
	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

DOCUMENT CONTROL


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	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

Amendment Details:

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1	1	0	01.12.2021	First Issue	Shilajit Ray Satish Shah	Snehal Shah Abdulrashid Shaikh
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	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

1. PURPOSE

- 1.1. HT Cable Fault Location, Tracing and Testing Work

2. SCOPE OF DOCUMENT

- 2.1. The scope of this document is to define a structured activity-level flow for HT Cable Fault Location, Tracing and Testing Work
- 2.2. The process document aims to define the guidelines to ensure the process effectiveness as required by the Integrated Management System whenever implemented.

3. FIELD OF APPLICATION

- 3.1. This procedure is used for HT Cable Fault Location, Tracing and Testing Work in TPL-D's franchisee areas of Bhiwandi & SMK.

4. FREQUENCY

- 4.1. As and when required

5. AUTHORITIES AND RESPONSIBILITY

- 5.1. The Head of Distribution is responsible for implementation of this procedure for effectiveness.
- 5.2. The Head of HT O&M/Projects at respective locations are responsible for execution of this procedure for effectiveness.

6. REFERENCES

- 6.1. OEM Manual


7. SPECIFIC COMPETENCY REQUIREMENTS

- 7.1. Technician/GET/Jr.Exe/Exe/AM/M should have Knowledge of
 - (1) Operation of Feeders, Power Transformers, DTCs, Switchgears & Substation/switching station equipment
 - (2) Safe working practices and use of PPE
- 7.2. Technician/GET/Jr.Exe/Exe/AM/M having valid authorization from General Manager Distribution shall have authority for electrical isolation and issue of PTW
- 7.3. As per competency profile and assessment.

8. INTERFACE WITH OTHER DEPARTMENTS/SECTIONS, IF ANY

- 8.1. Control Room/NPC for Outage/Switching Information
- 8.2. Safety Department for information of work execution
- 8.3. Drawing department for Network Updation
- 8.4. Admin Department for vehicle management

9. TOOLS AND TACKLES

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

- 9.1. Cable fault locating van / equipment with accessories as applicable
- 9.2. Cable route tracing equipment / kit with accessories as applicable
- 9.3. Cable pressure test instrument kit/cable testing van as applicable
- 9.4. Megger as applicable
- 9.5. Multimeter
- 9.6. Earthing leads and testing rod for switchgear.
- 9.7. Portable extensions switch board
- 9.8. Live line detector and Discharge rod
- 9.9. Test lamp

10. PERSONAL PROTECTIVE EQUIPMENTS / SAFETY TOOLS

Following PPEs shall be used to carry out work at site.

- 10.1. Safety shoes/ Gum Boot
- 10.2. Safety Helmets /full mask Helmet
- 10.3. Safety Gloves of 22KV class
- 10.4. Barricading tape (if required)
- 10.5. Caution board / “Men at work” sign board (if required)
- 10.6. Barricading cone (if required)


11. SIGNIFICANT RISK PARAMETERS

- 11.1. Quality Management System : Low
- 11.2. Impact on Environment: High
- 11.3. Health and Safety Risk : High
- 11.4. Energy Management : Medium
- 11.5. Asset Management Risk : Medium

12. PROCEDURE

12.1. JOB PREPARATION

- (1) Identification of the purpose for the HT Cable Pressure test / location / route tracing.
- (2) Transportation of equipment (cable pressure testing kit / cable route tracing kit /cable testing van) to site.
- (3) Collecting switching details from Control room / concerned department
- (4) Verify temporary switching with updated SDB from control room
- (5) Prepare temporary switching and inform to control room for cable route tracing

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021


- (6) Ensure SDB page available at site.
- (7) Study and keep the required cable route drawings/GIS drawings for cable fault localization.
- (8) Ensure availability and good condition of all required tools, tackles, PPE's, and equipment's required to execute the job.

12.2. PRECAUTIONS

- (1) Use all required PPEs during execution of the job.
- (2) At each location where isolation has been carried out and in which provision is there for pad locking, provide LOTO / Padlock, Put the NTC Sticker and mention the details as under.
- (3) Keep NTC tag and mention the details as under
 - (a) Reason for Isolation.
 - (b) Date and Time of Isolation.
 - (c) Isolation carried out by Engineer Name/ Sign of Engineer/ Contact Number.
- (4) Wherever the work is to be carried out in the above isolated system/ part of the system, then LOTO / Padlock is to be provided on all its isolated ends.
- (5) If isolation is already done, then verify at all isolation points along with tag as per switching with following information.
 - (a) Engineer name and sign
 - (b) Reason for Isolation.
 - (c) Date and Time of Isolation.
- (6) After isolation, ensure zero potential on equipment where work is to be carried out using suitable device (like HV line detector/ Earth Discharge Rod.)
- (7) Use insulated hand gloves of HV class if following activities to be carried out
 - (a) Use of live line detector
 - (b) Local Earthing.
 - (c) Connecting / removing / changing cable probe or shorting leads on cable under test.
 - (d) Working with live MSP/FSP.


12.3. ISOLATION

- (1) For isolation equipment from the system follows the procedure as per OCP No: TPDF02-DIS01-OCP-005 for Distribution Network Isolation and Normalisation as per the switching requirement.
- (2) Authorised person issue "Permit to work" as applicable to competent person after required isolation and local earthing.


	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

12.4. WORK PROCEDURE


- (1) Provide barricading and caution board across lowered cable termination
- (2) Use Live Line Detector and Discharge rod to ensure positive isolation
- (3) Prepare the Fault Locating / cable testing Instrument.
- (4) Wear safety gloves & provide the power supply to the instrument (Cable Fault Van / cable testing kit) from FSP/MSP/switch board/DG set .
- (5) Remove Cable Earthing
 - (a) After connection Move the isolator of both end of the section from 'Earth' position to 'OFF' position or Open the cable if require
 - (b) If through circuit side/cable box bus-bar in breaker panel / Cable Box, remove the shorting link.
 - (c) If shorting is done on outdoor HT cable termination, remove the same at above respective location.
- (6) Connect the H.T. Lead to one of the phase of testing rods OR Cable cores.
- (7) Earth the two other phases/cores by shorting to earth using short link
- (8) 'Test' the first core by providing required test voltage 16 to 18 kV DC voltage for approx. 1 minute
- (9) If instrument 'Trip', then particular phase/core has Fault, Similarly 'Test' remaining two cores.
- (10) If instrument does not 'Trip', then,
 - (a) Check the leakage current value.(it should be in mA and steady)
 - (b) Similarly 'Test' other two cores.
 - (c) While changing (testing) other core, first switch off HT, then discharge all cores with discharge rod with wearing safety gloves of 22 KV class.
- (11) If all three cores/phases are healthy:
 - (a) First switch off HT then Main Supply of the testing equipment.
 - (b) Wear safety gloves & remove the power supply to the instrument from FSP/MSP/switch board/DG set
 - (c) Discharge all cores with discharge rod with wearing safety gloves
 - (d) Remove all connections.
- (12) On completion of cable pressure work disconnect the cable under test connected with cable fault van / cable fault testing equipment.
- (13) Cable fault location with cable fault van if required
 - (a) Prepare the cable fault locating van ready for fault location

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021


- (b) Depute one person to remain present at far end location where cable end is lowered
- (c) If test terminal available “Earth” faulty cable at test point & connect cable in test terminal and do not “Earth” faulty cable at far end during test
- (d) Follow the test procedure of the testing van / cable fault testing equipment to test / locate the cable fault
- (e) Give earth connection to Cable Fault Van
 - I. To do so, connect the protective earth connection using the earth lead supplied to substation earthing. (Note that earthing clamp should only be attached to clean metallic points of contact. Earthing only via the safety earth of the mains power supply is not sufficient.)
 - II. Connect the auxiliary earth connection to a ground rod (earth spike) as close as possible to the cable fault van with connecting cable supplied for the same. Only when the AC mains connection is not plugged in, the cable fault locating system is completely turned off
- (f) The moment that the AC supply is plugged into a power supply, the system will be in standby mode (In built safety feature is given Cable fault Van). Ensured that No button is lit yet
- (g) To start the system, push WHITE BUTTON given on operating panel desk (which will glow after pressing it)
- (h) The control and safety circuits are then activated
- (i) Testing procedure
 - I. Under Test Mode: System offers the possibility of an insulation resistance test
 - II. Select “Insulation Test 05 KV” and Select operating mode “Testing” in main menu.
 - III. Activate field “HV ON”.
 - IV. Within 5 sec Press GREEN BUTTON.
 - V. If the phase is healthy, screen will display “time stopped, no breakdown occurred”.
 - VI. Read insulation resistance value. In case of healthy phase the value will come in M Ohm.
 - VII. If a breakdown occurs during the test with timer turned on, the unit will shutoff and ground the cable over a discharge resistor and the breakdown voltage will be displayed on the screen.
 - VIII. Turn Off with the field “HV-Off” or by the pushing RED BUTTON.
 - IX. Discharge each core after carrying out insulation test to discharge any stored energy during insulation test carried out on the cable.

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

- X. Carryout insulation test of cable for each core to identify type of fault as well as which core/cores is/ are got faulty
- (j) Operating Procedure for DC Hipot
- I. Light in GREEN BUTTON on
 - II. Select the range for breakdown Select “breakdown recognition” in main menu
 - III. Activate field “HV-ON
 - IV. Within 5 sec. Push GREEN BUTTON
 - V. Select maximum voltage
 - VI. Press the rotary selector switch to start test, voltage will start rising
 - VII. If a breakdown occurs, the breakdown voltage is shown in the screen
 - VIII. The information line at the bottom of display will show “breakdown has occurred”
 - IX. The unit will turn off the high voltage and ground the test cable over a discharge resistor
 - X. If no breakdown occurs the high voltage remains on, and then turns off with the field “HV–Off” or by pushing the RED BUTTON. This indicates that core gets open
- (k) Fault Pre-locating
- I. Pre locating Mode ARM (Arc Reflection Method)
 - i. The Arm method requires a TDR (Time Domain Reflectometer) to be connected
 - ii. Selecting this mode will internally connect the ARM filter and surge generator
 - iii. Connect the signal connection of TDR to the connection for ARM and the TDR trigger connection to the ARM Trigger
 - iv. Releasing a “Single Shot” will discharge the surge capacitor of the system via an inductive filter into the faulty cable
 - v. Surge operation can cause sudden noise levels.
 - vi. The surge operation creates ozone. It is necessary to operate the instrument under well ventilated condition to keep ozone levels below limit values for the operator
 - vii. Surge impulse is to be given to each core of faulty cable to know about type of breakdown (i.e. open circuit/ short circuit and identifying which phase /phases)
 - II. Operating Procedure:

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

- i. Connect the test leads as recommended on each phase of cable one by one
 - ii. Out of two cores of test lead one core is to be connected on cable termination & other core is to be connected on common earth terminal made at above location
 - iii. Inject the test signal (surge pulse) as recommended in each phase for reference graph
 - iv.
 - v. Time Domain Reflector will send a low energy signal through the cable causing no insulation degradation
 - vi. If cable found faulty then system switch to fault reference mode. Then inject voltage greater than breakdown voltage.
 - vii. The signal will be reflected from the point of fault & on screen it will give approximate fault distance reading.
 - viii. Check the end Pick & open pick in the computer screen
 - ix. By this check and decide which phase/phases are got faulty at approximately what distance from the point of location referring the drawing sheets
 - x. Above location is to be verified at site with drawing sheet whether any excavation work is being done at said location
- III. Pin Pointing: There is sound field method is being used for pin pointing the location. Operating Procedure is as below
 - i. Light in GREEN BUTTON
 - ii. Select “Pinpointing” in Main Menu
 - iii. Activate Field “Acoustic”
 - iv. After selecting the desired voltage range from above menu
 - v. Activate Field “HV-ON”
 - vi. Within 5 seconds Push GREEN BUTTON
 - vii. Select Max. Voltage
 - viii. By selecting “Single shot” only one single pulse will be released
 - ix. In timing mode. After the “Timer On” has been activated, another field appears. Here a pulse rate ranging from 3 sec to 10 seconds can be selected
 - x. With Digi phone instrument, at the pin point location thumping sound to be checked nearby the pin point location & earmarked the exact location where maximum intensity of sound can be

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021


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- xi. During pin pointing, if engineer feels that discharge thumping surge impulse voltage to be raised / lowered, he / she should be in contact with technician who is at cable fault van for monitoring & assisting thumping process being carried out. Any instruction for increasing/decreasing the intensity of surge impulse is to be given by the authorized person (i.e. engineer) to the technician for necessary action for above thumping process at respective substation location from where cable fault is being located
- xii. After pin pointing Switch off the supply for Surge Generator. This will automatically discharge surge capacitance through established discharged path
- xiii. Discharge the stored energy through insulated earth discharge rod by connecting cable lead to earth connection after sometime (preferable after two minutes)
- xiv. In case of open circuit fault, from far end same above process is to be carried out to verify & confirming the pin pointed location of cable fault

IV. Burn Mode: Under this mode high energy output is being fed to faulty cable in case of high resistance or open circuit fault to alter the fault condition under control condition. Operating Procedure is as below

- i. Light in GREEN BUTTON
- ii. Select “Burning” in Main Menu
- iii. Activate Field “HV-ON”
- iv. Within 5 second push GREEN BUTTON
- v. Setting the voltage. Observe the output current
- vi. Set the desired output current via the voltage adjustment
- vii. Set Max. Current. (Default is at 30%)
- viii. After selecting the desired voltage range from above menu
- ix. 8 KV Rang: Max 750 mA (Current rang- 1000mA)
- x. 20 KV Range: Max 100 mA (Current Rang-100mA)
- xi. Turn off with the field “HV OFF” or by pushing the RED BUTTON
- xii. After burning the cable at fault location by above method, again pin pointing is to be done

(14) On completion of cable fault testing work, follow the recommended procedure of the SWGR to disconnect the cable under test connected with cable fault van / cable fault testing equipment If fault location has been identified then after verifying & confirming the same, excavation work is to be done on above location for exposing the cable. If Road opening permission is required, process for getting the permission from

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

respective authorities to be followed.

(15) If cable route tracing is required, follow the following procedure

- (a) Go to both ends of section and confirm that cable ends are in the 'Earth' position
- (b) Make connections of cable route tracer equipment to the Testing Rod/testing terminal / cable end termination and put the isolator in 'OFF' position
- (c) Confirm that the opposite end of the cable section is in the short and Earth condition
- (d) Start the cable route tracer instrument
- (e) Check the deflection of instrument at the Cable & confirm that instrument is working properly
- (f) Start travelling on the probable cable route as mentioned in the drawing OR approximate route of cable with receiver perpendicular to the cable route
- (g) Mark the points where deflection is maximum with noise by head phone and deflection on receiver
- (h) Mark such points at approximately 50 meters distance along the route of cable
- (i) After tracing work is completed, remove the leads of the instrument & testing road

12.5. RESTORATION (IF REQUIRED)

- (1) Take clearance from concerned person and Cancel "Permit to work"
- (2) Shift all the manpower and tools and tackles from the site.
- (3) Remove excess material & scrap from the job area.
- (4) For normalisation of above switching follow the procedure as per OCP No: TPDF02-DIS01-OCP-005 for Distribution Network Isolation and Normalisation.
- (5) Inform Control room regarding normalisation of section.
- (6) Remove the temporary switching from the control room giving all relevant details

12.6. WORK CHECKLIST

- (1) Not Applicable


12.7. UPDATION

- (1) Update in GIS / SAP, if applicable.

13. IMPACT ANALYSIS OF SIGNIFICANT RISKS

13.1. QUALITY MANAGEMENT SYSTEM


- (1) Details of Quality Issues involved
 - (a) Improper Handling of Instruments

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

- (2) Details of Quality Assurance plan
 - (a) Work Quality/OCP/On Job Training to Operator
 - (b) Effective supervision at time of testing

13.2. HEALTH AND SAFETY

- (1) Details of Health and Safety Hazard involved
 - (a) Pick-axe on live cable
 - (b) Contact with sharp edges
 - (c) Hit by Excavation tool
 - (d) Accident to public due to working without Area barricading
 - (e) Penetration of dust particles in eyes during excavation
 - (f) Working in bending position / Awkward Posture
 - (g) Excessive work load
 - (h) Ingress of polluted water in excavated pit
 - (i) Contact with Live terminal/ cable/ wire/ busbar
 - (j) Use of faulty Tools
 - (k) Negligence of use of safety PPEs / Non usage of PPEs/ Use of faulty PPEs
 - (l) Poor illumination
 - (m) Road/RCC breaking activity by JCB Machin or Road breaker - Exposure to continuous Hand-arm & full-body vibrations
 - (n) Road/RCC breaking activity by JCB Machin or Road breaker - Exposure to continuous Noise
- (2) Health and Safety Precautions required
 - (a) Follow the OCP
 - (b) Ensure the Interlocking & Gas/SF6 level
 - (c) During connection & reconnection use a Discharge Road for discharging
 - (d) Use an Emergency Switch during short circuits & fire
 - (e) Ensure the PPEs in healthy condition & use all required PPEs during execution of the job
 - (f) Barricade the working area by barricading tape.
 - (g) Ensure the Tools & Tackles in working condition
 - (h) Keep the fire extinguisher & First aid box ready within reachable limit for any exigency in cable fault locating van only.

	Torrent Power Ltd. – Distribution Franchise	Doc. No.: TPDF02-DIS01-OCP-002
	OCP - HT CABLE FAULT LOCATION, TRACING AND TESTING WORK	Rev. No. /Dt: 00 / 01.12.2021

- (i) Persons Awareness

13.3. ENVIRONMENT

- (1) Details of Environmental impact
 - (a) Resource Depletion
 - (b) Heat Radiation
 - (c) Air Pollution
 - (d) Land Contamination
- (2) Precautions to minimize Environmental impact
 - (a) Ensure PUC for vehicle
 - (b) Records the Vehicle's trip (Common monitoring)

13.4. ENERGY MANAGEMENT

- (1) Details of energy use involved
 - (a) Fuel Energy used for operation for Van
- (2) Precautions to minimise energy use
 - (a) Switch off the van when not in use

13.5. ASSET MANAGEMENT

- (1) Details of Asset related Risk
 - (a) NIL
- (2) Mitigation plan for asset related risks- NIL
 - (a) NIL

14. LIST OF ATTACHMENTS

Sr	Document /Record Description	Reference No.
1)	HV Cell Activity Checklist	TPDF02-DIS01-CHK-001-F05
2)	Permit To Work	TPDF02-SAQ02-OCP-005-F02

***** End of Procedure *****