TECHNICAL SPECIFICATION:

1.0 Scope: This volume provides the scope and procedures for Hot line maintenance work in EHT lines and maintenance of equipment in EHT substation by hot stick or live line bare hand work procedure and using recommended insulated tools & tackles and aerial devices on pilot basis to the following Transmission Elements;

Grid Substations:

a) 400/220/132/33kV Grid Substation Meramundali
b) 400/220/132/33kV Grid Substation Mendhasala
c) 400/220/132/33kV Grid Substation Lapanga
d) 400/220/33kV Grid Substation New-Duburi
e) 220/132/33kV Grid Substation Budhipadar

Transmission Lines:

a) 400kV Meramundali-Mendhasala Double Circuit Line
b) 400kV IB-Lapanga Double Circuit Line
c) 220kV Budhipadar-Tarkera Double Circuit Line
d) 220kV Lapanga-Katapali-Bolangir Line
e) 220kV Kuchei-Balasore Double Circuit Line

2.0 Working Procedure:

Following working procedure shall be adopted during live line maintenance work in EHT Line and substation.

a). The Engineer-In charge of the line has to be notified prior to starting of live line work.

b). All cares should be taken to prevent the equipment or any part thereof from coming within the specified minimum clearance distance of an energized conductor or part / Equipment.

c). It is the responsibility of the Agency to determine and establish the requirements which allow qualified individuals to work on energized Line / equipment. It is the responsibility of each qualified person to adhere to the requirements of the Agency, and to ensure all proper precautions are being followed. The following topics should be addressed when establishing the requirements for work live:

1) Work limits/approach boundaries
2) Clearances for live line work
3) Appropriate PPE for live line work
4) Special tools for live line work
5) Special work equipment for live line work
6) Qualifying employees for live line work
7) Recommended live line work practices

3.0 Recommended live line work clearances

Live line work clearances are measured between an energized apparatuses and a ground source. Live line clearances define where live line maintenance can be performed. It is recommended that two sets of live line clearance be defined. Normal live line clearances define where qualified employees can follow normal live line procedures to do live line work. Restricted live line clearances defines areas where restricted clearance provisions must be followed in order to work the line live, or alternatively, live line work is prohibited.

It is the Agency's responsibility to determine the minimum clearances. The recommended minimum clearance between an energized apparatuses and a ground source for "Normal Live Line Work" is 4'-0".

Restricted live line clearances are areas where the minimum clearance for normal live line maintenance cannot be maintained. Some examples include; clearances to tunnel of overhead bridges, station canopies, and other structures. Working on energized OCS with in a restricted clearance area requires additional provisions. Work should be prohibited in restricted clearances zones unless employees are qualified to work within restricted clearance areas and appropriate measures are employed to mitigate the additional risk.

4.0 General Precautions

1) Live Line maintenance should not be started when if the threat of lightning is present
2) The automatic re-closure of breakers feeding the line section should be made inoperable while live line maintenance is being performed.
3) All work equipment and insulating tools should be inspected for defects before work begins.
4) Proper PPE should be worn when performing live line work
5) Care should be taken to maintain proper clearances when using conductive materials.
6) When working on energized conductors, care should be taken to make sure the conductor does not flash over to adjacent objects located along the line.
7) A well-developed set of formal, written work rules should be provided for safe implementation of live line work.

5.0 Precautions when working a line live

1) When working a line live the worker shall be insulated from ground and objects
2) Only tested and dielectrically approved insulating lift mechanisms

6.0 Recommended PPE for live line work

The agency should establish requirements for PPE when performing maintenance on energized OCS equipment. Personal protective equipment which is selected should conform to all applicable safety standards as outlined by ANSI, ASTM, NFPA, and OSHA.

Suggested personal protective equipment which should be considered for qualified employees performing live line work includes; Fire resistant clothing, eye protection, fire resistant fall protection harness, fire resistance reflective safety vest, hard toe foot protection, electrical protective gloves, sleeves, and nonconductive hard hat.

The agency should establish guidelines for the proper use and care of all PPE. In addition guidelines should be established for when different pieces of PE is required to be worn.

7.0 Electrical protective gloves and sleeves

Electrical protective gloves consist of a flexible rubber glove with gauntlet and a soft pliable leather glove that is worn over the rubber glove to protect it against punctures or abrasions. Electrical protective gloves are marked with ANSI/ASTM classifications, classifications are based on the Maximum Use Voltage. Electrical protective gloves must be electrically tested and certified at their voltage class before initial use. Electrical protective gloves must be electrically tested periodically in accordance with the USA Standard Specification for Rubber Protective Equipment for Electrical Workers. It is recommended that an outside testing agency do all testing of gloves and sleeves. The Agency should establish a minimum and maximum period between tests.

In addition to the electrical test, is recommended that Agency establish guidelines for testing prior to each use. These guidelines should include testing rubber gloves and sleeves for punctures and cuts. Inspecting leather gloves for wear, cuts etc. Gloves and sleeves should not be used if visual inspection proves them to be defective.

8.0 Special tools for live line work

The American National Standards Institute, American Society for Testing and Materials & Occupational Safety and Health Administration have a number of standards which describe the requirements for testing tools and apparatus used to perform maintenance on the OCS. Agencies should observe these standards as they apply to the safety of the users of the equipment. The equipment to which these standards apply is:

(a)Hot Sticks
(b)Shotgun Hot Sticks
(c)High Voltage Gloves and Sleeves
(d)High Voltage Insulated Tools
(e)Rubber Blankets and Mats
(f)Insulated Bucket Trucks or Elevated Platforms
(g)Slings
(h)Rubber Line Hoses
(i) Truck mounted Aerial Device for hotline maintenance

These items should be tested and inspected daily before each use if used daily. All rubber protective materials should be stored in a dry environment unfolded. If any defect is found while inspecting the protective equipment, the immediate supervisor should be notified and the equipment taken out of service.

An inspection and testing program should be established by the agency. All required inspection and testing should be provided by an independent laboratory. A log, which details the testing performed on the equipment, should be established by the agency and should be in addition to the test information provided by the test laboratory.

9.0 Qualification / Training for employees for live line work

Employees doing live line work on the OCS(Overhead Contact System) should have satisfactorily completed a formal training course of instruction and practice. Records should be maintained that include training and work experience in the areas that they are expected to perform. Qualified employees should be reexamined periodically to determine the adequacy of the workers knowledge of the rules and procedures, their ability to use tools and techniques. The Agency has to furnish list of employees, qualification, details of training imparted and work experience along with the bid.

10.0 Written Procedures: A written procedure shall be available for each type of live-line maintenance performed. Each written procedure shall specify the minimum crew size required by classification, the principal tools to be utilized, and each major step in the procedure to be performed. Apprentices must meet the requirements for section 2.4. Procedures shall be periodically reviewed or updated to reflect current work practices, safety concerns, and new equipment. The specific written procedure for the live-line maintenance to be performed shall be available to the crew at the tailgate safety meeting. This procedure will be discussed during the tailgate safety meeting held before performing the live-line maintenance. Live-line maintenance must not be attempted with less than the minimum number of qualified personnel as stated in
Each written procedure. A written Job Hazard Analysis **(JHA)** is required for live-line maintenance. A JHA is an integral part of the preparation for live-line work, and as such, it shall be reviewed and discussed prior to engaging in the live line work. Changes to the written procedure made during the work shall be developed through discussion among experienced craftsmen and supervisory personnel.

2.3 Supervision. Live-line maintenance shall be monitored by a supervisor or acting supervisor trained and certified. The supervisor shall observe and direct the work while maintenance is being performed and is to remain on the jobsite in no work status and pay strict attention to the ongoing procedural activities while procedural live-line work is being done. The supervisor shall be aware of the physical and mental condition of each crew member. No one, including the supervisor, shall be allowed to work in a condition that could jeopardize the safe operation of the crew or equipment.

2.4 Craftsmen Instruction and Certification. Only certified personnel shall perform or supervise work on energized lines or equipment. Certification for live-line work should ensure that an individual is not only knowledgeable but also competent in performing work on energized equipment. Exception: During training sessions, personnel may be uncertified. The step of an apprentice and the extent of his specific involvement in live-line training is left to the Area/District. The Division Director designated by the responsible Area or District Manager shall certify that personnel performing live-line maintenance have satisfactorily completed:

(1) **Certification**. Certification is required for those performing the bare hand or hot stick technique. If certification is received in the bare hand/hot stick technique, then a separate hot stick technique certification is not required. However, if hot stick technique certification is received and a worker needs to perform bare hand work, the bare hand/hot stick certification must be completed. Hourly requirements do not include travel time.

(a) **Bare hand/Hot stick Technique**. A 64-hour training program consisting of a combination of Class room and hands-on or on-the-job training is required, which includes competency testing. The classroom portion will include discussions on the applicable safety rules and maintenance procedures.
(b) **Hot stick Technique**. A 32-hour hot stick training program consisting of a combination of Class room and hands-on or on-the-job training is required, which includes competency testing. The classroom portion will include discussions on the applicable safety rules and maintenance procedures.

(2**) Physical Condition**. Craftsmen shall pass an annual physical examination in accordance with the current edition of WAPA Order 3339. Recertification is not a requirement. However, additional training may be done at any time.

13.0 Minimum Electrical Approach Distance - The minimum working distance from energized conductors and equipment for personnel. This includes:

1) The minimum approach distance to be maintained by workers and objects carried by them (except insulated live-line tools) from energized conductors and equipment;

2)The minimum distance workers shall maintain themselves and their support platforms, or be maintained by other means, from grounded parts or other energized conductors or equipment when approaching, leaving, or bonded to an energized conductor or piece of equipment; and

3) The minimum distance any piece of mechanized equipment may be set up or operated from an energized conductor or piece of equipment by other than properly trained and supervised O&M personnel.

14.0 Live-Line Maintenance - Maintenance activities performed on energized conductors or equipment with a phase-to-phase voltage exceeding 600 volts by the hot stick technique or 69 kV by the bare hand technique. Live-line maintenance does not include such activities as switching, hardware tightening, climbing inspection, hole digging, pole setting, conductor stringing, etc.
Live-Line Tools - Equipment used in live-line maintenance procedures including but not limited to hot sticks, pole gins, switching sticks, and insulated ladders.

15.0 Hot stick Technique - Live-line work performed by a worker placed at ground potential while maintaining the required electrical clearances from ground to the energized conductor/equipment.

16.0 Insulated Aerial Device - Vehicular-mounted articulating or telescoping boom-type personnel lift device equipped with fiberglass boom section(s) for insulation and metal-lined fiberglass bucket(s) or metal platform for personnel support, designed, constructed, tested, and certified in accordance with ANSI A92.2, "Vehicle Mounted Elevating and Rotating Work Platforms." Insulated Live-Line Tools - All hand-held and structure-mounted tools having an insulated section or

nonconductive property that is designed, tested, and approved for contact with energized conductors.

17.0 Nonconductive Rope - A flexible rope of twisted or braided synthetic polymer fibers maintained in a clean dry condition for use in conjunction with live-line maintenance. Nonconductive ropes can be used as handiness or taglines.

18.0 Job Supervisor - Any person authorized to request, receive, and release Clearances and Hot Line Orders and who is charged with the responsibility for the job.

Insulated Aerial Devices. Aerial devices shall have the minimum dielectric strength required for the voltage being worked.
Requirements. Insulated aerial devices used in the bare hand technique shall comply with the following requirements:
(1) Aerial device equipment shall be manufactured for performing live-line maintenance and shall only be used according to manufacturer's instructions.

(2) In order to prevent arcing across a vacuum space in a hydraulic line, all insulated aerial devices with hydraulic lines to controls at the platform or bucket shall be equipped with check valves in the lines and an atmospheric relief valve in the hydraulic system at the support platform. When the boom is in an energized attitude, the engine shall not be shut down nor the hydraulic pump disengaged.

(3) The hydraulic system of the vehicle may be used to power hydraulic tools at the support Platform if it conforms to ANSI A92.2 1990 standards. Hydraulic driven tools used from insulated aerial devices shall be maintained as part of that aerial device's hydraulic system
and not used from other hydraulic systems.

(4) Hydraulic lines for use with hydraulic tools shall neither be built into nor attached to the outside of the insulated boom portion of aerial device equipment.

(5) The support platform of insulated aerial devices may be single or double fiberglass buckets or a single metal platform equipped with an approved open-rail system. Fiberglass buckets shall be metal lined with the liners bonded together on double-bucket equipment. Fiberglass buckets shall not be considered an insulator when using the bare hand technique.

(6) The use of a permanently installed current monitor is recommended for monitoring leak age current in the boom during the bare hand technique. An ammeter, calibrated in 10-microampere (or less) scale divisions, shall be kept within the insulated aerial device. The ammeter shall be tested annually with a certification of attached to the meter or its case.

(7) Metal linked buckets and platforms shall be furnished with a minimum of two bare hand bonding leads. A spring loaded breakaway clamps shall be attached to each bonding lead.

(8) Insulated aerial device shall be annually inspected and tested in accordance with Appendix-C.

(9) A minimum approach distance table reflecting the minimum approach distances shall be printed on a plate of durable nonconductive material mounted so as to be visible to the operator of the boom.

Preoperative Tests: Before raising the insulated aerial device into the work position, all controls (ground level and bucket or platform level) shall be checked. In addition, for insulated aerial devices with hydraulic lines to controls at the support platform level, the support platform shall be raised to its maximum height and left in the raised position for 5 minutes for the hydraulic leak down test. Initial contact of an energized conductor shall be made with no one on the support platform or bucket so that the leakage current in the boom may be measured. No one standing on the ground shall be in contact with the vehicle while the leakage current test is being made. The leakage

current reading shall be taken while standing on the vehicle before starting work each day, each time a higher voltage is to be worked, and when an additional test is needed. A written record of these tests shall be maintained with the equipment. If the dielectric arm-current, after 3 minutes, is less than 1
Micro ampere for each kilovolt of nominal phase-to-ground voltage (refer to table below, rounded up to the nearest 10μA), and relatively the same as previous dielectric arm-current readings from tests on the same voltage and under similar conditions, the work platform may be used for bare hand work. Work operations shall be suspended immediately upon indication of a malfunction in the equipment.

Safety Procedures: When working on the platform, both legs shall be inside the support platform at all times with at least one foot on the bottom of the support platform. Personnel shall be belted to the aerial device. All work at elevated heights must adhere to fall protection requirements outlined in section 16 of the PSSM and chapter 2 of the PSMM. One person, capable of operating all controls, shall be stationed on the ground near the vehicle when personnel are on the support platform. This person shall keep other persons from walking under the work 13 area and keep them clear of the vehicle when the support platform is elevated. All movements of the lift assembly shall be controlled by the workers when they are on the support platform, except under emergency conditions. Under these emergency conditions, the ground operator shall mount the vehicle by means of an insulated device or such that he does not simultaneously contact the vehicle and ground. No one on the ground shall be in contact with the vehicle or protective ground cable while the support platform is in an energized position.
Minimum Approach Distances. A nonconductive measuring device shall be readily accessible to assist employees in maintaining the required minimum approach distance. When approaching energized equipment from an aerial device, the distance between the worker envelope and any part of the uninsulated section of the boom must be greater than or equal to the minimum phase-to-ground distance. This is important when working with the boom in a jack-knifed position. In addition, the minimum approach distances for the following scenarios must be maintained:

(1) When a worker is accessing the outside phase of a structure, from the outside, the distance between the worker envelope, and any part of grounded equipment, must be greater than or equal to the minimum electrical approach distance.

Distance between the worker envelope and uninsulated truck and boom components. This must be greater than or equal to the minimum electrical approach distance
Worker envelope = 4 foot radius.
Greater than or equal to the minimum electrical approach distance

Insulated Boom - Worker positioned at Outside of Phase.

(2) When a worker is accessing an energized conductor in an aerial device from the inside or between phases the distance must be greater than or equal to the minimum approach distance and the distances must be greater than or equal to the minimum electrical approach distance. The worker envelope is an 8 foot diameter sphere around the worker in the bucket or platform.

(3) For work on the energized terminal end of a bushing, on equipment with a phase-to-phase Voltage of less than 200 kilovolts, the support platform must be positioned so that none of the Bushing insulation is shunted and the minimum distances to grounded parts and other phases are not violated. For work on the energized terminal of a bushing, on equipment with a phase-to-phase voltage of 200 kilovolts or more, the support platform must be positioned so that no more than 10 percent of the bushing insulation is shunted and the minimum distances to grounded parts and other phases are not violated.

Distance between the worker envelope and uninsulated truck and boom components. This must be greater than or equal to the minimum electrical approach distance.

Worker envelope = 4 foot radius.

Greater than or equal to the minimum electrical approach distance.
Greater than or equal to the minimum electrical approach distance.
Total minimum electrical approach distance with worker in the envelope. This must be greater than or equal to 2E plus the minimum electrical approach distance.

Insulated Boom - Worker positioned at Inside of Phase
Insulated Ladders. Insulated ladders may be used as personnel support for live-line maintenance using the bare hand technique on energized conductors and equipment with a phase-to-phase voltage rating of 115 kilovolts and above, provided minimum distances specified in appendix D are maintained. Only ladder sections made of FRP shall be used as insulated ladders in live-line maintenance using the bare hand technique.

Preoperative Tests. Insulated ladders shall be tested for leakage current at the beginning of the day, each time a higher voltage is to be worked, and when additional tests are needed. A fused and protected micro. Ammeter shall be used for testing the dielectric current through the ladder legs with each leg bonded together at the metering point. If the measured dielectric ladder-current, after one minute, is less than 1/3 microamperes for each kilovolt of nominal phase-to-ground voltage (refer to table below, rounded up to the nearest 10µA), the insulated ladder may be used for bare hand work. Written records of these tests shall be kept with the equipment. Live-line maintenance shall be suspended if there is an indication of a malfunction in the equipment.

Minimum Approach Distances. If the structure does not have the minimum total approach distance required by the following, the line must be worked by the hot-stick method or worked de-energized. The insulated ladder shall be secured and positioned to provide (at least) the minimum phase-to-ground distance specified in appendix D plus a worker envelope that allows for the worker. This distance varies and is dependent on the access procedure performed. This distance has been defined for the following cases:

(1) A worker and insulated ladder is to be swung or hoisted into the inside position of an energized conductor or piece of equipment When employing this procedure, the worker must move out on the ladder to the minimum electrical approach distance **plus 1.2 meters (4 feet),** prior to the ladder being hoisted into the work position. The worker must remain at this location on the ladder until after the ladder is hoisted or swung the minimum electrical approach distance away from the energized conductor or piece of equipment.

(2) A worker and insulated ladder is to be swung or hoisted into the outside position of an energized conductor or piece of equipment. When employing this procedure, the worker must maintain the minimum phase to ground distance prior to the ladder being hoisted or swung into the work position. The worker must remain at this location on the ladder until after the ladder is hoisted or swung the minimum electrical approach distance away from the energized conductor or piece of equipment.

Acceptable Dielectric Current (µA)
Voltage (kV) Voltage (kV) for Insulated Ladders
Phase-to-Phase Phase-to-Ground µ = 10-6
72.6 - 121 67 less than 30
138 - 145 80 less than 30
161 - 169 93 less than 40
230 - 242 133 less than 50
345 - 362 200 less than 70
500 - 550 318 less than 110

Scope: This volume provides the scope and procedures for live line insulator washing in EHV transmission line and sub-stations of OPTCL in the state of Odisha AS BELOW,

Transmission **Lines:** Washing of all insulator strings, fittings and associated hardware on energized EHV lines.

Sub-**stations:** Washing of busbar insulators, equipment bushings, post insulators, and gantry insulators at specified voltage levels.

Experience**:** Minimum 3 years documented experience in live-line insulator washing at ≥220 kV.

Certification**:** Personnel certified in hot-line/live-line maintenance (hot-stick/wet-washing method) from a recognized training institute such as NPTI/authorized OEM.

Equipment & Technology

- **Insulator Washing System:**
  - High-pressure water jet system with adjustable pressure 7–10 kg/cm² (or as recommended by OEM).
  - Electrically insulated telescopic boom or hot-stick arrangement rated for the highest system voltage plus 20 % safety margin.
  - Non-conductive hoses meeting ASTM D149 or IS equivalent dielectric strength (>400 kV/m).
- **Water Quality:**
  - Conductivity ≤50 µS/cm (preferably ≤30 µS/cm).
  - pH 6.5–7.5; free from suspended solids and contaminants.
  - Continuous online conductivity monitoring and auto-shut feature.
- **Support Vehicles/Platform:**
  - Insulated aerial lift truck meeting IS 17742/IEC 61057 or equivalent.
  - Emergency grounding and earthing kits.

Safety Provisions

- Work to be carried out strictly under Permit-to-Work & Line Clearance procedures.
- Real-time communication with Sub-Load Despatch Centre (SLDC/Control room).
- Minimum approach distances as per CEA Safety Regulations/IS 5613 Part II.
- Full PPE: Arc-rated clothing, insulated gloves (IS 4770), face shield, fall-arrest harness, dielectric boots.
- Site-specific risk assessment and Job Safety Analysis (JSA) before commencement.

Execution & Methodology

- Pre-inspection of line/sub-station, identification of insulator strings, and pollution severity mapping.
- Live-line washing using ultra-pure demineralized water at prescribed pressure and angle to avoid mechanical stress.
- Sequential washing from top to bottom to prevent contamination run-off.
- Recording of washing parameters: water conductivity, pressure, ambient temperature, humidity, wind speed.

Testing & Acceptance

- Post-washing visual and thermal inspection (IR camera) to detect hotspots or partial discharge.
- Insulation resistance/ leakage current checks where practicable.
- Submission of washing logbook, water quality certificates, and photographic documentation.

Safety and Operational Guideline Cum Rule to be followed during execution of live (Hot) line maintenance work:-

- Electric shock or arc-flash injury to Contractor personnel.

Mitigation: Strict adherence to live-line work procedures, use of personal protective equipment (PPE) including insulating gloves, sleeves, helmets, and flame-retardant clothing.

- Human error due to fatigue or miscommunication.

Mitigation: Restrict live-line work duration, ensure job briefing and "**permit-to-work" system**, and deploy experienced, trained personnel only by the contractor.

- Weather-related hazards (rain, lightning, high wind, humidity).

Mitigation: **Suspend live-line activity during adverse weather**; verify surface dryness and safe atmospheric conditions.

- Inadequate coordination with Load Despatch Centre (SLDC).

Mitigation: **Mandatory intimation and clearance from SLDC** prior to work; establish radio/telephonic contact during operation.

- Interference with existing relay or protection systems.

Mitigation: **Disable auto-reclosure and coordinate with protection engineers** before commencing live work

- Non-availability or deterioration of hot-line tools (fiberglass sticks, insulated platforms, aerial lifts, etc.).

Mitigation: Maintain inventory and calibration register; periodic inspection and replacement schedule. This will be ensured by the Contractor and supervised by OPTCL engineer.

- Transportation and accessibility issues at remote tower locations.

Mitigation: Advance site survey and logistics planning. Coordination between OPTCL & Contractor personnel will be ensured.

- Accidental contact of tools or personnel with trees, nearby buildings, or communication lines.

Mitigation: Maintain right-of-way clearance, barricade working area, and deploy safety observers. To be ensured by OPTCL & Contractor before commencement of work.