SUPPLY USED FOR TESTING

DATE OF INSPECTION:----------

1	ELCB of adequate rating installed.	Yes	
2	3 pin plug for 1 phase supply.	Yes	
3	Ensure adequate sizing of power supply cables	Yes	
4	Confirm proper earthing of the supply earthing points.	Yes	
5	Ensure adequate rating of supply point so that ELCB / MCB does not trip during test	Yes	

Remarks (If any) :

Prepared & Checked By (Name & Signature) :